TITLE:

BANKING SYSTEM RESILIENCE AND STABILITY: CONSTRUCTING A COMPOSITE INDICATOR FOR DEVELOPED COUNTRIES

AUTHORS:

PhD. Cristina Ruza, Faculty of Business and Economics, UNED, Spain.

PhD. Marta de la Cuesta, Faculty of Business and Economics, UNED, Spain.

PhD. Juan Diego Paredes, Faculty of Business and Economics, UNED, Spain.

Abstract:

The aim of this paper is to empirically appraise the health of banking systems by applying a new theoretical framework based on complex system theories. For doing so we propose a composite indicator for analysing the resilience and stability of banking systems for a group of advanced economies including the group of G7 countries, Spain and Portugal. The empirical results reveal quite different patterns in the aftermath of the financial crises. While some countries have improved its relative position within the ranking, we find others evolving just in the opposite direction. The main purpose of the indicator is not to make predictions of future banks' behaviour, but rather to use it as an early warning system for policymakers and supervisors in identifying signs of weakness, as well as a useful tool to identify the best practices.

Keywords: *resilience, financial stability, banking system, composite indicator, financial crises, macroprudential regulation.*

JEL category*: E44, G01, G20.*

Acknowledgements

I would like to convey special thanks to the University of Bangor, which hosts us as academic visitors and allows us to access to Bankscope Database.

1. Introduction

The idea that financial deepening generally stimulates economic growth dated back to Schumpeter (1911) a century ago. However, newer research conducted in the wake of the global financial crisis has gained currency, and they focus the attention on the limits upon which the financial system should continue expanding without threatening the entire system's sustainability. UNEP (2015:4) has recently stated "too much finance may actually harm economies" so there is a point until which economies may benefit from the positive effects of financial development, but we must be aware because further financial deepening contributions may diminish, or even turn negative (Sahay *et al*, 2015; Loayza *et al*, 2018).

The recent financial crisis has posed several questions about the effectiveness of microprudential regulation in isolation. We have learnt that traditional microprudential instruments to fight against financial shocks were not enough in a context of globalisation and highly interconnected banking systems (Yellen, 2014). A plausible explanation is that complex systems cannot be understood simply as the sum of their parts (Holling, 1973). The neoclassical economic framework stills considers each banking institution as the unit of analysis, and so microprudential regulations have been tailored to safeguarding solvency by ensuring that each banking institution is safe and sound in itself. As stated by Cecchetti and Tucker (2016) it is not each institution's capital ratio what defines the overall health of the banking system, but a set of varied dimensions that influence the overall banking system resilience.

A new framework has enter the playground and a growing number of advocates are devoting efforts to appraise the health of banking systems by considering not only the ability of individual banks to withstand shocks (resilience), but the system's tendency to generate shocks in the first place, and its ability to adapt and evolve in response to them within a stable domain (financial stability).

In this paper we try to identify the theoretical factors that influence the resilience and stability of banking systems, and we apply composite indicator techniques for obtaining a measure of banking system's health for the most salient banking

systems covering the period 2004-2015.

This paper is organised as follows. The next section reviews the theoretical arguments underlying resilience and stability objectives from the perspective of complex systems theories. The third section provides details of the sample, variables and methodological issues. Empirical results are presented in the fourth section. The paper ends with a section of conclusions, and some recommendations for policy makers and supervisors are provided.

2. Resilience and stability: a new approach to complex banking systems.

The concept of resilience was firstly introduced in the studies of ecologic systems in the 70s as a movement towards the complex systems theory (Walker and Cooper, 2011). The seminal work in which the concept of resilience was firstly introduced was Holling (1973). He initially defined resilience as "*the ability of the system to absorb shocks in the state of the variables and afterwards return to the initial state of equilibrium prior to the change*". However, over time resilience studies have evolved and focused on the conditions that lie beyond a steady state of equilibrium. Those conditions are capable of moving the system towards a different point of equilibrium (Holling and Gunderson, 2002: 27-28). Therefore, stability and resilience are complementary targets when analysing complex systems because a system should be able to both respond to a shock and afterwards move to a new state of equilibrium as part of an evolutionary process.

Regarding the banking system, in order to capture all the dynamics that govern complex systems we should considered the aggregated system rather than individually analysing each institution. Following Matteucci and Buzai (1998), we cannot think of simple aggregation because the whole system is more than the sum of their parts.

Cecchetti and Tucker (2016: 10) stated that a standard of resilience is at the core of financial stability because "the financial system as a whole should be 'sufficiently' resilient to ensure that the core services of payments, credit supply, and risk transfer and pooling can be sustained in the face of large shocks".
Caruana (2012: 2) argues that "financial stability is about resilience and (…) we need to have reliable buffers in the system that will prevent macroeconomic

surprises or problems at a specific institution or market, from disrupting the broader financial system".

Going further, Bakir (2016) points out that financial stability (instability) was more likely when interactions among structural and institutional complementarities and agents reinforced one another for conservative (opportunistic) banking behaviour.

In recent years a vast number of academic studies have devoted efforts to appraise systemic risk in financial systems, however no conclusive results have been obtained yet. Banque du France (2013) proposed some indicators like the distance to default, banking stability indicators and marginal expected shortfalls, while Holló and Kremer (2012) proposed a composite indicator of systemic stress in the financial system, but they recognised that this indicator only provide a very rough, stylised and highly imperfect view on the state of instability. One reason is that sources of global risks have evolved in the wake of recent financial innovations, as it has been proved with the advent of the great financial crisis[1]. The Duisemberg School of Finance (2015) conceive a wide taxonomy of non-traditional sources of global risks that can cause a disruption of the financial system, and distinguishes two components of financial resilience; structural and behavioural. They identify the types of financial systems that tend to be more stable; those with institutions less complex and with non-opaque interconectedness, doing traditional-boring banking, of medium size (not "too big to fail"), with funding structures not dependant on wholesale funding sources, and with low levels of concentration and competition. UNEP (2015) emphasised the role played by the size of the financial system (related to the size of the economy), and the environment in which financial institutions operate (business models more or less market-oriented, diversity of players, concentration, complexity, transparency and the role of the public sector, among others).

A step forward in the literature is the use of complex ecosystems models for rethinking the highly integrated dynamics of risk in modern financial markets. These have started to be applied by main policy makers in OECD countries. Kambhu *et al* (2007) recognise that systemic risks threatening banking system bear a strong resemblance to the dynamic of existing complex adaptive systems

[1] Alcidi (2011).

in the real world. This new vision started to take shape and some studies have explored how to unify disciplines and include relationships that govern complex system to the analysis of banking institutions and the special nature of financial systems exposed to systemic risks (Haldane and May, 2011). The seminal work of Gai (2013) states that financial systems in general, and banking system in particular, behave like complex adaptive systems and shows how lessons from network disciplines - such as ecology, epidemiology, and statistical mechanics - shed light on our understanding of systemic risks.

Table 1 summarises the main literature review of recent studies about resilience and its measurement as a new and promising field of research.

AUTHOR(S), YEAR	OBJECTIVE	SAMPLE	PERIOD	METHODS	KEY FINDINGS
Bakir (2016)	He analyses how interactions among interdependent structures, institutions, and agents inform about financial stability.	Australian case study. He uses "purposeful sampling" in choosing its interviewees and he also uses written primary and secondary sources.		He applies an interpretive approach.	Of the G-20 nations, only two have not had an extended financial crisis; Australia and Canada, and they share several striking similarities which set them apart from the U.S. and the U.K .
Anand *et al* (2013)	They estimate an econometric model of financial system resilience.	Accounts data for the U.K. banks, and BankScope. They define a network consisting of 17 domestic banks, 240 overseas banks, and 50,000 firms.	2007	A network model is defined and the calibration uses the principle of maximum entropy to estimate the empirical distributions of exposures.	They include the role of macroeconomic fluctuations, asset market liquidity, and network structures for determining aggregate losses in a stylised financial system. The outcomes of the model seem to be broadly plausible when compared to empirical evidence.
New Economics Foundation (2015)	They construct a composite indicator of financial system resilience.	Canada, France, Germany, Italy, Japan, the U.K., the U.S.	2005-2012	They equally weigh seven variables related to diversity, interconnectedness, financial system size, asset and liability composition, complexity and leverage.	The ranking of countries from more to less resilient in 2012 are the following: 1º) Germany, 2º) Japan, 3º) France, 4º) Italy, 5º) Canada, 6º) U.S. and 7º) U.K.
IMF (2016a)	They assess financial system stability and resilience.	Morocco	2014-2017	Stress tests; top-down (TD) and bottom-up (BU) exercises based on macroeconomic scenarios and sensitivity analyses.	A two-level framework is proposed: a) Risk assessment of bank capitalisation, bank profitability, non-performing loans, funding sources, total large exposures, and b) stress testing of solvency, liquidity and contagion and concentration risks.
Bui *et al* (2016)	They estimate the ultimate effect of an increase of bank capital buffers in enhancing financial system resilience.	Australia	1981-2014 2002-2014	Regression analysis of the determinants of individual bank's future loss rates. Simulation analysis of loan losses over 3 years.	Australian bank loss rates are positively related to past loss rates, lagged loan growth, and are negatively related to the GDP growth, deposit ratio, and bank size.
Cecchetti and Tucker (2016)	They proposed a standard measure of resilience by			The measure of resilience has two	They compute an approximation of resilience (p,s) as a joint function of

	reassessing the impact of finance on growth.			factors: the probability of crises occurrence (p) and the severity of the crises itself (s).	capital adequacy, liquidity and maturity transformation in the simplest representation.
Brida *et al* (2016)	They analyse the interconnectedness of stock market networks during the crises episode, and propose a hierarchical organization of the Euro Stoxx market.	Euro Stoxx market.	2002-2014	Multidimensional generalisation of the minimal spanning tree methodology.	At the time of the financial crisis (2008) the network becomes a more centralized one. During the period 2008–2014 hierarchy becomes more country-specific, including within the same sub-cluster countries like France, Germany, Italy and Spain.
Selmier (2016)	They discern design principles and derive the necessary design rules, which strengthen the financial environment and enhance financial resilience.	Australia, Brazil, Canada and China.	2003-2013	Macro-level comparison.	Policy-makers in Australia, Brazil, Canada and China struck an oligopolistic bargain with their domestic top banks, behind which national banks operate protected from foreign competition and threat of acquisition, and pursue lower risk banking business.
Aldasoro and Alves (2017)	They characterise the multi-layered structure of the network of large European banks, and propose measures of decomposition of global systemic importance into layer-specific contributions.	A unique dataset of anonymised bilateral interbank exposures between 53 large European banks.	End 2011	A multi-layer network (nodes can be present in all or a subset of the layers, and links can exist between different nodes in different or similar layers).	The results highlight that an institution's role in the channel of transmission is a key issue for determining the “global importance of such institution”. Their results indicate that the notion of importance may not be related to its traditionally studied core-periphery role.

Table 1: Literature review

Source: own elaboration.

Inspired by these studies and following Bakir (2013, 2016) we propose a theoretical framework of an agent-based model, which do not impose rationale "model consistent" expectations, thus it would allow to model complex interactions between heterogeneous agents (Giese *et al*, 2013). We have defined a comprehensive framework of resilience and stability because resilience is conceive as the capacity of a system, not to return to an initial point of equilibrium after a shock, but to evolve and move to a new state of equilibrium within a stability domain.

We have grouped the main determinants of resilience and stability into three different streams (Figure 1):

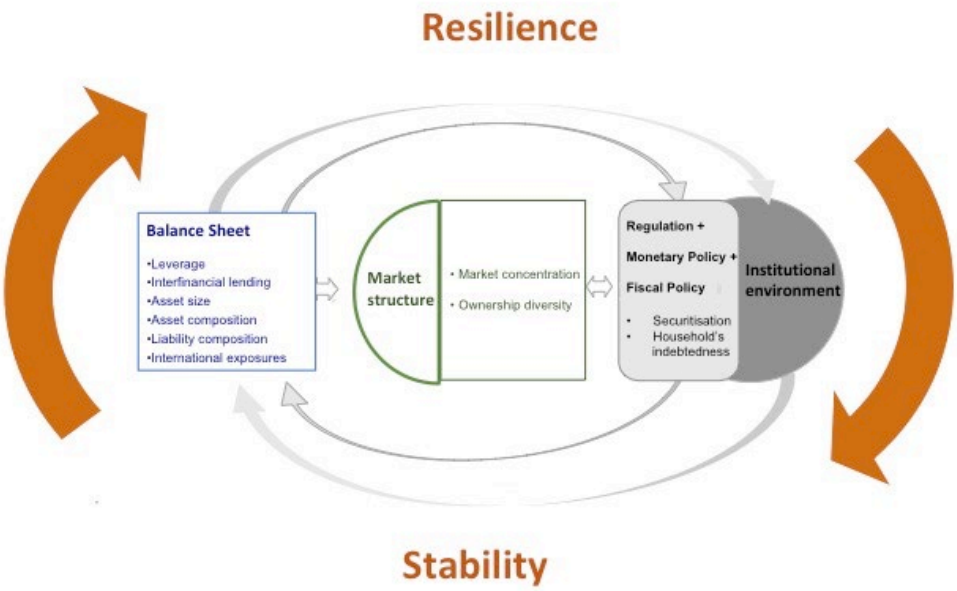

Figure 1: Theoretical framework

Source: Own elaboration.

The first level is based on banks' **balance sheet information**:

a) Leverage. It is widely accepted that higher bank's capital is associated with higher bank values and higher probabilities of surviving crises. However, the existing conflict of interest among shareholders and creditors will unleash an excess banking leverage over time (Admati *et al,* 2013; Basso and Costain, 2016). This is a clear indication of possible difficulties of recovery for a financial institution in the event of a crisis.

b) Interfinancial linkages. Acemoglu *et al* (2015) revealed that there is a certain point beyond which a high interconnected network will serve as a mechanism for shock's propagation rather than a firewall (Rochet and Tirole, 1996; Duisenberg School of Finance, 2015 and Brida *et al*, 2016). Interfinancial lending serves as a proxy of the degree of interconnectedness within the banking system.

c) Asset size. A new consensus seems to be emerging that expanding the size of banks is possitve up to a point, but further increases could endanger the whole system because of the systemically importance of any disturbance and its negative effects (Cecchetti and Kharroubi, 2012; Arcand *et al* 2015; UNEP, 2015, Loayza *et al*, 2018).

d) Asset composition is critical for assessing the overall level of bank's vulnerability. NEF (2015) consider the proportion of credit allocated by banks to the overall real sector as a proxy of the importance of banking core activities (traditional banking), which in turn are less risky for banks.

e) Liability composition. A high dependence on wholesale funding implies that a collapse of a large institution can have a domino or propagation effect that quickly spreads out across the system, and lead to a systemic collapse when confidence in the system disintegrates. Then, stable sources of funding would prevent fire sales situations (De Haas, 2012).

f) International exposure. Globalisation has turned the international banking system into systemically important, so long as a crisis will found no barrier that will impede the crisis to continue expanding elsewhere (Greenspan, 2010; IMF, 2015).

The second level of the theoretical framework is related to the structure of the market in which banks operate.

g) Market concentration. The recent M&A processes had lead to higher doses of concentration and larger institutions, some of which have deserved the consideration of systemically important and super-spreaders' of contagion effects due to the scale, interconnectedness and complex nature of their activities (Duisenberg School of Finance, 2015; Bank of England, 2015; UNEP, 2015).

h) Ownership diversity. The lower the diversity of players the higher the

probability of banks engaging in correlated risks, hence increasing the risk of several and simultaneous failures (Acharya and Yorulmazer, 2007, Liikanen, 2012, UNEP, 2015). In addition, 'rational herding hypothesis' (Alama and Tortosa-Ausina, 2011) refers to situations in which it is rational for agents to mimic the actions of others, even though such mimicry can potentially lead to aggregate outcomes that are suboptimal.

The third level considers the institutional environment and policies that influence banking behaviour, *i.e.* the regulatory framework, monetary and fiscal policies.

i) Securitisation: The popularity of the "originate-to-distribute" system of lending implied that loans had become another tradable financial asset' that in turn contributed to increase the pro-cyclicality of bank lending (UNEP, 2015; NEF, 2015). Basel III accord defined a regulatory capital charge for securitisation exposures to ensure that securitisations with higher-risk underlying exposures do qualify for an adequate capital.
j) The role played by monetary authorities by promoting environments of low interest rates were twofold from a resilience perspective. From one side, it stimulates economies' recovery after the recession, but it has also provoked perversely- induced banking institutions to expand credit beyond prudential criteria. In this context, households have incurred in excessive indebtedness, particularly in the segment of mortgage credits. Then the rhythm of households' indebtedness had rapidly expanded before the crises as an early-warning symptom of bank's fragility (Duisenberg School of Finance, 2015). Going further, fiscal policies have decisively influenced agents' incentives to get into debt (Estrada and Saurina, 2016). As an example we can cite some tax deductions applicable to housing purchases in most advanced economies.

As long as we are interested in macroprudential regulatory concerns, we have left aside the level of bank's capital, which is fixed by the microprudential regulation in force.

3. Methodology

To appraise the multidimensional nature of resilience and stability we propose a composite indicator (CI) that summarises the information of the main determinants previously identified. The purpose of the CI is not to make predictions about banks' behaviour, but rather to use it as a tool for appraising the overall health of the most salient banking systems.

The sample comprises the group of advanced economies like Canada, France, Germany, Italy, Japan, the U.K., the U.S., Spain and Portugal. The reason to choose this group of countries is to devise whether or not there are significant differences between the group of G7 and the two Southern European countries that received financial help from the EU (Spain and Portugal). In doing so we will be better able to assess the path of convergence between these two groups of countries with different levels of economic development. This attempt constitutes an advance regarding the previous work of NEF (2015) that only focuses the attention on the group of G7.

The period of analysis covers from 2004 up to 2015 due to data availability from official and homogeneous sources[2]. At the time of carrying out the empirical analysis we collected the more recent data available, that encompass both ex-ante and ex-post years of the great financial crisis. In that way we could assess the extent of the deterioration of the banking system's health, and how the process of recovery took place afterwards.

We normalise all variables by using the minimum-maximum method, taking into account the expected sign of each variable. This sign is defined according to theoretical expectations and recent empirical evidence. Table 2 summarises all the variables used in this study and their definitions.

[2] At the time of submitting this study Offices for National Statistics of Japan and Canada have not yet published data for 2015, and so the composite indicator are not calculated for these countries in that year.

Variable	Definition	Source	Comments
International exposure (InternExp)	Exposure of domestic systems to foreign claims.	Bank for International Settlements (BIS).	Total International Claims / GDP
Interfinancial linkages (InterfinLinks)	Financial activity among financial institutions in proportion to credit to the real sector.	Financial Accounts (Central Banks).	Loans received by financial institutions / Loans received by households and IPSFL
Bank's assets size (BkSize)	Size of the banking system relative to the country's size.	Statistics of the European Central Bank.	Total Assets of Monetary Financial Institutions/ GDP.
Asset composition (AssetComp)	Proportion of bank's assets financing real activities.	World Bank, World Development Indicators Database.	Domestic Credit to the Private Sector / Banks' Total Assets
Liability composition (LiabComp)	Broad non-core liabilities[3].	Country aggregated balance sheets from Bankscope.	Total liabilities (-) Equity (-) Reserves (-) Derivatives (-) Funds from customers / GDP
Market concentration (MkConcent)	Share of assets of the three largest commercial banks.	World Bank, Financial Development and Structure Database.	$\frac{\sum_{i=1}^{3} Top\ Bank'sAssets}{\sum_{i=1}^{n} Bank'sAssets}$
Ownership diversity (OwnDivers)	Michie and Oughton Diversity Index[4].	Federal Reserve Bank of St. Louis.	$CD_d = 1 - \sum_{i=1}^{3} \partial_i^2$
Leverage (Leverage)	Equity multiplier ratio.	OECD database.	Banks' Financial Assets/ Equity
Securitisation (Securitisat)	Size of securitisation exposures.	Securities Industry and Financial Markets Association (SIFMA) & Office for National Statistics (Canada and Japan).	Volume outstanding of securitisation / GDP
Household indebtedness (HHDebt)	Level of households' debt.	OECD database.	Households' debt / Gross Disposable Income

Table 2. Summary of variables

[3] In this study we follow the IMF definition proposed by Harutyunyan *et al* (2015) and Akdogan and Yildirim (2014).

[4] See Michie and Oughton (2013).

Source: own elaboration.

The choice of how to combine the variables is perhaps the most difficult aspect when constructing a CI. Among the various techniques, we have considered multiple factor analysis (MFA) and we have followed OECD (2008) guidelines for composite indicators, in particular methodological aspects regarding standardisation, weighting and aggregation processes.

The goal of MFA is to extract weighted linear combinations (factors) of a number of variables (Escofier and Pagès, 1994). The idea is that the first factor captures the higher variance of selected variables, while subsequent factors will be extracted in the same way taking into account the remaining variance. This technique has two main purposes: (i) to reduce the number of variables, and (ii) to detect the structure in the relationships between variables. This weighting scheme has been used in previous studies such as Sabatini (2009), García-Lautre and Abascal-Fernández (2004).

In our case we are dealing with a three-dimmensional dataset and we applied MFA to study tables, which include all the years of the sample corresponding to one variable across different countries[5]. The statistical software used for the analyses is FactoMineR (Lê *et al*., 2008).

MFA provides coordinates that indicate the relative importance of the tables in each of the dimensions. The weights of tables and the dimensions to be included into the CI are calculated from these coordinates (Nicoletti *et al.,* 2000). For each dimension (D), the weight of a table i (Ti) with a coordinate greater than 0.3 is obtained by dividing its squared coordinate by the sum of the squared coordinates of all the tables of the dimension. Equations (1), (2) and (3) summarise the procedure.

$$\forall i, (\mathrm{Coord}_{Ti\ Dk})^2 \text{ si } \mathrm{Coord}_{Ti} > 0.3 \qquad (1)$$

$$\forall k, \sum_{i=1}^{j} (\mathrm{Coord}_{Ti\ Dk})^2 \qquad (2)$$

$$w_{Ti\ Dk} = \frac{(\mathrm{Coord}_{Ti\ Dk})^2}{\sum_{i=1}^{j} (\mathrm{Coord}_{Ti\ Dk})^2} \qquad (3)$$

[5] Since we consider 10 variables, we have 10 tables, each one including the variables for the period 2004-2015

The CI proposed here balances both the contribution of all years considered in the sample and the variables included in the dimensions.

After constructing the CI we have tried to externally validate it with variables like the Z-score (convergence validity) or the non-performing loans (discriminant validity) by applying structural equations and panel data techniques. However we would need a larger sample of countries and a longer period of years to obtain some conclusive results.

Compared to NEF index (2015), we have refined the variables' definition, as for instance international exposure, interfinancial linkages, asset composition and liability composition. We have also tried different model specifications that include a more complete set of variables like; z-scores, non-performing loans' variability within a banking system, credit expansion, bank efficiency, house price index and indicators of regulatory quality. However, for the sake of simplicity we have reproduced here the simplest version that render better empirical results. Our methodology of MFA does not equally weight all the variables as NEF index does. MFA also permits us to select the more relevant variables for constructing our CI and to cluster the countries according to the different positions in a 3-D space. Lastly our index expands the time period covered and include some new countries.

4. Empirical results.

Table 3 shows the descriptive statistics of the main determinants of resilience and stability. Since all variables all normalised, their minimum value is 0 and their maximum value is 100. We observe that means are quite different among variables, while the value of the standard deviation ranges from 18.36 to 28.37. This narrow range has positive implications for the stability of the CI.

Variables	Mean	Standard deviation	Median
MkConcent	47.5	24.3	46.9
OwnDivers	45.3	27.7	55.6
InterfinLinks	67.8	28.9	77.5
InternExp	63.1	21.6	66.9

BkSize	76.9	18.4	79.2
HHDebt	40.6	21.8	35.6
AssetComp	32.2	24.7	25.9
LiabComp	65.2	25.3	74.2
Securitisat	70.1	28.4	75.1
Leverage	70.2	22.9	72.9

Table 3. Descriptive statistics

Source: own elaboration.

Table 4 shows the correlation matrix. The higher the correlation among variables the better the results of the MFA would be.

	Correlation Matrix								
	MkConcent	OwnDivers	InterfinLinks	InternExp	BkSize	HHDebt	AssetComp	LiabComp	Securitisat
MkConcent	**1**								
OwnDivers	0.45	**1**							
InterfinLinks	-0.49	-0.18	**1**						
InternExp	0.03	-0.57	0.22	**1**					
BkSize	-0.11	-0.19	0.56	0.62	**1**				
HHDebt	-0.21	0.27	0.38	-0.1	0.3	**1**			
AssetComp	-0.21	-0.5	0.28	0.62	0.6	-0.4	**1**		
LiabComp	-0.25	-0.46	0.31	0.64	0.77	0	0.71	**1**	**1**
Securitisat	-0.02	0.26	-0.04	-0.22	0.29	0.41	0.06	0.19	
Leverage	-0.12	-0.29	0.53	0.51	0.83	0.14	0.68	0.71	0.35

Table 4. Correlation matrix

Source: own elaboration.

Results of MFA are presented in panel A (Table 5). The first three components that we selected account for 79.08% of the variance. We appreciate that the first two components comprise more than a half of the cumulative variance (64.09%), while the third adds an additional 15% of variance. Following Nicoletti *et al* (2000) these components have eigenvalues greater than one, each component accounts for more than 10% of variance, and these three components account for more than 60% of the cumulative variance.

Panel A. MFA core results			
	D1	**D2**	**D3**
Eigenvalue	4.63	2.19	1.6
% of variance	43.47	20.61	15
Cumulative % of variance	43.47	64.09	79.08
Panel B. Coordinates of the tables			
	D1	**D2**	**D3**
OwnDivers	0.350	0.212	0.226
AssetComp	0.710	0.112	0.020
HHDebt	0.019	0.793	0.026
InternExp	0.620	0.184	0.032
InterfinLinks	0.331	0.207	0.204
Leverage	0.844	0.085	0.083
LiabComp	0.820	0.019	0.052
MkConcent	0.145	0.061	0.680
Securitisat	0.018	0.404	0.211
BkSize	0.770	0.117	0.062

Table 5. Results of the MFA

Source: own elaboration.

In Panel B (table 5) the coordinates of each variable are exhibited. If we look at coordinates with a value of 0.3 or higher, we appreciate that the first component covers seven variables, while the second includes two variables and the third component just considers one variable (green areas).

In dimension 1, “leverage” and “liability composition” present the highest coordinates. These two variables take into account the passive side of the balance sheet structure as a main area of concern. On a second level of importance there are: “asset composition” and “banking system’s size”, then “international exposure”, “ownership diversity” and “interfinancial linkages”.

In dimension 2 “household’s debt” is the most important variable, and this could be expected in a context characterised by a real state price bubble and poor risk controls of banks, followed by “securitisation”.

Dimension 3 informs about “market concentration”, and it mainly captures the singular case of Japan.

These results almost perfectly correspond to the theoretical streams previously defined: balance sheet information (D1), institutional environment (D2) and market structure (D3).

Once the score of each dimension is obtained, the CI will be calculated following equation 4, in which the weight of each dimension is obtained by dividing its sum of squared coordinates by the sum of the squared coordinates of all the three dimensions.

$$\text{Composite Indicator (CI)} = 0.67 * D1(c,t) + 0.2 * D2(c,t) + 0.13 * D3(c,t) \quad (4)$$

MFA also provides the country’s coordinates in each of the dimensions. The graphic representation allows us to locate countries in a 3-D space and identify different groups of countris attending to their relative distance to each other.

Figure 2 exhibits the country’s coordinates in a 3-D scatterplot where all dimensions considered in the analysis have been jointly represented. As it can be appreciated, Japan and the U.K. constitute particular cases within the sample, according to their isolated positions very distant from others. Another distinctive group is formed by Italy, Spain and Portugal, with similar positions in dimensions one and two, while the positions corresponding to France, Germany, the U.S. and Canada appear fairly close in dimensions one and three, respectively.

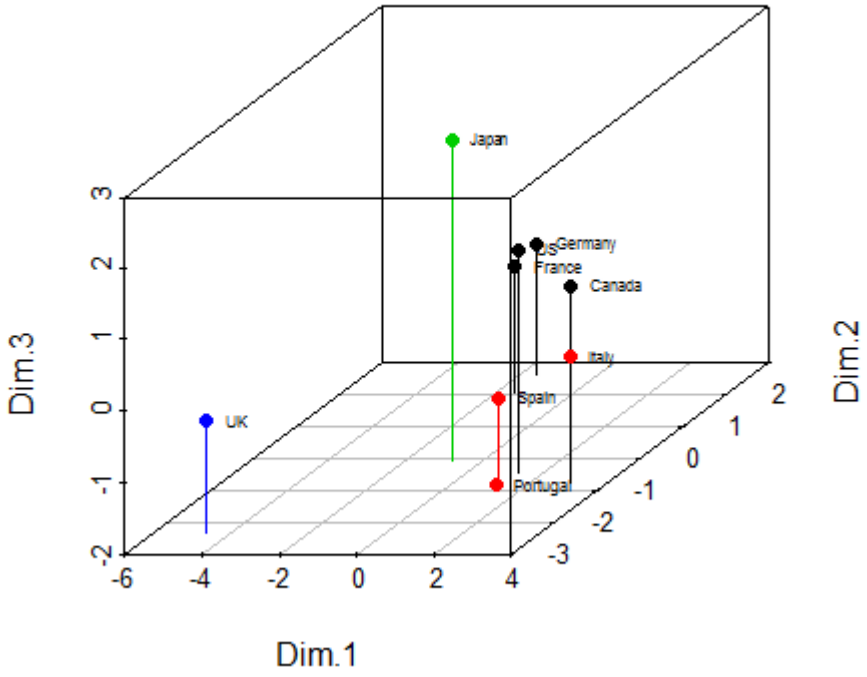

Figure 2. Country's Coordinates (colours should be used)

Source: own elaboration.

Next we will present the scores of the CI for the period 2004-2015. Since the values of the variables are normalised, the rank of values ranges from 0 when the system is not resilient to 100 when the system is fully resilient.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Canada	70.06	68.88	72.69	71.03	68.80	67.54	72.98	72.80	72.44	72.19	71.77	
France	65.54	60.25	55.80	51.98	49.33	48.82	49.11	50.20	50.76	52.74	53.68	53.98
Germany	57.86	58.96	55.34	52.97	51.90	51.01	50.99	53.28	53.80	56.71	57.48	59.43
Italy	72.92	71.09	69.91	66.66	61.76	61.90	59.43	55.17	55.78	59.90	62.04	61.27
Japan	61.61	63.66	63.08	62.87	61.07	62.48	62.62	62.70	63.76	63.14	61.79	
Portugal	58.43	56.57	55.87	55.28	52.63	50.09	48.22	49.04	50.70	52.72	55.39	54.70
Spain	62.91	64.69	63.05	58.68	54.79	55.70	54.70	57.78	55.86	58.83	60.09	59.49
U.S.	72.08	70.48	68.48	66.99	67.17	67.48	70.55	71.61	73.46	73.34	73.52	74.78
U.K.	40.18	37.05	29.41	22.68	15.23	19.15	21.62	24.68	28.84	33.53	38.02	42.88

Table 6: Composite Indicator of resilience and stability
Source: own elaboration.

According to our results, the U.K. banking system is an isolated case of study because its CI has registered a tendency of enlarging its distance from the rest of economies until the advent of the crises in 2008. In this year the U.K. registered a turning point at a 15% level of resilience. Afterwards, the U.K. entered into a convergence period towards the rest of developed countries, even though in 2015 it has not yet reached any of them.

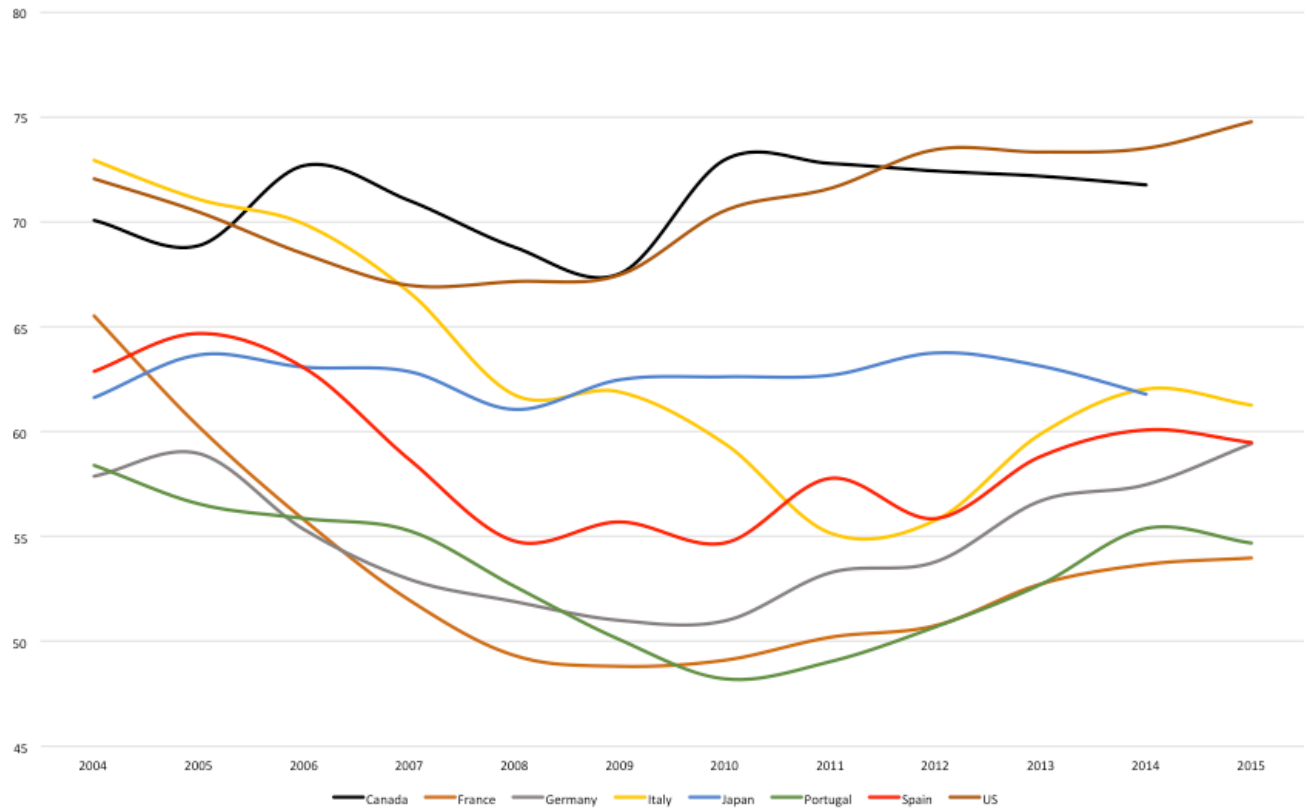

Figure 3: Composite indicator of resilience and stability*
Source: own elaboration.
* United Kingdom lies out from the range displayed in the graph.

We can see in Figure 3 (excluding the U.K.) different behaviour between the group formed by the U.S. and Canada, and the rest of banking systems analysed. Canada shows one of the most resilient banking systems, and it has been considered a paradigmatic case of study and a guide to be followed for improving resilience[6]. Indeed, during the harsh moments of the crisis Canada's CI remained at a level of 67%. Bakir (2016) stated that in contrast to the U.S. and the U.K.,

[6] Data for Canada in 2015 was not yet published by the time of this study.

Canadian banking system is rooted in the commercial banking model rather than the investment-banking model. Moreover, highly profitable domestic lending opportunities limited the incentives for excessive risk taking for major Canadian banks prior to the crisis (Bordo *et al*, 2011 and Knight, 2011). Banks had strong capital quality[7] and a pragmatic approach in state and market relations, rather than a dogmatic approach guided by neoliberal ideology (Min, 2010: 1, and Knott, 2012: 81). Market structures and conditions that limited competition and takeover threats and that supported high profits through conventional banking emerge as the major factors that explain Canadian conservatism (*ibid*: 286).

In the case of the U.S., the CI overpassed that of Canada in 2012, and by the end of 2015 it reached a level close to 75%. Some lessons should be extracted from these results because the U.S. was the country where the first piece of the domino had fallen down with the dramatic collapse in value of subprime mortgages, but it has also proved to be the stronger financial system in recovering after the crises.

Japan seems a country that remains unchanged in terms of the CI over the period analysed. Distinctive features of Japanese financial system are the almost inexistence of securitised assets and the pre-eminence of core business activities within the banking industry.

Among the European countries, we find in most cases a clear deterioration of resilience in the years previous to 2008, and different rhythms of recovery afterwards. Moreover, no significant differences can be appreciated between Spain and Portugal and the group of G7. According to our results, attention in Portugal should be paid to concentration levels within the banking system, and the need to foster diversity of players in the retail deposit market. In Spain the prevalence of banks within the financial system still strong, but there still an excess of capacity. Particularly remarkably has been the rationalisation of

[7] Tier one capital in Canada was in common shares and retained earnings.

banking system in Spain that has lead the saving banks to underwent a substantial consolidation and governance reforms from 2009 to 2012[8].

These results of the CI do not coincide with previous studies. In NEF (2015) Italy appeared as the most resilient country, and with a slight deterioration over the period analysed. According to our results, Italy has suffered a profound deterioration in terms of resilience and stability, which in turn is much more close to the real situation of the Italian banking system's health (profound structural reforms are still needed).

Regarding the rest of countries, in our study Canada seems to be a paradigmatic case to be followed. This outcome has been previously suggested by extensive number of studies (Bakir, 2013, 2016; Selmier, 2016), so our results are in line with them.

To conclude, lets emphasise that according to our results the recovery process of resilience-stability among the countries analysed inititates around 2011, while the U.S. has started its recovery some years earlier. One lesson that we might have learnt from the U.S. experience is the need of prompt actions in the aftermath of a shock. This is the case of the macroprudential toolkit developed and implemented by the Dodd-Frank Act (2010)[9] that points the direction towards which macroprudential regulation should evolve (Berner, 2015). According to Evans[10] (2017), when a shock hits the market, potential lenders tend to hoard liquidity, while from the other side those that need liquidity can't get enough. In those grounds policy actions should be directed at increasing public confidence in the ability of institutions to withstand financial shocks with no delay. Maybe the same recipe was used in the Europe, but not as soon as it would have been necessary.

5. Concluding remarks

Macroprudential policy aims to enhance the resilience of the financial system and to dampen systemic risks that spread through the system. However, none

8 See De la Cuesta *et al* (2015), Ruza *et al* (2016).

9 Wall Street Reform and Consumer Protection.

10 Federal Reserve Bank of Chicago

macroprudential tool will remove the financial system susceptibility to cyclicality and shocks, but they will improve the financial system's resistance to shocks, the capacity of recovery after the shock, and what is more important it will serve as an important signal for identifying and addressing a potential future crises before it is too late (Group of Thirty, 2010). Resilience and financial stability can be seen as complementary goals in the quest for improving the health of banking systems in an era full of new challenges.

In this work we have tried to analyse the health of banking systems in line with complex system theories and macroprudential concerns. To do that we have construted a CI that summarises into a single figure multi-dimensional factors of a group of advanced economies that would not be classified under the same variety of capitalism, the same region, or legal system. In this sense we go further other econometric approaches studies that, according to Selmier (2016) have tended to look for similarities in financial system structures, at different levels of development, and perhaps influenced by regional or cultural similarities. In addition, we have gone beyond NEF (2015) empirical attempt because we have defined an underlying theoretical model to explain the comprehensive framework that relates resilience and stability based on three streams. Our empirical results have identified three dimensions that almost perfectly correspond to the theoretical streams previously defined: balance sheet information (D1), and institutional environment (D2) and market structure (D3).

The CI for the group of countries considered reveal quite different patterns in the aftermath of the financial crisis. While some countries have improved its relative position within the ranking, we find others evolving just in the opposite direction.

We are aware that CI's methodology is not panacea and its main limitation is that CI is built up from underlying sub-indicators, which are weighted and valued. Then, some degree of researcher's subjectivity is involved in the choice of variables. Nevertheless, Giese *et al* (2013) have recommended that authorities should be able to make their action more predictable by relying on "presumptive indicators" that would help them to identify emerging threats to reilience in order to set and communicate policy actions.

We hope that the CI proposed in this study will serve as an early warning system for policy makers and supervisors in identifying signs of weakness, as well as a

useful tool to identify the best practices. We agree with Goodhart (2011) that when a number of indicators signal financial system vulnerabilities, the macroprudential authority might be required to either act on the signal or explain why it chooses not to.

Future lines of research will be the inclusion of new variables related to banking corporate behaviour and conduct risks, and the analysis of further connections among resilience, economic growth and income inequality, among others.

REFERENCES

1. Acemoglu, D.; Ozdaglar, A.; Tahbaz-Salehi, A. (2015), "Systemic risk and stability in financial networks", *American Economic Review*, nº 105 (2), p. 564-608.

2. Acharya, V. V.; Yorulmazer, T. (2007), "Too many to fail — an analysis of time-inconsistency in bank closure policies", *Journal of Financial Intermediation*, Vol. 16, nº 1, p. 1-31.

3. Admati, A.R.; DeMarzo, P.M.; Hellwig, M.F.; Pfeiderer, P. (2013*), The Leverage Ratchet Effect*, Working Paper Series, Max Planck Institute for Research on Collective Goods, available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2304969

4. Akdogan, K.; Yildirim, B.D. (2014), *Non-core Liabilities as an Indicator of Systemic Risk and Liquidity Stress Test Application on Turkish Banking System,* Working Paper nº 14/12, Central Bank of the Republic of Turkey.

5. Alama, L.; Tortosa- Ausina, E. (2011), *Bank Branch Geographic Location Patterns in Spain: Some Implications for Financial Exclusion*, Working Paper, nº 2011/10, IVIE.

6. Aldasoro, I.; Alves, I. (2017), *Multiple Interbank Networks and Systemic Importance- An Application to European Data*, Bank for International Settlements Working Papers nº 603. available at http://www.bis.org/publ/work603.pdf

7. Alcidi, C.; Gros, D. (2011), "Great recession versus great depression: monetary, fiscal and banking policies", *Journal of Economic Studies*, nº 38(6), p. 673-690.

8. Anand, K.; Gai, P.; Kapadia, S.; Brennan, S.; Willison, M. (2013), *"*A network model of financial system resilience*"*, *Journal of Economic Behavior and Organisation*, nº 85, p. 219– 235.

9. Arcand, J.L.; Berkes, E.; Panizza, U. (2015): "Too much finance?", *Journal of Economic Growth*, nº 20(2), p. 105-148.

10. Bakir, C. (2013), *Bank Behaviour and Resilience*, Palgrave Macmillan Studies in Banking and Financial Institutions, Hampshire, England.

- (2016), "How can interactions among interdependent structures, institutions, and agents inform financial stability? What we have still to learn from global financial crisis", *Policy Sciences*, August, p. 1-23.

11. Banque du France (2013), *Financial Stability and Macroprudential Policy*, Focus nº 9, February 19.

12. Bank of England (2015), *One Bank Research Agenda*, Discussion Paper, February, available at http://www.bankofengland.co.uk/research/documents/onebank/discussion.pdf

13. Basso, H.S.; Costain, J. (2016), *Macroprudential Theory: Advances and Challenges*, Occasional Paper nº 1604, Banco de España, available at ttp://www.bde.es/f/webbde/SES/Secciones/Publicaciones/PublicacionesSeriadas/DocumentosOcasionales/16/Fich/do1604e.pdf

14. Bordo, M.; Redish, A.; Rockoff, H. (2011), *Why didn't Canada have a banking crisis in 2008 (or in 1930, or 1907, or…)?,* Research Working Paper nº 17312, National Bureau of Economic.

15. Berner, R. (2015), "Can the financial sector promote growth and stability?", available at https://www.brookings.edu/events/can-the-financial-sector-promote-growth-and-stability/

16. Brida, J.G.; Matesanz, D.; Seijas, M.N. (2016), "Network analysis of returns and volume trading in stock markets: The Euro Stoxx case", *Physica A*, vol. 444, p. 751-764.

17. Bui, C.; Scheule, H.; Wu, E. (2016), *The value of Bank Capital Buffers in Maintaing Financial System Resilience*, Working Paper nº 089/2016, project nº F002, Centre for International Finance and Regulation, February.

18. Caruana, J. (2012), "Building a resilient financial system", Keynote speech, BIS.

19. Cecchetti, S.G.; Kharroubi, E. (2012), *Reassessing the Impact of Finance on Growth,* BIS Working Paper nº 381, Bank for International Settlements.

20. Cecchetti, S.G.; Tucker, P.M.W. (2016), *Is There Macroprudential Policy Without International Cooperation?,* Discussion Paper Series nº 11042, Centre for Economic Policy Research.

21. De Haas, R.T.A. (2012), "Foreign banks and financial stability: Lessons from the great recession," in Volz, U. *Financial Stability in Emerging Markets: Dealing with Global Liquidity*, German Development Institute, Bonn.

22. De la Cuesta, M.; Ruza, C.; Fernánde, B. (2015), "Banking System and Financial Exclusion: Towards a More Comprehensive Approach", in *Liquidity Risk, Efficiency and New Bank Business Models*, Palgrave Macmillan, p. 127-161.

23. Duisenberg School of Finance (2015), *Non-Traditional Risk Sources and Financial System Resilience*, Duisenberg Strategy Series nº 201501, Amsterdam.

24. Escofier, B.; Pagès, J. (1994), "Multiple factor analysis (AFMULT package)", *Computational Statistics & Data Analysis*, vol. 18, nº 1, p. 121–140.

25. Estrada, A.; Saurina, J. (2016), "Spanish boom-bust and macroprudential policy", *Revista de Estabilidad Financiera,* nº 30, p. 36-61.

26. Evans, C. (2017), "Toward a More Resilient Financial System", speech delivered on May 23, 2017, before the Shanghai Symposium on OTC Derivatives in Shanghai, China, available at https://www.chicagofed.org/publications/speeches/2017/05-23-toward-a-more-resilient-financial-system-shanghai

27. Gai, P. (2013), *Systemic Risk: The Dynamics of Modern Financial Systems*, Oxford University Press.

28. García-Lautre, I.; Abascal-Fernández, E. (2004). "A methodology for measuring latent variables based on multiple factor analysis", *Computational Statistics & Data Analysis*, vol. 45, nº 3, p. 505-517

29. Giese, J.; Nelson, B.; Tanaka, M.; Tarashev, N. (2013), *How Could Macroprudential Policy Affect Financial System Resilience and Credit?. Lessons from the Literature*, Financial Stability Paper nº 21, Bank of England, May.

30. Goodhart,C.A.E. (2011), “The macro-prudential authority: powers, scope and accountability”, *OECD Journal: Financial Market Trends*, Vol. 2011, nº 2.

31. Greenspan, A. (2010). *The Crisis*, Brookings Papers on Economic Activity, Washington, DC: Brookings Institution.

32. Group of Thirty (2010), *Enhancing Financial Stability Resilience: Macroprudential Policy, Tools, and Systems for the Future,* Washington, available at http://group30.org/images/uploads/publications/G30_EnhancingFinancialStabilityResilience.pdf

33. Haldane, A. G.; May, R. M. (2011), “Systemic risk in banking ecosystems”, *Nature*, vol. 469, nº 7330, p. 351-355.

34. Harutyunyan, A.; Massara, A., Ugazio, G.; Amidzic, G.; Walton, R. (2015), *Shedding Light on Shadow Banking*, Working Paper 15/1, International Monetary Fund.

35. Holling, C. S. (1973), “Resilience and stability of ecological systems”, *Annual Review of Ecology and Systematics*, nº 4 (November), p. 1-23.

36. Holling, C. S.; Gunderson, L. H. (2002), “Resilience and adaptive cycles” in Gunderson, L.H.; Holling, C.S. editors. *Panarchy: Understanding Transformations in Human and Natural Systems,* Island Press, Washington, D.C., USA”, p. 25-62.

37. Holló, D.; Kremer, M. (2012), *CISS- A Composite Indicator of Systemic Stress in the Financial System*, European Central Bank Working Paper Series nº 1426, available at https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1426.pdf?6d36165d0aa9ae601070927f3ab799fc

38. International Monetary Fund. (2015), “Why the Global Financial System Is More Resilient”, Press Release by IMF director Gerd Häusler, October 7.

39. International Monetary Fund. (2016a), “Morocco”, *Financial System Stability Assessment*, February.

40. International Monetary Fund. (2016b), “Fostering stability in a low-growth, low-rate era”, *Global Financial Stability Report*.

41. Lê, S., Josse, J.; Husson, F. (2008). “FactoMineR: An R Package for Multivariate Analysis”, *Journal of Statistical Softwar,* nº 25(1). p. 1-18.

42. Kambhu, J.; Weidman, S.; Krishnan, N. (2007), *New Directions for Understanding Systemic Risk: A Report* on a Conference Cosponsored by the Federal Reserve Bank of New York and the National Academy of Sciences, Washington D.C, The National Academies Press.

43. Knight, M. (2011), "Canada's banks: Too conservative to fail?" In G. Anderson & C. Sands (Eds.), *Forgotten partnership redux: Canada–U.S. relations in the 21st century,* p.223–268.

44. Knott, J. (2012), "The President, congress, and the financial crisis: Ideology and moral hazard in economic governance", *Presidential Studies Quarterly*, nº 42(1), p. 81–100.

45. Loayza, N.; Ouazad, A.; Rancière, R. (2018), *Financial Development, Growth, and Crises: Is there a Trade-Off?,* Working Paper nº 24474, available at http://www.nber.org/papers/w24474

46. Liikanen, E. (2012), *High-level Group on Reforming the Structure of the EU Banking Sector*, October, available at http://ec.europa.eu/internal_market/bank/docs/high-level_expert_group/report_en.pdf

47. Matteucci, G. D. B.; Buzai, G. (1998), *Sistemas Ambientales Complejos: Herramientas de Análisis Espacial*, EUDEBA Editors, Buenos Aires.

48. Michie, J.; Oughton, C. (2013), *Measuring Diversity in Financial Services Markets: A Diversity Index*, Discussion Paper Series, nº 113, Centre for Financial and Management Studies, April.

49. Min, D. (2010), True north: The facts about Canadian mortgage system, Centre for AmericanProgress, Washington.

50. New Economics Foundation (2015), *Financial System Resilience Index: Building a strong financial system,* available at http://b.3cdn.net/nefoundation/3898c6a7f83389375a_y1m6ixqbv.pdf

51. Nicoletti, G.; Scarpetta, S.; Boylaud, O. (2000), *Summary Indicators of Product Market Regulation with an Extension to Employment Protection Legislation*, Economics Department Working Papers nº 226, OECD.

52. OECD. (2008), *Handbook on Constructing Composite Indicators. Methodology and Userguide*, OECD Publications, Paris.

53. Rochet, J.C.; Tirole, J. (1996), “Interbank lending and systemic risk”, *Journal of Money, Credit and Banking*, nº 28(4), p. 733-762.

54. Ruza, C.; Fernández-Olit, B.; De la Cuesta, M. (2016), “Methodological Approaches to Analyse Financial Exclusion from an Urban Perspective”, in Pinto A., Zilberman D. (eds) *Modeling, Dynamics, Optimization and Bioeconomics III,* Springer Proceedings in Mathematics & Statistics, vol 224. Springer, Cham, p. 403-418.

55. Sabatini, F. (2009), “Social capital as social networks: A new framework for measurement and an empirical analysis of its determinants and consequences”, *The Journal of Socio-Economics*, vol. 38, nº 3, p. 429-442.

56. Sahay, R.; Čihák, M.; N’Diaye, P.; Barajas, A.; Bi, R.; Ayala, D.; Gao, Y.; Kyobe, A.; Nguyen, L.; Saborowski, C.; Svirydzenka, K.; Yousefi, S.R. (2015), *Rethinking Financial Deepening: Stability and Growth in Emerging Markets*, IMF Staff Discussion Note, nº 15/08, International Monetary Fund.

57. Schumpeter, J.A. (1911), *The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle,* Harvard University Press.

58. Selmier, W. T. (2016), “Design rules for more resilient banking systems”, *Policy and Society,* nº 35, p. 253-267,

59. UNEP (2015), *Effects of Financial System Size and Structure on the Real Economy*: *What do we know and what do we not know?*, Inquiry Working Paper nº 15/10, United Nations Environment Programme, available at: http://unepinquiry.org/wp-content/uploads/2015/11/Effects_of_Financial_System_Size_and_Structure_on_the_Real_Economy.pdf

60. Walker, J.; Cooper, M. (2011), “Genealogies of resilience: From systems ecology to the political economy of crisis adaptation”, *Security Dialogue*, nº 42(2), p, 143-160.

61. Yellen, J.L. (2014), “Monetary Policy and Financial Stability”, International Monetary Fund, Washington D.C., speech, July.