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Article

A multidimensional financial attractiveness index: Scoring and classification of financial systems

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Abstract: This research paper aims to benchmark the characteristics of financial systems for 102 countries worldwide from the period of 2005 to 2017. The financial systems' database encompasses four main dimensions, each consisting of several variables for every indicator: (a) financial depth, (b) financial efficiency, (c) financial access, and (d) financial stability. The objective is to closely analyse the different factors that contribute to the attractiveness of financial and economic systems globally. Furthermore, this paper employs a literature review and an empirical modelling and classification of financial systems worldwide to assess their attractiveness. The modelling process utilizes two statistical analysis methods: discriminant analysis (PCA) and neural analysis. By doing so, this research paper aims to identify the most appropriate measures to strengthen these systems and economies. The main conclusion of the research is to establish a ranking of the world's best countries and also the validation of the hypothesis that macroeconomic conditions are the effective determinants of the classification dimensions of financial systems.

Keywords: attractivity; classification; financial depth; financial efficiency; financial access; financial stability

JEL Classification: D53; E44; G15

1. Introduction

The dominant paradigm in finance today sees the opening up and liberalization of financial systems as the path to considerable financial development. The main idea is that capital inflows can provide the necessary funding for a strong economy, and this can only be achieved through a stable, resilient, and a well-functioning financial system.

Capital inflows and the ability of financial systems to attract investment and capital have positive externalities on a country's macroeconomic conditions, notably through wealth creation, financing for SMEs and VSEs, smoothing consumption, and cushioning exogenous shocks. These various advantages are associated with risks that can affect the stability of the financial system. Several studies have shown that the openness and attractiveness of financial systems can have negative effects on the resilience of the financial system, through time inconsistency, when capital flows stimulate financial cycles and create a certain procyclicality with systemic risk (Henry, 2007; Rodrik, 1998; Stiglitz, 2000).

Financial systems able to attract capital flows are those that have been able to put in place a number of mechanisms and policies aimed at removing barriers to entry and exit, such as easing regulatory restrictions, liberalization, opening up the capital account, and adopting a floating exchange rate regime. These measures have certainly

increased liquidity on domestic financial markets, giving domestic companies, households, and financial institutions better access to funds available on international capital markets (Andreasen and Valenzuela, 2016; Bekaert and Harvey, 2000; Chari and Henry, 2004).

The scientific community also recognizes that stimulating competition by opening up the financial system improves its productive and allocative efficiency (Baltagi et al., 2008; Claessens et al., 2001).

That said, there is a potential relationship between the attractiveness of the financial system and its level of development. Works of Claessens et al. (2001); Hellmann et al. (2000); Luo et al. (2016), confirm that the increased openness of the financial system can have negative effects on financial development, via regulatory mechanisms and economic policies (government and Central Bank) which can hinder competition and have negative impacts on the local intermediation system. The same applies to the bond market. Indeed, the increased openness of the financial system implies a restructuring of portfolios in search of higher yields, leading to a disengagement from the local market and a prioritization of international markets (Barr and Priestley, 2004; De Santis and Gérard, 2009). This allocation strategy increases interconnections between markets and countries, thus increasing the risk of cross-border contagion (Firano et al., 2022).

The notion of the attractiveness and openness of a financial system is different, but openness can only have an effect if the financial system is attractive. Indeed, empirical studies confirm that increasing the degree of financial openness is beneficial to financial development (Bekaert et al., 2011; Hermes and Nhung, 2010; Lee and Chou, 2018).

A country with a high degree of financial openness should have a high degree of financial development. As such, the control variable between financial development and the openness of the financial system is its degree of attractiveness. There are several examples of countries where liberalization reforms and the removal of entry and exit barriers have been carried out without having a significant effect on financial development, and consequently on economic growth and development. This can be partly explained by the existence of financial frictions in these countries, especially in the developing countries (Firano et al., 2020). In addition, most studies have affirmed that the opening up and inflow of capital is positive for the stock market, which remains conditioned, in particular, by the nature of the capital account and the exchange rate regime in force (Chinn and Ito, 2005; Firano et al., 2017; Levine and Zervos, 1998).

The fundamental hypothesis of this research paper is that attractiveness is a necessary and sufficient condition for a policy of opening up the financial system. Only this attractiveness can optimize the openness-development relationship. To this end, we propose in this paper an attempt to quantify the attractiveness of the world's financial system via a classification based on a multidimensional approach. Indeed, attractiveness does not imply that the financial system will be able to deliver significant financial and economic development, as this will depend on a number of other factors and policies.

This paper is structured as follows: in the first section, we present a literature review on indicators for measuring or approaching the attractiveness of the financial

system. The second section presents the methodology adopted and the proposed measures. We will then present the results obtained and conclude with a discussion of the results and their implications in terms of the economic policies to be implemented.

2. Literature review

Classifying financial systems is a complex, if not impossible, task. However, to provide a framework for comparing and evaluating the policies implemented to open up the financial sector after the 1980s, it is essential to establish a scale for comparing financial systems.

Beyond the classification objective itself, this paper will provide a framework for assessing the link between characteristics and measurement criteria and financial sector policies. As such, this section provides an empirical structure and substance to the complexity and multidimensionality of financial system functioning by focusing on four characteristics of financial institutions and markets. Indeed, until now, four dimensions have been used to approach a financial system: efficiency, depth, access, and stability. In fact, several studies have focused on each of these components without considering the dependence and interconnection between them. We know that each dimension in itself is complex to measure and assess; however, measuring a financial system depends on these different components.

By definition, depth aims to assess and measure the financial systems composed of financial institutions and markets. Access seeks to gauge and measure how much individuals can and do utilize markets and financial institutions. Efficiency aims to assess and measure how efficiently the production functions of financial services are used by financial markets and institutions. Financial stability measures the resilience and robustness of the financial system to potential shocks (World Bank, 2017).

Financial depth refers to the extent to which a country's financial system is developed and able to support economic growth and development. It is measured by the size, diversity, and accessibility of a country's financial institutions and markets. A country with a high level of financial depth is able to provide a wide range of financial services and products to its citizens and businesses, which, in turn, can support economic growth and development (Andreasen and Valenzuela, 2016; Fischer and Valenzuela, 2013; Henry, 2003; Henry, 2007).

One important aspect of financial depth is the size of a country's financial system, measured by the total value of financial assets as a percentage of gross domestic product (GDP). A larger financial system is able to provide a greater amount of credit and other financial services to support economic growth. In addition, a larger financial system can also help cushion the economy during economic downturns by providing a buffer against financial losses (Klein and Olivei, 2008).

Another important aspect of financial depth is the diversity of a country's financial system, measured by the variety of financial institutions and markets available. A diverse financial system is able to provide a wide range of financial services and products, which can help meet the needs of different sectors of the economy and different types of borrowers. A diverse financial system can also help reduce the risk of a financial crisis by spreading risk across different types of institutions and markets (De Santis and Gerard, 2009). Accessibility is also an

important aspect of financial depth, measured by the proportion of the population that has access to formal financial services.

A financially inclusive system is one where a large proportion of the population has access to banking services and other financial products, regardless of their income level or location. This can be achieved through various means such as providing financial education, reducing barriers to entry for new financial institutions, and amplifying the use of technology to increase access to financial services. A country with a high level of financial depth is also likely to have a well-developed regulatory and supervisory framework in place. This is important to ensure that financial institutions and markets operate in a safe and sound manner and to protect consumers from fraud and other financial crimes. The effectiveness of the regulatory and supervisory framework can be measured by the level of compliance with international standards and the level of transparency in the financial system. Financial depth is important for economic growth and development as it allows businesses and households to access credit and other financial services they need to invest, grow, and plan for the future.

This, in turn, can lead to increased job creation, higher productivity, and economic growth. Furthermore, a deep and well-functioning financial system is able to mobilize savings, channel them into productive investments, and promote financial stability. The key point of McKinnon (1974) and Shaw (1974) theory is that financial repression has a negative impact on financial development and bank performance. Financial repression in emerging countries must disappear, according to McKinnon and Shaw, who call for financial freedom. They believe that in order to generate genuine growth and development, governments must improve their financial sectors. According to several studies, economic expansion is merely a by-product of financial development. It argues that the demand for financial services increases along with the growth of the real economy, contributing to the development of the financial industry. In this paper, we propose an approach to quantifying the attractiveness of financial systems worldwide.

The aim is to establish a ranking of the different financial systems according to the outlined dimensions. Our scientific contribution is to make financial openness conditional on attractiveness. In our view, financial liberalization or integration policies can only succeed if the financial system is attractive. Access to financial services is important for economic development and financial inclusion, enabling individuals and businesses to manage their finances, access credit for investment and growth, and plan for the future. However, physical access may be limited in some areas, particularly in rural or low-income areas, as is the case with the digital divide issue. Digital financial services, such as mobile banking and digital wallets, have become increasingly popular in recent years and have the potential to extend financial access to a wider population. Financial inclusion is the provision and access to financial services for all population components, especially the poor and other marginalized members of the population (Ozili, 2018). Financial inclusion can also be described as the provision of banking services at an affordable cost to wide sections of the poor and low-income groups (Mahendra Dev, 2007).

3. Methodology and approach

The approach described in this paper is a statistical one, based on the use of proxy variables capable of describing the multidimensional nature of the attractiveness of the financial system. The characteristics of the financial system are multidimensional, and the variables that can be used to approach them are numerous. Moreover, the theoretical links between these different characteristics are complex to identify. We, therefore, used the World Bank database to extract data describing the various dimensions: access, stability, efficiency, and depth.

To ensure a better presentation of the countries in the analysis panel, we have opted for a selection based on the country's income level as shown in **Table 1**. We considered low-income countries (6), middle-income countries (23), upper middle-income countries (31), and high-income countries (42), i.e., a total of 102 countries. The use of this number depends on two factors: the availability of data on the financial systems in question and the heterogeneous level of development between countries. Similarly, the choice of countries respected the geographical representativeness of all continents to enable a better analysis of geographical disparities and potential spatial dependencies.

Table 1. Number of countries by income level.

Type of income	Number of countries
High income	42
Low income	6
Lower middle income	23
Upper middle income	31
Total countries	102

The database used covers all four dimensions. First, we adopted several variables to measure access. Five indicators were selected for comparative analysis of access to financial services: the number of banks in place, the number of ATMs, the percentage of bank branches per 100,000 people, the percentage of market capitalization of the top 10 companies, and the percentage of traded value of the top 10 companies (Čihák and Levine, 2012).

The indicators adopted to assess access to the financial system in **Table 2**, confirm the supremacy of high- and middle-income countries. The degree of access is correlated with the level of income, as confirmed by most theories and empirical studies. On average, high-income countries manage to achieve over 60% credit as a percentage of GDP. Moreover, savings in these countries are quite substantial, with the percentage of deposits as a function of financial assets exceeding 90%. Similarly, access to financial services (ATMs and branches) is very high, as shown by the level of over 50 ATMs and 21 branches per 100,000 inhabitants. In the empirical literature, various indicators of efficiency have been used. Price synchronization, which is measured as the degree of co-movement of individual stock returns on a stock market, is one of them. The variable seeks to capture the information content of daily stock prices, as a market can only function successfully if prices are informative about the performance of individual companies (Čihák and Levine, 2012).

Table 2. Variables by income level.

Access indicators	Domestic credit to GDP	Deposit money bank assets to bank assets (%)	ATMS per 100,000 adults	Bank branches per 100,000 people
High income	76	94	65	21
Upper middle income	66	93	57	26
Low income	47	83	33	19
Lower middle income	46	92	25	12

Efficiency is also approximated by the cost of financial intermediation. Indicators such as overheads as a proportion of total assets, net interest margin, loan-to-deposit spread, non-interest income as a proportion of total income, and cost-to-income ratio are all measures of efficiency for institutions. Measures such as return on assets and return on equity are variables used to approximate intermediation efficiency. Indeed, efficient financial organizations are more profitable, but not all the time.

For example, an inefficient financial system may generate relatively high profitability if it operates in a situation of economic recovery, while an efficient system hit by a negative shock may generate losses. Indeed, as with the other dimensions, fairly basic measures of efficiency are required. It is possible to calculate efficiency indicators based on data envelopment analysis and other more complex measures for a subset of countries (Angelidis and Lyroudi, 2006). In financial markets, efficiency measures focus more on measuring transactions than on directly assessing transaction costs.

The turnover ratio, or the ratio of turnover to capitalization on the stock market, is a basic indicator of stock market efficiency. The idea behind the use of this variable is that the greater the turnover (liquidity), the more efficient the market. Bid-ask spread and turnover ratio are the most widely used variables in the bond market.

Table 3. Others variables by income level

Line labels	Bank overhead costs, percent of total assets	Bank concentration (%)	Net interest margin (%)	Bank non-interest income to total income, in percent	Bank interest revenue, percent of interest-bearing assets	Bank cost to income ratio, in percent
High income	6.7	64.0	3.8	37.3	3.7	51.2
Upper middle income	5.1	66.5	4.2	34.3	4.2	55.5
Lower middle income	3.6	62.6	5.1	33.9	5.3	53.1
Low income	4.1	80.5	5.7	42.3	5.7	58.6

The production function of financial systems, and banking systems in particular, is even more optimal in middle and high-income countries, attesting to greater financial efficiency as shown in **Table 3**. The degree of optimization of financial services production charges and costs is largely effective when economic financing objectives are taken into consideration. Indeed, the margin rate of the financial system is quite low in high-income countries, with an even higher level of costs. This is essentially due to the desire to facilitate access to financing and make financial

services more efficient. In terms of competition, the level of concentration is also low in high-income countries, in contrast to other country categories.

Regarding financial stability, Iannotta (2007) compared the provision for loan losses (LLP) and total loans as proxies for bank credit risk. The financial sector is highly dependent on financial stability. There is a wealth of work on measuring systemic risk, such as stress tests and other financial stability assessment tools.

The *Z*-score is another indicator proposed to approximate the degree of financial stability. A higher level indicates a lower probability of insolvency. The *Z*-score has several advantages and disadvantages. Perhaps the most important disadvantage is that *Z*-scores are based entirely on identifying information. The *Z*-score has the advantage that it can be used for institutions that do not have access to more sophisticated, market-based data. Non-performing loan ratios, for example, are better known than the *Z*-score, but they are also recognized as late indicators of soundness (Čihák and Schaeck, 2010).

Excessive credit expansion is another possible indicator of financial instability. According to the International Monetary Fund (IMF), around 75% of credit booms in emerging markets end in banking crises. Households and businesses accumulate large debts over time as revenues fail to keep pace. Non-performing loans and defaults increase as incomes fall or asset prices plummet. Indeed, the gap between the credit-to-GDP ratio and its long-term trend (credit-gap) is the most effective indicator for measuring the financial cycle and financial vulnerabilities.

The notion of financial stability is even more complex to capture and measure as depicted in **Table 4**. However, we have included a few variables that can summarize it, namely profitability rates, the *Z*-score, and the level of liquidity of liabilities. We still note that high-income countries rank higher than other countries in terms of profitability and also in terms of risk, which these countries are better able to control. Furthermore, it should be noted that the level of shareholder profitability is even more striking in low- and middle-income countries, despite the low level of economic profitability, in contrast to what we see in developed financial systems.

Table 4. Financial variables by income level.

Line labels	ROA	Banking system *z*-scores	ROE	Liquid liabilities to GDP (%)
High income	6.4295	12.71	13.85333945	74.969
Low income	2.3803	15.098	18.38615385	53.553
Lower middle income	2.2816	15.351	20.86220736	55.644
Upper middle income	5.3109	14.407	15.18355721	87.661

Finally, the depth of the financial system has been assessed by several indicators that describe the degree of deepening and development of the financial system. These indicators are summarized in the **Table 5**.

In terms of financial system depth, we have adopted a number of indicators, the levels of which also support the interdependence between countries' income levels and the degree of financial system depth. Indeed, high-income countries are those with high levels of credit, deposits, and financial development. It should be noted that their financial cycle, approximated by the "credit-gap," is even more significant, allowing

for the description of the level of confidence and positive anticipation of economic agents in these financial systems.

Table 5. Financial development by income level.

Depth indicators	Bank credit to GDP	Bank deposits to GDP (%)	Private credit to GDP (%)	Deposit to GDP (%)	Central bank assets to GDP (%)	Credit to Deposit	Bank credit to government and public enterprises, percent of GDP	Bank assets to GDP	Bank credit to Bank deposits (%)
High income	68.8	66.0	74.8	74.1	3.6	101.6	19.9	77.5	160.0
Upper middle income	61.8	70.2	63.9	74.2	5.2	101.2	16.3	73.6	113.0
Lower middle income	43.8	50.9	48.4	57.4	4.2	84.4	11.4	52.8	89.8
Low income	45.4	44.6	44.4	53.6	3.9	92.0	9.4	55.2	91.9

The methodological approach adopted in this paper is based on the concatenation of the four dimensions that characterize the financial system: efficiency, stability, access, and depth. The empirical description of the proposed idea is formulated as follows:

$$\text{Attractivity} = F(\text{Characteristics}) = F(\text{Stability}, \text{Efficiency}, \text{Access}, \text{Depth})$$

$F(.)$ is the function that represents the potential links between the various dimensions and the notion of attractiveness. The function to be fitted can be linear or non-linear, depending on the measurements proposed for each dimension. Given the complexity of the different dimensions to be measured, we have opted for two approaches to approximate the link function: the principal components approach and the neural approach.

The main idea behind Principal Component Analysis (PCA) is to reduce the size of a data set consisting of a large number of interdependent variables while retaining as much of the variation present in the entire data set as possible. This is achieved by transforming it into a new set of variables, the principal components (PCs), which are uncorrelated and ordered so that they retain most of the variation present in all the original variables (Jolliffe, 2002). The objectives of PCA are: (i) to extract the most important information from the data table, (ii) to compress the size of the data set by retaining only this important information, (iii) to simplify the description of the data set, and (iv) to analyze the structure of observations and variables.

In PCA, the components are obtained from the singular value decomposition of the data "X." More precisely, with Equation (1):

$$X = P\Delta Q^T \quad (1)$$

where P is the "$I \times L$" matrix of singular vectors on the left, Q is the "$J \times L$" matrix of singular vectors on the right, and Δ is the diagonal matrix of singular values.

singular vectors on the right, and Δ is the diagonal matrix of singular values. Note that $\Delta 2$ is equal to Λ, which is the diagonal matrix of (non-zero) eigenvalues of X^TX and XX^T. The Q matrix gives the coefficients of the linear combinations used to calculate the Factor Scores. This matrix can also be interpreted as a projection matrix, since by multiplying X by Q, we obtain the values of the projections of the observations onto the principal components.

The inertia of a column is defined as the sum of the squared elements of that column and is calculated as follows:

$$\gamma_i^2 = \sum_{i}^{I} x_{i,j}^2 \quad (2)$$

The sum of $\gamma_i^2\ j$ is denoted I and is referred to as the inertia of the data table or total inertia. Note that total inertia is also equal to the sum of the squared singular values of the data table.

The PCA methodology is checked using the neural network method. The main idea is to set up a second process based on a different approach, in order to corroborate or invalidate the results obtained. An artificial neural system simulates human learning. The system learns the nature of the relationship between inputs and outputs by repeatedly sampling sets of input-output information. Neural networks are characterized by three architectural features: inputs, weights and hidden units. Each piece of information is assigned a weight that indicates its relative importance for each hidden unit. These weights are "instructed" by the network during "training".

Each hidden unit calculates the weighed sum of all inputs and transmits the result to other hidden units. In parallel, the other hidden units weigh their inputs in order to transmit their signal to all other hidden units. Receipt of the signal from other hidden units further transforms the output of each node, and the system continues to reiterate until all information has been incorporated.

We note $(x_i)_{1\leq i<k}\ k$ pieces of information reaching the neuron, which are the characteristics of financial systems. In addition, each will be valued more or less in relation to the neuron by means of a weight. A weight is simply a coefficient w_i linked to the information x_i. The i-th piece of information reaching the neuron will therefore in fact be $w_i \times x_i$. However, there is an additional weight, which represents the bias coefficient w_0.

In practice, the neuron will perform a weighted sum of its inputs, rather than considering each piece of information separately. A new input is defined by:

$$\text{Input} = \left(\sum_{i=1}^{n} w_i \times x_i\right) - w_0 \quad (3)$$

This model incorporates complex correlations among the hidden units to improve model fit. Weights are determined via the activation function. This activation function, or transfer function, is a function that must return a real value close to 1 when "good" input information is given, and a real value close to 0 when it is "bad". We generally use functions with values in the real interval [0,1]. If we denote g the activation function, we obtain the formula giving the output of a neuron:

$$a = g(\text{input}) = g\left(\sum_{i=1}^{n} w_i \times x_i\right) - w_0 \quad (4)$$

Using these two approaches, we can build up the potential dependency structure between the different variables.

This index compilation approach was applied for the global indices and sub-indices based on the two competing approaches, namely the PCA approach and the neural network approach. The sub-indices have made it possible to reduce the dimensions that explain the dynamics of financial systems in the countries studied.

4. Results and interpretation

The process of constructing the country classification index was carried out in two stages: the computation of sub-indices by dimension and then the construction of an overall index. We assumed that the sub-indices are independent when computed. **Figure 1** shows the approach adopted to approximate the global index of financial system classification (Financial Attractiveness Index, FAI). Sub-indices and the FAI index are formed using two complementary approaches: PCA and neural analysis.

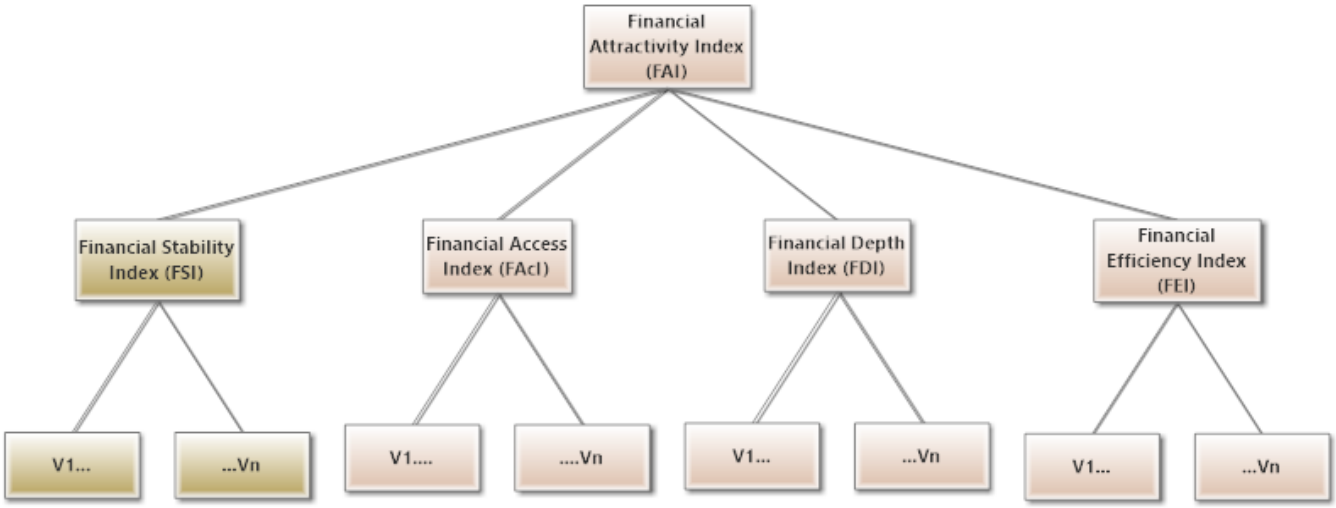

Figure 1. Flowchart for financial classification index.

The construction of the four sub-dimensions resulted in the classification of countries based on their level of performance. The data have been standardized using the mean and standard deviation to facilitate effective comparison between countries. The ranking is based on the average values obtained during the analysis period, specifically between 2008 and 2018.

In the classification results, significant heterogeneity in the ranking of countries was observed based on the considered dimensions as shown in **Figure 2**. Each country demonstrates dominance in one of the criteria examined. For instance, the United States of America excels in terms of access and depth of its financial system but ranks lower in the dimensions of stability and efficiency. Overall, it is noteworthy that countries with higher incomes generally attain acceptable rankings across all four criteria. To further validate and verify the results obtained from the principal component analysis (PCA), a neural network analysis was also conducted as an alternative classification approach as depicted in **Figure 3**. The results obtained largely align with those from PCA, with only a few exceptions for certain countries.

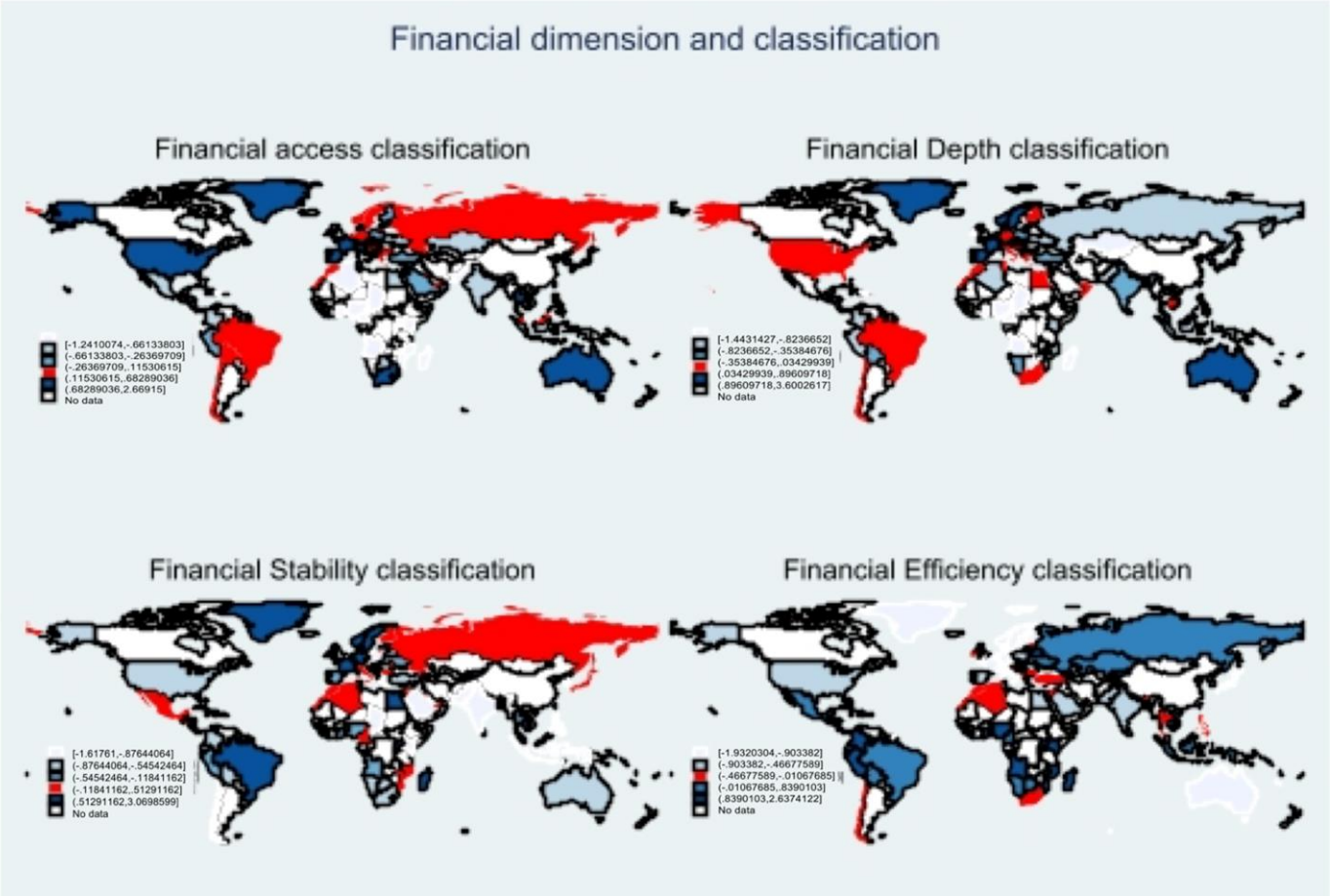

Figure 2. Financial dimension and classification (Using data analysis).
Source: By Author's data from the World Bank Group.

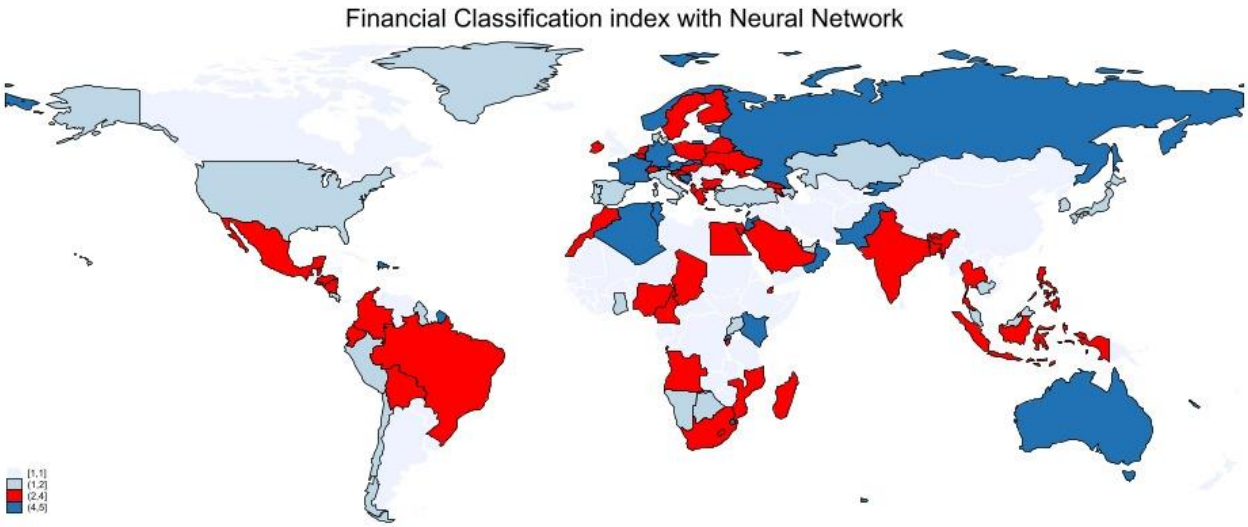

Figure 3. Financial classification index using Neural Network analysis.

The results clearly show that developed and emerging countries are the most attractive. However, developing and poor countries have low levels of attractiveness.

Examination of the evolution of the sub-indices constituting the attractiveness index reveals a high level of stability in the country ratings across most dimensions. The whisker graphs as shown in **Figure 4** further confirm that, on average, the ratings

remain relatively stable, with minor fluctuations captured by the volatility of the averages. The classification of countries based on attractiveness serves the purpose of enabling them to formulate policies aimed at improving the positioning of their financial systems among the top ranks. In pursuit of this objective, we have sought to identify macroeconomic determinants that could explain the observed ratings or scores assigned to the financial systems within the panel. Our goal is to model the relationship that elucidates the sub-dimensions of the index, facilitating the formulation of actions to enhance countries' rankings.

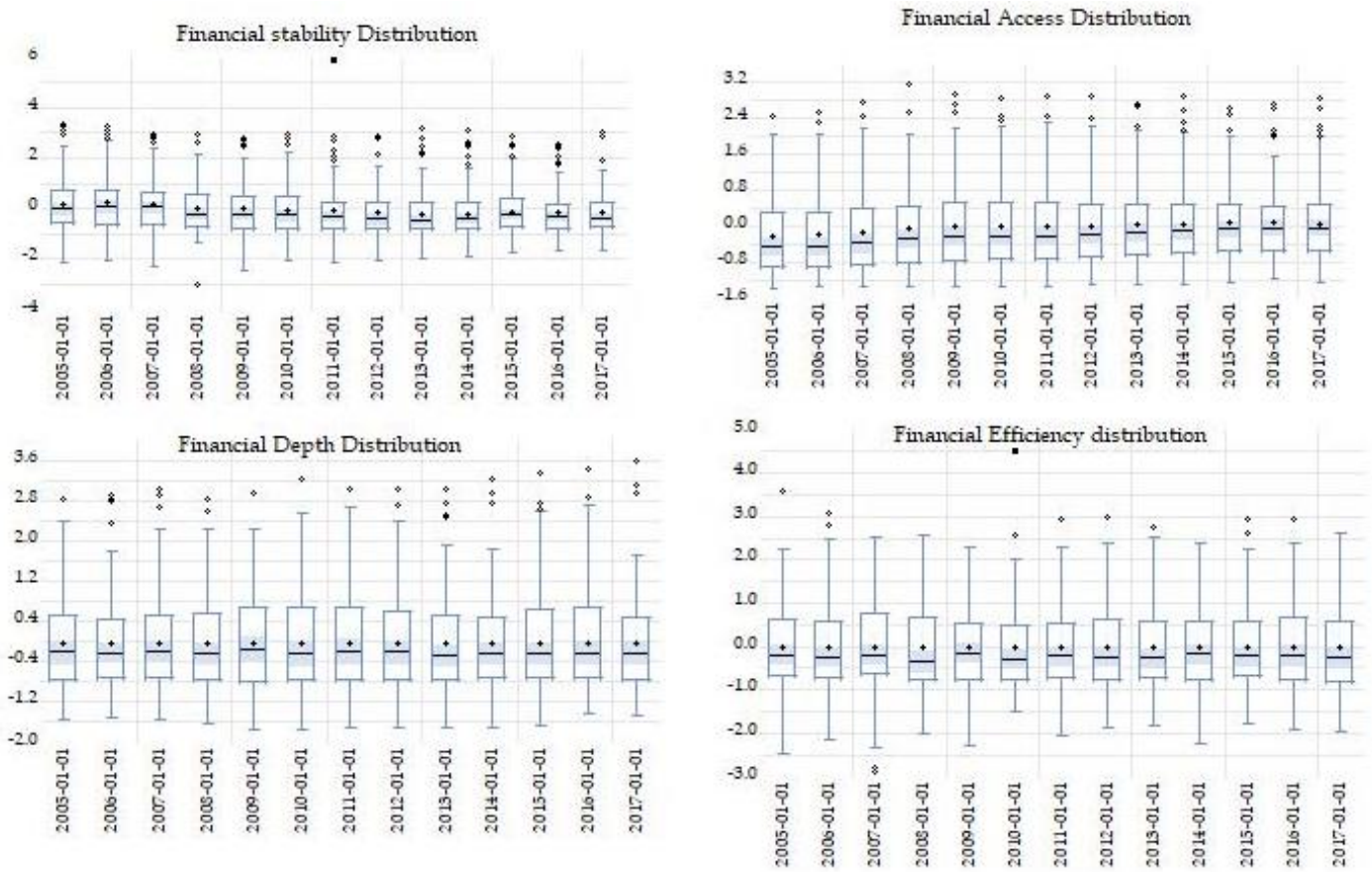

Figure 4. Decomposition of financial classification index by dimension (Evolution).

To achieve this objective, we have incorporated several variables that describe a country's economic situation. These variables encompass the economic growth rate, per capita income, investment intensity, balance of payments, interest rate, and inflation rate. Economic growth serves as a measure of the economy's development prospects and provides insights into its future growth potential. Per capita income, on the other hand, allows us to approximate the purchasing power of economic agents within a country, thereby offering an indication of poverty levels and wealth distribution within the economic system. Both these indicators hold significant importance for investment attractiveness, as they describe the potential of the domestic market.

Likewise, the inclusion of the investment intensity variable helps gauge a country's capacity to stimulate production and establish infrastructure that can attract investors. Encouraging investment conveys a long-term commitment to sustainable

growth from both public authorities and the private sector. The balance of payments serves as an indicator of external equilibrium, reflecting the country's competitiveness through trade or capital flows. A country with a large positive balance is deemed more competitive in terms of attractiveness.

The interest rate assumes great significance as most capital flows and investments seek satisfactory returns to foster capital growth. Furthermore, the interest rate exhibits a close link with the exchange rate, thus contributing to the description of financial system attractiveness. Lastly, the inclusion of inflation as an indicator of macroeconomic stability is crucial. Countries experiencing high inflation levels are generally considered unstable and may face unfavorable conditions regarding monetary policy implementation, thereby impacting short-term interest rates and medium to long-term exchange rates. A stable inflation rate is a vital factor in determining financial system attractiveness. **Table 6** displays summary statistics for each of the macroeconomic variables.

Table 6. Statistical analysis of macroeconomic variables.

	Access	**Current balance of payment**	**Depth**	**Efficiency**	**Gross fixed capital formation (GFCF) (Investment)**	**Inflation**	**GDP per capita**	**Stability**	**GDP Growth**
Mean	-4.620×10^{-12}	-2.154×10	-8.060×10^{-13}	2.420×10^{-12}	1.240×10^{11}	4.471×10	1.681×10^{4}	1.290×10^{-11}	3.625496
Median	−0.184889	−2.430988	−0.200829	−0.194809	2.05×10^{10}	3.255863	6538.982	−0.200454	3.561698
Maximum	3.177907	45.45407	3.600262	4.543076	4.02×10^{12}	59.21974	112,417.9	5.914943	34.5
Minimum	−1.353843	−41.52687	−1.729578	−2.851572	2.01×10^{8}	−8.97474	277.9598	−2.990585	−15.13647
Std. Dev.	0.914975	10.09896	0.99515	0.982017	3.91×10^{11}	5.136284	21,070.95	1	4.064648
Skewness	1.017178	0.552865	0.932062	0.631466	6.736465	3.539007	1.847138	1.073397	0.60349
Kurtosis	3.688693	6.284538	3.602377	3.461889	54.64349	28.05461	6.369865	4.623281	10.51457
Jarque-Bera	249.6731	579.5225	198.447	93.35552	132,577.2	33,552.66	1237.681	397.8036	2864.903

Table 7. Estimation results (Panel data, fixed effect).

Model and specification	**Access**	**Depth**	**Efficiency**	**Stability**
	Coefficient	**Coefficient**	**Coefficient**	**Coefficient**
Growth rate	−0.017028***	0.001963***	0.011517***	0.009 995*
Log(PERCAP)	0.710164***	0.091551***	−0.815931***	−1.226343***
Inflation	−0.003634***	0.001529**	−0.000156	0.005552
Log of FBCF	−0.038526	0.030588	0.100861	−0.036581
Current_balance	−0.008103***	0.001180***	7.01×10^{-5}	0. 014 496***
Deposit_rate	-	0.010025***	0.032575***	−0.020 496**
C	−5.323503***	2.8***	2.7***	11.31151***
R-squared	0.974113	0. 977 980	0.910936	0.749457
Adjusted *R*-squared	0.971343	0. 975 333	0.899 908	0.719 649
Log likelihood	519.0918	388.7967	−109.2361	−419.2 553
F-statistic	351.5805	369.5346	82.60 008	25.14236
Prob(*F*-statistic)	0.000000	0.000000	0.000000	0.000000

Significant: ***1%, **5%, *10%.

The modelling adopted aims to explain the behavior of the indices developed for all the dimensions that characterize financial systems. As such, four models were estimated. In panel data, the specifications adopted allow a fixed effect estimate to be required due to non-compliance with the low exogeneity assumption of specific effects. As such, LSDV estimation was relevant for all four specified models. The results obtained are presented in the **Table 7**.

The results of the estimates are consistent with the requirements for validation of models in panel data. The determination coefficients are close to the unit for confirming the hypothesis that the characteristics of financial systems are dependent on macroeconomic balances.

First, we were able to verify that accessibility to the financial system depends on GDP per capita, inflation, gross fixed capital formation (GFCF) and the current account balance. The coefficients associated with the variables are statistically significant at the 5% level, with the exception of the variable Gross fixed capital formation (GFCF), which is not statistically significant because *t*-statistic = 0.66 < 2.96. Let us first note that this model contains two variables, GDP/per capita and gross fixed capital formation (GFCF), to which we have applied a logarithmic transformation (translog). This method not only reduces the scale of the variables, but also ensures the homogeneity of all explanatory variables, which facilitates the interpretation of the results. The coefficient associated with the variable GDP per capita: 0.710: there is a positive and significant relationship between GDP per capita and access to financial services. An increase in the level of development leads to better financial access for all countries. In addition, a 1% increase in GDP per capita implies a 0.71% increase in access to financial services. The higher the level of development, the greater the attractiveness.

On the other hand, there is a negative relationship between inflation and access to financial services. When goods prices rise, financial access deteriorates. Countries with high inflation are not attractive. The relationship between gross fixed capital formation (GFCF) and financial access is not significant. The current account coefficient is negative by −0.008, indicating a decreasing relationship between it and access.

The Depth dimension is explained as a function by GDP per capita, inflation, Gross fixed capital formation (GFCF), current balance and Deposit Rate. In this variable, we note that all the coefficients associated with the variables are statistically significant at the 5% threshold, except for the Gross fixed capital formation (GFCF) variable, which is not statistically significant because *t*-statistic = 0.88 < 2.96. The coefficient associated with the variable GDP per capita: 0.38: there is a positive and significant relationship between GDP per capita and financial depth. A 1% increase in GDP per capita implies a 0.38% increase in financial access. The higher the level of development, the greater the improvement in attractiveness. In addition, there is a negative relationship between inflation and financial depth. The deposit rate is slightly significant as *t*-statistic = 2.937885 < 2.96. The relationship between Gross fixed capital formation (GFCF) and financial access is not significant. The coefficient of the current balance is negative −0.006, indicating a decreasing relationship between it and depth.

The Efficiency dimension is explained as a function of GDP per capita, inflation, Gross fixed capital formation (GFCF), current balance and Deposit Rate. In this variable, we note that all the coefficients associated with the variables are statistically significant at the 5% threshold, except for the Gross fixed capital formation (GFCF) variable, which is not statistically significant because *t*-statistic: –3.91 < 2.96. The coefficient associated with the variable GDP per capita = −0.81: there is a significant negative relationship between GDP per capita and financial efficiency. A 1% increase in GDP per capita implies a 0.81% drop in financial efficiency. The lower the level of development, the more attractiveness deteriorates. There is a negative relationship between inflation and financial efficiency. The deposit rate is significant as *t*-statistic = 3.375480 < 2.96. The relationship between Gross fixed capital formation (GFCF) and financial efficiency is not significant. The coefficient of the current balance is positive at 7.01, indicating an increasing and positive relationship between it and efficiency.

The stability is explained by GDP per capita, inflation, Gross fixed capital formation (GFCF), current balance and Deposit Rate. In this variable, we note that all the coefficients associated with the variables are statistically significant at the 5% threshold, except for the Gross fixed capital formation (GFCF) variable, which is not statistically significant because *t*-statistic: −0.401304 < 2.96.

The coefficient associated with the variable GDP per capita = −1.22: there is a negative and non-significant relationship between GDP per capita and financial stability. A 1% increase in GDP per capita implies a −1.22% drop in stability. The lower the level of development, the greater the decline in attractiveness. There is a negative relationship between inflation and stability. The deposit rate is not significant as *t*-statistic = −2.010063 < 2.96. The relationship between Gross fixed capital formation (GFCF) and financial access is not significant. The coefficient of the current balance is positive: 0. 014496, indicating an increasing relationship between it and financial stability.

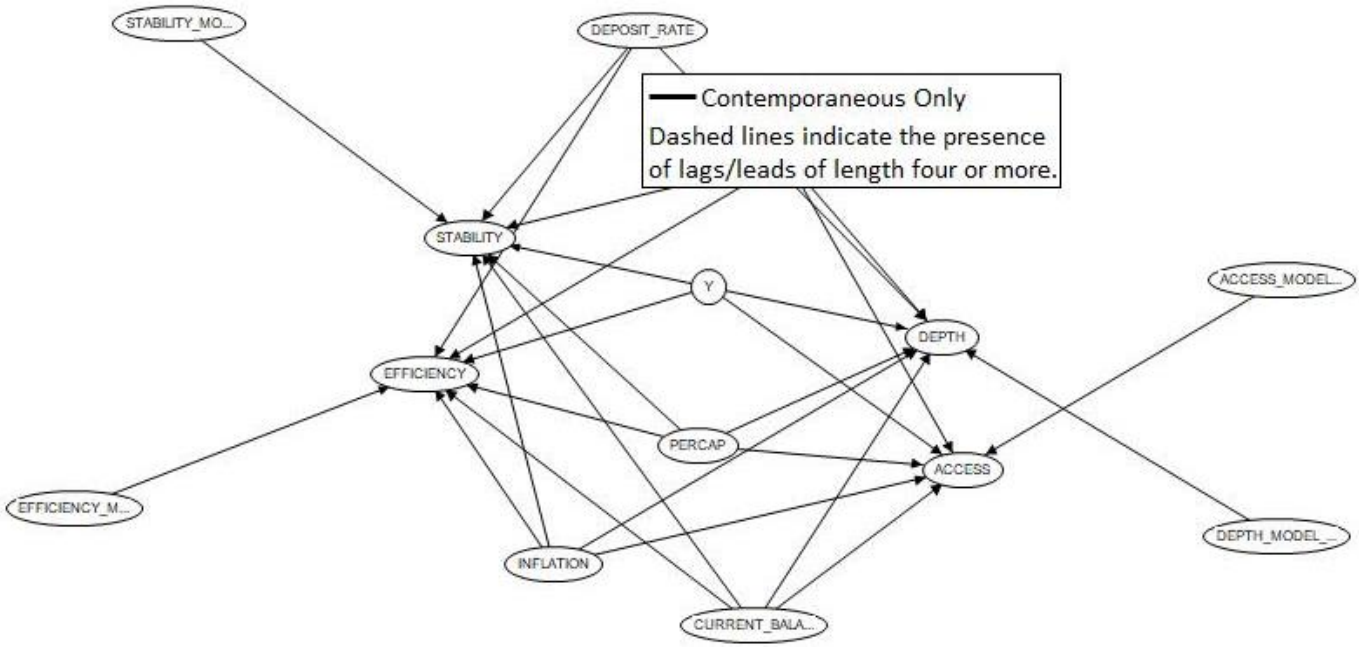

Figure 5. Interconnexion and complexity of classification.

Estimating the models in panel data confirmed the macroeconomic effects on the dimensions of financial systems. However, the different dimensions are interdependent, which makes simultaneous or network relationships prevail between the different dimensions of the financial system, hence the complexity of classifying or discriminating between the world's financial systems. **Figure 5** allows to visualize this multidimensional property where the four dimensions are interdependent and also interconnected with the macroeconomic conditions present in each country.

5. Concluding remarks

Measuring and classifying financial systems aims to benchmark the economies of different countries. This classification was conducted through two different approaches: Principal Component Analysis (PCA) and neural analysis, which were used to confirm the results obtained from PCA. This paper provides a theoretical and empirical framework to understand the complexity and multidimensionality of financial system operations. It also aims to compare and analyze the development of financial systems over the past few decades using the four criteria and features mentioned.

It is important to note that a good financial system does not always outperform another in terms of efficiency, and a deep financial system does not necessarily guarantee broad financial access. Each of these features and characteristics is linked to additional elements of socio-economic progress, growth, development, financial sector regulation, and the overall financial support environment. Due to the distinctiveness of the four criteria for a financial system, it is essential to study and assess each component separately. The financial system is inherently multidimensional, encompassing financial depth, accessibility, efficiency, and stability, which are all crucial when comparing and classifying financial systems.

Financial institutions and markets need to measure and evaluate these characteristics. The four characteristics of a financial system exhibit considerable diversity and come in various forms and sizes. In a nutshell, the results of the analysis clearly demonstrate that developed and emerging countries are more attractive in terms of their financial systems. Conversely, developing and poor countries exhibit lower levels of attractiveness. The classification of countries based on attractiveness is relevant as it enables countries to devise and implement policies that can improve the positioning of their financial systems in higher rankings. Therefore, in this paper, efforts have been made to identify the macroeconomic determinants that may explain this situation or the scores assigned to the financial systems under consideration.

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