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METHODOLOGICAL APPROACH FOR CONSTRUCTING AN AGGREGATE FINANCIAL STABILITY INDEX: THE CASE OF MOROCCO

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ABSTRACT
This study develops an Aggregate Financial Stability Index (AFSI) for Morocco covering 2000–2023, providing a multidimensional assessment of the resilience of the national financial system. The research contributes to the literature by integrating, for the first time in the Moroccan context, the four key dimensions of financial development, vulnerability, soundness, and the global economic climate into a single composite indicator. Using Min–Max normalization and differentiated weighting, the index measures structural stability and quantifies the volatility contributions of each component. The findings reveal a broadly resilient system, supported by strong prudential regulation and sustained financial reforms, yet increasingly exposed to external shocks and macro-financial vulnerabilities. Financial development and vulnerability appear as the main drivers of overall volatility, while the influence of the global economic climate has intensified since 2010. The originality of this research lies in its empirical decomposition of volatility sources and its operational framework for macroprudential monitoring. The AFSI provides policymakers and supervisory authorities with a predictive tool for assessing systemic risk and enhancing financial stability in emerging economies facing global uncertainty.

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INTRODUCTION

Financial stability remains an essential condition for sustainable economic development, particularly in emerging economies where it underpins investor confidence, the mobilisation of savings and the financing of the real economy. According to the European Central Bank (2024), it is defined as the ability of financial institutions, markets and infrastructures to withstand shocks without major disruption to their functions. In Morocco, Bank Al-Maghrib (2025) has made it a central objective of its policy, notably through the work of the Systemic Risk Coordination and Supervision Committee (CCSRS).

The international prudential framework, with the Basel III agreements (Basel Committee, 2017), has strengthened macroprudential tools to better understand systemic risks. At the same time, recent literature has seen the development of quantitative approaches aimed at measuring financial stability using aggregate indices. These composite indicators, such as

the one proposed by AL-Rjoub (2021) for Jordan, make it possible to synthesise several dimensions of the financial system into a single indicator, facilitating monitoring and comparison over time.

However, studies specific to the Moroccan case, such as the work of Dehmej and Mikou (2020), still have certain limitations. Few of them manage to simultaneously integrate the four key dimensions of financial development, financial vulnerability, financial soundness and the global economic climate, while quantifying their respective contributions to overall volatility.

Our research aims to fill this gap by constructing an Aggregate Financial Stability Index (AFSI) for Morocco for the period 2000–2023. Using a rigorous standardisation and weighting methodology, this index aims not only to measure the evolution of Morocco's financial resilience, but also to identify the dominant factors contributing to its instability. The results will provide supervisory authorities with a valuable decision-making tool in an increasingly uncertain international environment.

LITERATURE REVIEW

Financial stability, a central concept in economics and finance, refers to the ability of a financial system to absorb shocks and maintain its essential functions on an ongoing basis. According to the European Central Bank (2024), it corresponds to the resilience of financial institutions, markets and infrastructures in the face of economic imbalances and shocks. This systemic view emphasises the continuity of financial functions that are crucial for sustainable economic growth and shared prosperity (Cairó & Sim, 2023). In the Moroccan context, Bank Al-Maghrib (2025) emphasises that financial stability is a pillar of sustainable development, promoting investor confidence, the mobilisation of savings and the financing of the real economy.

The role of financial stability in economic resilience and growth is universally recognised. The International Monetary Fund (2024) emphasises the importance of proactive macroprudential supervision to prevent systemic vulnerabilities. International prudential regulation, notably the Basel III standards (Basel Committee, 2017), aims to strengthen the resilience of banks through increased capital and liquidity requirements, thereby reducing systemic risk. In Morocco, macroprudential supervision is institutionalised through the Systemic Risk Coordination and Supervision Committee (CCSRS), based on risk mapping and stress tests including sensitivity analyses and stress scenarios (BAM, 2023).

Recent literature on financial stability regulation distinguishes between two complementary approaches: microprudential and macroprudential. The first, which forms the

basis of the Basel I and II agreements, focuses on the individual soundness of financial institutions through capital and liquidity standards (Abass & Pop, 2023). The second, developed with Basel III, specifically targets systemic risks and procyclical dynamics through instruments such as the countercyclical buffer (Borio, 2014). These two approaches are synergistic: one ensures institutional resilience, while the other strengthens overall stability by targeting aggregate vulnerabilities.

Methodologies for constructing financial stability indices offer various approaches for aggregating heterogeneous indicators into composite indices. AL-Rjoub's (2021) work for Jordan demonstrates that sub-indices can be constructed through data normalisation (min-max or Z-score), followed by specific weighting or aggregation using principal component analysis (PCA). The selected variables generally cover four dimensions: financial development, financial vulnerability, financial soundness and the global economic climate. The selection of indicators is based on their theoretical and empirical relevance, with justifications based on IMF recommendations, Basel standards and macroprudential practices (IMF FSI, Basel III).

In the Moroccan context, Dehmej and Mikou (2020) adopt a similar methodology but adapted to local specificities. They select 25 indicators grouped into five sub-indices, including an innovative systemic risk sub-index (MES and SRISK). The indicators are standardised using the empirical distribution function and then weighted according to their sensitivity to GDP, while temporal correlations between sub-indices are taken into account to reflect joint risks. These methods make it possible to construct a robust aggregate index that reflects both the structural dimensions and temporal dynamics of financial stability.

Despite the existence of multiple financial stability indices at the international and regional levels, several limitations persist in the Moroccan context. Existing studies, although useful, do not simultaneously integrate the four essential sub-indices of financial development, financial vulnerability, financial soundness and the global economic climate. Furthermore, few studies combine standardisation, differentiated weighting and analysis of the volatility and growth of indicators to track the temporal dynamics of the financial system.

This study aims to fill these gaps by constructing an aggregate financial stability index for Morocco, structured around these four sub-indices and incorporating the joint effects and dynamic movements of financial indicators. The objective is to provide a robust and predictive tool for assessing the resilience of the Moroccan financial system, guiding macroprudential supervision and supporting economic and financial decision-making.

METHODOLOGY

Financial stability indicators are often specific variables chosen to capture the financial dimensions deemed relevant in the literature. To simplify data analysis and management, these indicators can be grouped in various ways (by function, by sector, etc.) to create sub-indices or broader blocks.

However, in this study, grouping is based on partial dimensions of stability. Each of these dimensions acts as a separate pillar that captures a specific aspect of financial stability. These four dimensions are :

1. Financial development
2. Financial vulnerability
3. Financial soundness
4. The global economic climate

These groupings are detailed in **Table 1**.

Table 1: Structure of the Aggregate Financial Stability Index (AFSI)

Indicator	Rating	Impact	Index
Total Credit/GDP	Id1	+	Financial Development Index (IDF)
Capita/GDP	Id2	+	
Interest rate differential	Id3	-	
HH Index	Id4	+	
Inflation rate	Iv1	-	Financial vulnerability index (IVF)
Debt/GDP ratio	Iv2	+	
Current account balance	Iv3	+	
Real exchange rate	Iv4	-	
Credit/Deposits	Iv5	-	
Capital to Assets Ratio	Is1	+	Financial soundness index (ISF)
Non-performing Loans	Is2	-	
Z-score	Is3	+	
Liquid Reserves	Is4	+	
Global growth	Iw1	+	World Economic Climate Index (ICE)
Global inflation	Iw2	-	
Economic climate	Iw3	+	

Source: *author's calculations based on data from the IMF, World Bank, BAM, HCP, Manar Stat and IFO.*

All variables are expressed as percentages, and the series covers the period 2000–2023. The data used in this study comes from reliable sources that are recognised nationally and internationally. Macroeconomic and financial indicators were extracted from the International Monetary Fund (IMF), notably from International Financial Statistics and the World Economic

Outlook, as well as from the World Bank through the Global Financial Development Database and World Development Indicators.

Data specific to the Moroccan financial system comes from Bank Al-Maghrib (BAM) annual reports and banking statistics, supplemented by national statistics from the High Commission for Planning (HCP) and information available in ManarStat, which compiles local financial and economic data. In addition, exogenous variables and those reflecting the global economic climate were collected from the IFO and the World Economic Climate database, providing insight into the influence of international factors on Morocco's financial stability.

The financial development index aims to measure the depth, efficiency and dynamism of the Moroccan financial system. The variables selected are based on the recommendations of the International Monetary Fund (IMF, 2020) and the World Bank (Global Financial Development Database, 2023), which consider the ratio of total credit to the private sector to GDP (Id1) as a fundamental indicator of the degree of financial intermediation. An increase in this ratio generally reflects broader access to finance and better allocation of productive capital. The market capitalisation/GDP ratio (Id2) complements this measure by illustrating the development of the capital market, which drives diversification of funding sources and market efficiency. The interest rate spread (Id3) is introduced as an indicator of intermediation costs: a high spread reflects financial system inefficiency and an increased risk of disintermediation (IMF, 2019). Finally, the Herfindahl-Hirschman Index (Id4) measures banking concentration, with a higher value indicating a lack of competition and structural fragility in the event of a systemic shock (Bank Al-Maghrib, Financial Stability Report, 2023). Together, these variables capture the structural and competitive dimensions of financial development in Morocco.

The financial vulnerability index combines macroeconomic indicators that may expose the financial system to internal and external shocks. The inflation rate (Iv1) is considered a major macroeconomic risk factor influencing price stability and the real return on assets (IMF, 2021). The public debt-to-GDP ratio (Iv2) reflects the overall level of debt and the government's ability to support the financial system in times of crisis, according to analyses by the World Bank (2022). The current account balance as a percentage of GDP (Iv3) indicates the external sustainability of the economy, while the real effective exchange rate (Iv4) assesses competitiveness and vulnerability to exchange rate shocks (Bank Al-Maghrib, 2022).

Finally, the loan-to-deposit ratio (Iv5) reflects the degree of liquidity in the banking system and its dependence on internal financing, in accordance with the recommendations of the Basel Committee on Banking Supervision (Basel III, 2011). An excessive level of this ratio is often interpreted as a sign of liquidity stress, increasing the likelihood of systemic fragility. These

variables therefore provide an understanding of the vulnerability of the Moroccan financial system to macro-financial imbalances.

The financial soundness index (FSI) aims to assess the resilience of the banking sector. The regulatory capital-to-assets ratio (Is1) measures banks' ability to absorb losses, in accordance with the Basel Committee's solvency standards (2011).

The non-performing loan ratio (Is2) assesses the quality of banking assets, a key indicator of stability in Bank Al-Maghrib reports (2023). The Z-score (Is3) combines profitability, leverage and volatility to estimate the probability of bank failure (IMF, 2020). Finally, the ratio of liquid reserves to assets (Is4) provides information on the system's ability to cope with sudden deposit outflows, in accordance with the short-term liquidity ratio (LCR) requirements defined by Basel III.

In addition, the global economic climate index (ICE) incorporates exogenous variables affecting national financial stability: global economic growth (Iw1), global inflation (Iw2) and a synthetic economic climate index (Iw3) derived from publications by the IMF (World Economic Outlook, 2023) and the World Bank. These variables capture the global macro-financial conditions that influence Morocco's financial stability through trade, monetary and investment channels.

1. Methodology of the Composite Financial Stability Index

As part of this study, all of the variables selected were normalised using the Min-Max method, an approach widely used in the construction of composite economic and financial indices (IMF, 2020; World Bank, 2022; Bank Al-Maghrib, 2023). This method allows the different series to be brought to a common scale between 0 and 1, thus facilitating their comparability and aggregation within the same sub-index. The transformation was carried out using the following formula:

$$M_{j,t} = \frac{x_{j,t} - min(x_j)}{max(x_j) - min(x_j)} \quad (1)$$

Where $x_{j,t}$ represents the observed value of variable j at period t, $min(x_j)$ and $max(x_j)$ denote the minimum and maximum values observed over the study period, respectively. This transformation ensures that the lowest value of a variable corresponds to 0 and the highest to 1, allowing for a consistent interpretation of the results. Furthermore, in order to harmonise the economic meaning of the indicators, variables for which a high value reflects an unfavourable situation for financial stability (such as the inflation rate, the non-performing loan ratio, the credit-to-deposit ratio or the real effective exchange rate) have been inverted according to the following relationship:

$$M^{*}_{j,t} = 1 - M_{j,t} \quad (2)$$

This inversion ensures that, for all variables, a high value indicates an improvement in financial stability, in line with the principles of directional consistency recommended in the macroprudential literature (Basel Committee, 2017; IMF, 2020). The exclusive application of the Min-Max method, combined with the inversion of unfavourable variables, thus makes it possible to obtain homogeneous, interpretable and comparable sub-indices, providing a solid basis for the construction of the aggregate financial stability index.

The weighting adopted is based on a simple and balanced approach, known as uniform weighting, which assigns equal weight to each variable within the same sub-index. This method, widely used in empirical work on financial stability (IMF, 2021; World Bank, 2023; Bank Al-Maghrib, 2022), avoids introducing biases linked to arbitrary weightings or differences in scales between indicators. It is based on the assumption that each variable contributes equally to the dimension it represents, whether financial development, financial vulnerability, financial soundness or the global economic climate.

Mathematically, each sub-index $S_{k,t}$, calculated for period t, is obtained by the arithmetic mean of the normalised variables that comprise it, i.e.:

$$S_{k,t} = \frac{1}{n_k} \Sigma x^{*}_{j,t} \quad (3)$$

Where $x^{*}_{j,t}$ denotes the normalised variable (using the Min-Max method or its inverse, depending on the sign of its effect). This approach ensures consistency, simplicity and transparency in the construction of the index, while maintaining a clear interpretation of the various dimensions of financial stability. It is in line with the recommendations of the Basel Conference on Macroprudential Policy (BIS, 2017), which advocates the use of balanced and explicit aggregation methods in the design of synthetic macroprudential indicators.

Each sub-index is then constructed on the basis of a simple arithmetic average of the standardised indicators that comprise it, according to the uniform weighting principle described above. This method, which is favoured in the empirical literature on financial stability (IMF, 2021; World Bank, 2023; Bank Al-Maghrib, 2022), is based on the idea that the different components of the same dimension have equivalent economic importance. It thus preserves the statistical neutrality and internal consistency of each sub-index, while ensuring a clear and balanced interpretation of the results.

Mathematically, the sub-indices are constructed as follows:

$$\overline{D}_i = \frac{1}{4}\sum_{k=1}^{4} Id_k \ (4) \ ; \quad \overline{V}_i = \frac{1}{5}\sum_{k=1}^{5} Iv_k \ (5) \ ; \quad \overline{S}_i = \frac{1}{4}\sum_{k=1}^{4} Is_k \ (6) \ ; \quad \overline{W}_i = \frac{1}{3}\sum_{k=1}^{3} Iw_k \ (4)$$

Where Id_k, Iv_k, Is_k et Iw_k, represent, respectively, the normalised variables belonging to the sub-indices of financial development (IDF), financial vulnerability (IVF), financial soundness (ISF) and global economic climate (ICEM). This balanced aggregation reflects a rigorous and transparent approach in line with the methodological recommendations of the Basel Conference on Macroprudential Policy (BIS, 2017) for the construction of composite macro-financial indicators.

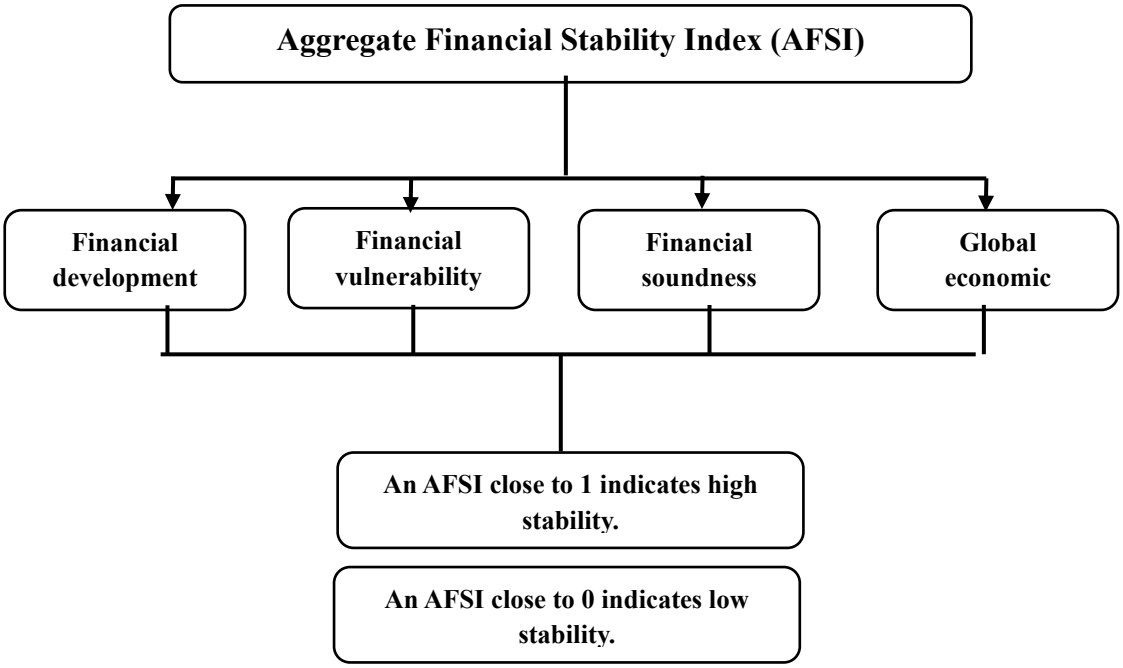
Initially, principal component analysis (PCA) was tested to determine the weights of the sub-indices, but the coefficients proved to be insignificant (KMO and Bartlett tests), indicating that the variables did not form reliable components. Thus, equal weights were applied for the aggregation of sub-indices, in line with several previous studies (Dehmej & Mikou, 2020).

Once the sub-indices have been constructed, the next step is to aggregate these components to obtain the overall financial stability index. In line with the economic logic of the model, each sub-index does not contribute equally to overall stability: certain dimensions — such as financial development, vulnerability and system strength — carry more weight than external factors related to the global economic climate. Therefore, different weights have been assigned to reflect this relative importance. More specifically, the first three sub-indices are each given a weight of 3, while the global economic climate is given a weight of 1, resulting in a total sum of weights equal to **W=3+3+3+1=10**.

The final aggregation of the overall financial stability index is therefore calculated using the following formula:

$$IASB = \frac{3\times IDF_t + 3\times IVF_t \ 3\times ISF_t \ 1\times ICEW_t}{10} \quad (5)$$

Where IDF_t, IVF_t, ISF_t et $ICEW_t$ represent the sub-indices for financial development, financial vulnerability, financial soundness and the global economic climate at period t, respectively. This hierarchical weighting gives greater weight to the internal structural dimensions of the Moroccan financial system, in line with the recommendations of the International Monetary Fund (2021) and Bank Al-Maghrib (2022), which emphasise the importance of domestic fundamentals in financial resilience.



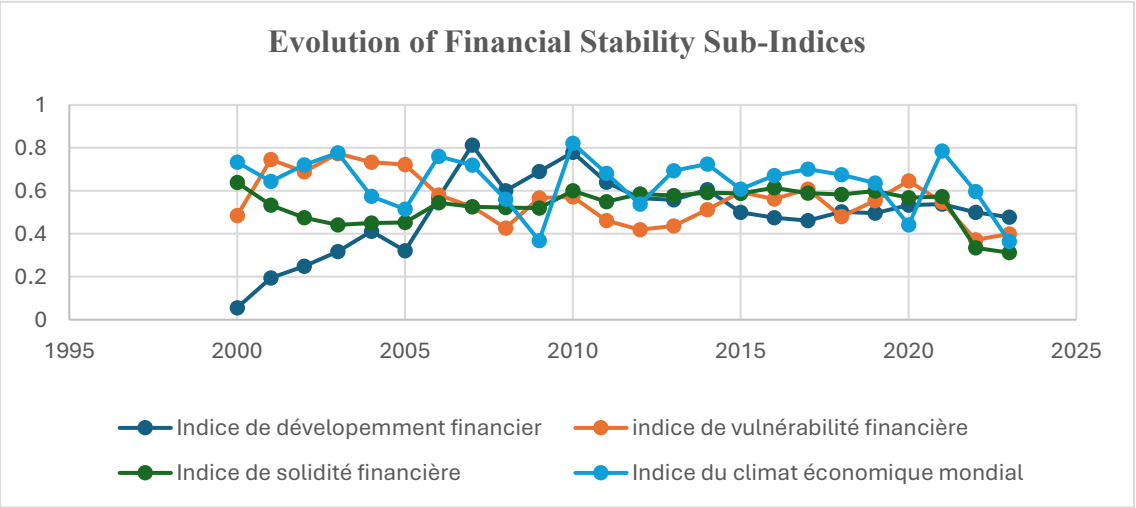
Source: *Designed and produced by the author.*

Figure 1: Conceptual model of the Aggregate Financial Stability Index (AFSI)

2. Evolution of the Moroccan financial system (2000–2023)

An analysis of the evolution of the sub-indices, presented in Figure 2, reveals contrasting dynamics before and after the 2008 global financial crisis. During the period 2000-2008, financial development and the global economic climate showed an upward trend, reflecting Morocco's increased integration into the global economy and a favourable international context. At the same time, financial soundness remained stable, indicating the resilience of the national banking system.

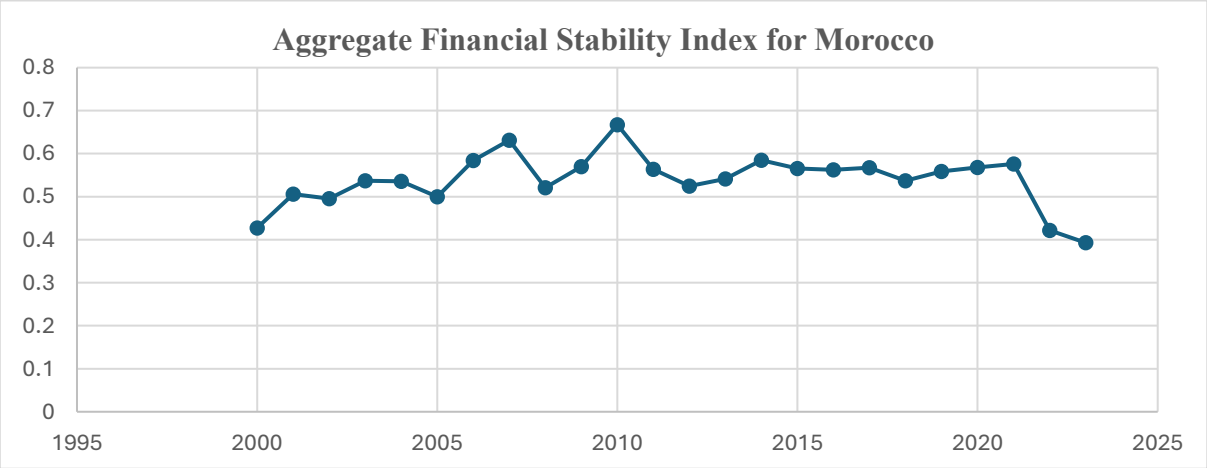
However, the gradual rise in the financial vulnerability index from the mid-2000s onwards signalled an accumulation of macro-financial risks, often associated with dynamic private credit, which made the economy more sensitive to external shocks.



Source: *Author's calculations.*

Figure 2: Dynamics of financial stability components in Morocco (2000–2023)

The post-2008 period has been marked by the impact of this crisis and subsequent shocks to the global economy. There has been a clear decoupling: the global economic climate and financial vulnerability have experienced pronounced volatility, with deep troughs corresponding respectively to tensions on international markets and episodes of financial stress. In contrast, the financial soundness index has proven remarkably resilient, demonstrating the effectiveness of prudential regulations and the robustness of the Moroccan banking sector's foundations. After a correction, financial development is back on an upward trajectory, illustrating the continued reforms and modernisation of the financial system despite a difficult external environment.



Source: *Author's calculations.*

Figure 3: Evolution of Morocco's Aggregate Financial Stability Index (2000–2023)

Analysis of the aggregate index's trajectory between 2000 and 2023 highlights structural resilience, albeit tested by a sequence of exogenous shocks. The period leading up to the 2008 global financial crisis was marked by sustained improvement, reflecting the cumulative benefits of financial sector reforms and prudent macroeconomic management. This trend was temporarily reversed by the shock of 2008–2009, with a contraction in the index revealing the country's sensitivity to international financial turmoil. The vigorous recovery that followed, peaking in the mid-2010s, illustrates the strength of the country's fundamentals and the resilience of the system.

The recent period (2020-2023) is particularly instructive. The pandemic shock of 2020 caused a significant correction in the index, reflecting the impact of lockdown measures on economic activity and the rise in credit risks. However, the recovery observed from 2021-2022,

although moderate, attests to the effectiveness of government support measures and the strength of the banking system's liquidity and capital buffers. The stabilisation or slight increase in the index in 2023, against a backdrop of global monetary tightening and inflationary pressures, suggests operational resilience but also persistent vulnerability to global shocks, marking a phase of consolidation in a deteriorating international environment.

3. Correlation matrix between financial stability sub-indices

Table 2: Pearson Correlation Matrix between Sub-Indices

Corrélation	IDF	IVF	ISF	ICEM
IDF	1.000	-0.410	0.113	-0.045
IVF		1.000	-0.008	0.136
ISF			1.000	0.428
ICEM				1.000

Source : *Author's calculations.*

Table 2 analyses the internal consistency between the four sub-indices of financial development, financial vulnerability, financial soundness and global economic climate, highlighting generally weak to moderate correlations over the period 2000–2023. The negative correlation between financial development and vulnerability (-0.41) reflects an economically consistent relationship: a strengthening of the financial system is accompanied by a reduction in structural weaknesses. On the other hand, the links between development and soundness (0.11) or with the global economic climate (-0.05) remain weak, indicating that these dimensions evolve relatively independently.

The average positive correlation between financial soundness and the global economic climate (0.43) suggests that the Moroccan financial system is somewhat dependent on international economic conditions. Overall, the weak correlations observed confirm that each sub-index captures a distinct but complementary aspect of financial stability, thus ensuring the structural validity and economic relevance of the aggregate index constructed.

4. Measuring the Volatility of the Aggregate Financial Stability Index in Morocco

The previous descriptive analysis, while illuminating, does not provide an in-depth understanding of the underlying dynamics of the financial stability index, nor does it accurately identify the components that contribute most to its fluctuations. To remedy this and better understand the volatility of the Aggregate Financial Stability Index for Morocco (IASF) and the share attributable to each of its sub-indices, a more sophisticated analysis, inspired by the pioneering method of Chanut and Laroque (1979), is implemented. This approach makes it possible to quantify the contribution of each component's volatility to the total volatility of the aggregate index.

Modelling the temporal evolution of the aggregate index $\boldsymbol{At}$ and its $\boldsymbol{m}$ components $\boldsymbol{C_{i,t}}$, for $\boldsymbol{i=1,\ldots,m}$ and over the period **t=1,...,T**, is based on the fundamental aggregate relationship:

$$\boldsymbol{At} = \sum_{\boldsymbol{i=1}}^{\boldsymbol{m}} \boldsymbol{C_{i,t}} \quad \textbf{(6)}$$

The annual growth rate of this aggregate, denoted $\boldsymbol{g_t}$, is therefore calculated as follows:

$$\boldsymbol{g_t} = \frac{\boldsymbol{A_t - A_{t-1}}}{\boldsymbol{A_t - 1}} \quad \textbf{(7)}$$

Parallèlement, la contribution de chaque composante $\boldsymbol{i}$ à ce taux de croissance global, désignée par $\boldsymbol{g_{i,t}}$, est définie par :

At the same time, the contribution of each component i to this overall growth rate, denoted by $\boldsymbol{g_{i,t}}$,is defined by:

$$\boldsymbol{g_{i,t}} = \frac{\boldsymbol{C_{i,t} - C_{i,t-1}}}{\boldsymbol{A_{t-1}}} \quad \textbf{(8)}$$

It follows directly from equations (9), (10) and (11) that the growth rate of the aggregate is exactly equal to the sum of the contributions of its components:

$$\boldsymbol{gt} = \sum_{\boldsymbol{i=1}}^{\boldsymbol{m}} \boldsymbol{g_{i,t}}, \ \textbf{For } \boldsymbol{t = 2, \ldots, T} \quad \textbf{(9)}$$

In the specific case of the IASF, whose weighting structure is defined by the sub-indices of Financial Development (IDF), Financial Vulnerability (IVF), Financial Soundness (ISF) and Global Economic Climate (ICEM), equation (13) becomes:

$$\boldsymbol{gt = 0,3 g_{IDF,t} + 0,3 g_{IVF,t} + 0,3 g_{ISF,t} + 0,1 g_{ICE,t}} \quad \textbf{(10)}$$

Assuming that the series of growth rates and contributions $\mathbf{g_{1,t,\ldots}}$ $\mathbf{g_{m,t}}$, $\mathbf{g_t}$ form a second-order stationary stochastic process, we can express the mathematical expectation of the overall growth rate as the sum of the expectations of its contributions:

$$\boldsymbol{E[g] = \sum_{i=1}^{m} E[g_i]} \quad \textbf{(11)}$$

Soit $\boldsymbol{\sigma_{g_i}}$ l'écart-type de la série $\boldsymbol{g}_i$ et $\boldsymbol{\rho_{g,gi}}$ le coefficient de corrélation entre $\boldsymbol{g}$ et $\boldsymbol{g_i}$, L'écart-type de l'agrégat, $\boldsymbol{\sigma_g}$, peut être décomposé de la manière suivante :

Let$\boldsymbol{\sigma_{g_i}}$ be the standard deviation of series $\boldsymbol{g}_i$ and $\boldsymbol{\rho_{g,gi}}$ the correlation coefficient between $\boldsymbol{g}$ and $\boldsymbol{g_i}$, The standard deviation of the aggregate, $\boldsymbol{\sigma_g}$, can be broken down as follows:

$$\sigma_g = \sum_{i=1}^{m} \rho_{g,gi} \cdot \sigma_{g_i} \quad \textbf{(12)}$$

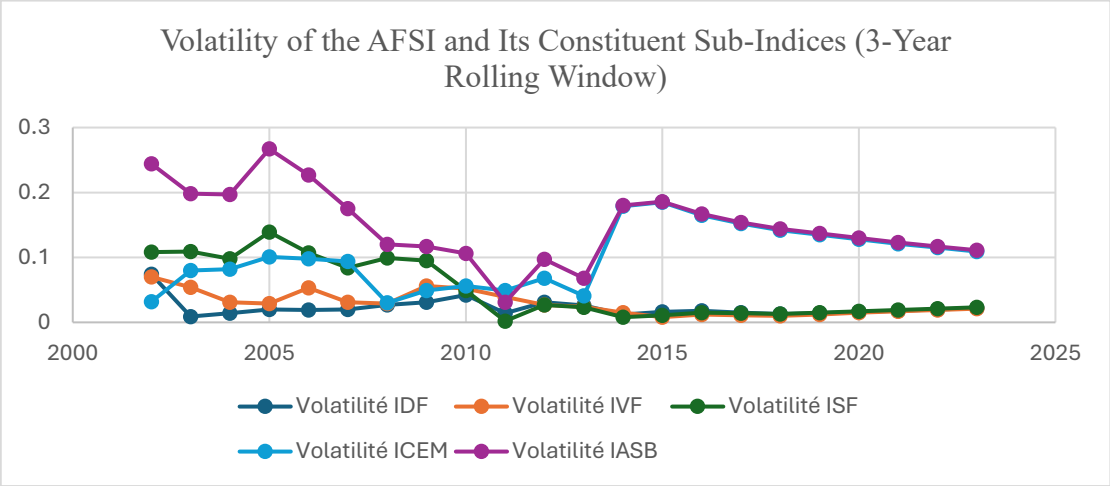
By substituting the theoretical moments in this equation with their empirical estimators (sample mean and standard deviation), we obtain concrete measures. The relative contribution of each component ***i*** to the average growth of the aggregate is given by:

$$cc_i = \frac{E[g_i]}{E[g]} \quad (13)$$

Whereas its contribution to the total volatility of the aggregate is calculated as follows:

$$vc_i = \frac{\rho_{g,gi} \cdot \sigma_{g_i}}{\sigma_g} \quad (14)$$

This last measure, vc_i, is particularly crucial. It indicates the extent to which the variability of each sub-index explains the overall variability of the IASF. A high, positive value of vc_i for a given sub-index indicates that it is a major source of instability for the Moroccan financial system as a whole.



Source: *Author's calculations.*

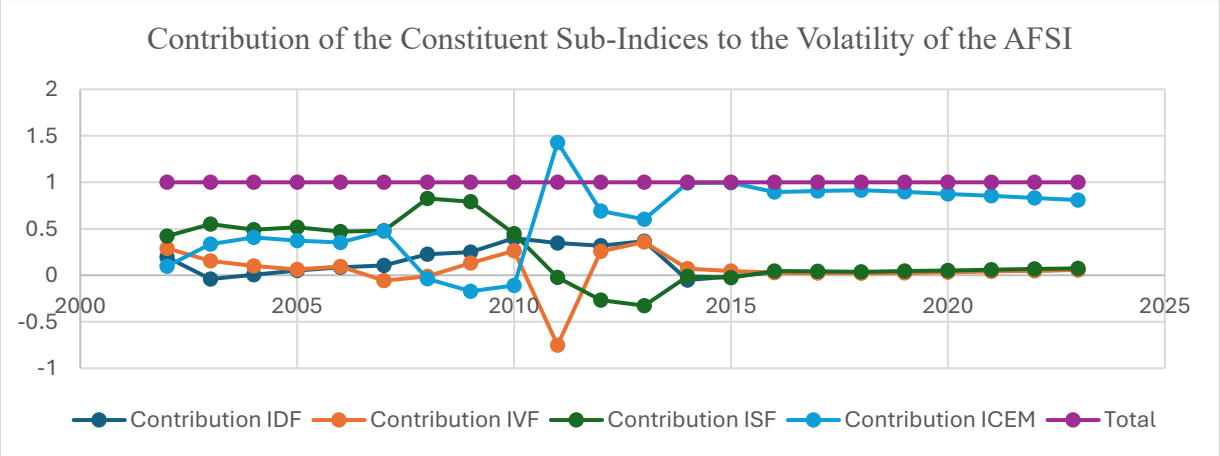
Figure 4: Volatility of the AFSI and Its Constituent Sub-Indices

Analysis of volatility over a three-year rolling window reveals distinct dynamics depending on the crisis period. During the 2002-2009 phase, marked by the impact of the international financial crisis, IASF volatility was high, peaking around 2005-2006. This instability was mainly driven by the volatility of the financial soundness index (FSI), which showed the strongest fluctuations, reflecting tensions on the solvency of the Moroccan banking system. At the same time, the financial vulnerability index (FVI) contributed significantly to this volatility, reflecting sensitivity to external macroeconomic shocks during this period.

The post-2010 period is characterised by a notable reduction in the overall volatility of the IASF, a sign of increased resilience in the national financial system. Nevertheless, there has been a change in the structure of contributions: the volatility of the Global Economic Climate Index (GECI) has gradually become the predominant factor, particularly since 2014. This shift reflects the growing importance of exogenous shocks, as evidenced by the impact of

geopolitical tensions and the COVID-19 pandemic, while domestic components (financial development and soundness) remain relatively stable as a result of structural reforms and regulatory policies.

After analysing the volatility of the IASF and its components, we must now assess the specific contribution of each sub-index to this overall volatility.



Source: *Author's calculations.*

Figure 5: Contribution of the Constituent Sub-Indices to the Volatility of the AFSI

Analysis of the relative contributions of the sub-indices to IASF volatility reveals a significant shift in the sources of financial instability between crisis periods. During the 2002-2009 phase, marked by the international financial crisis, the financial soundness index (FSI) emerged as the main contributor to volatility, with peaks exceeding 50% of total variance. This predominance reflects specific pressures on the resilience of the Moroccan banking system, while the financial vulnerability index (FVI) plays a secondary but growing role, particularly during the height of the crisis in 2008-2009.

The post-2010 period shows a structural transformation in the determinants of instability. The global economic climate index (GECI) is gradually becoming the dominant factor, accounting for up to 90% of total volatility at the end of the period.

This growing externalisation of sources of instability coincides with the increased integration of the Moroccan economy into international financial markets, while domestic factors (development and financial strength) are seeing their relative contribution decline, demonstrating the effectiveness of macroprudential policies implemented to strengthen the stability of the national financial system in the face of international shocks.

As formalised in equation (17), the relative contribution of each component to the total volatility of the aggregate can be quantified. The table below, which presents an analysis of the contributions to the growth and volatility of the Moroccan financial stability index, thus makes

it possible to identify the sub-indices whose fluctuations have had the greatest influence on the overall dynamics.

Table 3: Analysis of Contributions to the Growth and Volatility of the AFSI

Sub-Index	$(E[g_i])$	(cc_i)	$(\sigma_{(g_i)})$	$(\rho_{(g,g_i)})$	(vc_i)
IDF	0.0128	5.136	0.0593	0.767	(41.2 %)
IVF	0.0010	0.407	0.0610	0.535	(29.5 %)
ISF	−0.0082	−3.286	0.0356	0.449	(14.5 %)
ICEM	−0.0031	−1.257	0.0334	0.491	(14.8 %)
Total / $\sigma_{(g)}$ =	—	(100 %)	—	—	-100%

Source: *Author's calculations based on AFSI data, 2000–2023.*

An examination of the contributions to volatility shows that financial development (41.2%) and financial vulnerability (29.5%) are the main sources of instability. This structure highlights the system's sensitivity to shocks affecting financial intermediation and macroeconomic imbalances, particularly during periods of crisis. The high correlation between financial development and overall volatility (ρ=0.767) confirms that periods of credit expansion and financial innovation, while stimulating growth in the index, are also the main channel for the transmission of financial stability shocks in Morocco.

Discussion and policy implications

The results of the Aggregate Financial Stability Index (AFSI) highlight several important implications for economic policy-making and macroprudential supervision in Morocco. First, the strong contribution of financial development and financial vulnerability to the volatility of the index underscores the need to strike a balance between financial expansion and systemic risk management. As Borio (2014) and the IMF (2021) point out, unregulated financial deepening can increase procyclical risks and amplify macroeconomic shocks. It is therefore crucial that the Moroccan authorities continue to strengthen macroprudential tools, including countercyclical buffers, liquidity ratios, and capital requirements, in order to absorb tensions in times of financial stress.

Secondly, the rise of the global economic climate as a dominant factor of instability since 2010 confirms the external vulnerability of the Moroccan financial system to international cycles. This calls for greater coordination between monetary, fiscal, and macroprudential policies in order to mitigate the effects of external shocks (rising global interest rates, imported inflation, geopolitical tensions). As highlighted by the World Bank (2023) and Bank Al-Maghrib (2025), financial stability cannot be ensured without consistency between these three levers of action. The Systemic Risk Coordination and Oversight

Committee (CCSRS) should therefore play a stronger role in the early detection of vulnerabilities and the dissemination of a national culture of systemic risk prevention.

Finally, the IASF can serve as a strategic dashboard for public decision-making. By incorporating this index into official financial stability reports, authorities will have a continuous and predictive monitoring tool to assess the effectiveness of reforms, calibrate support measures, and strengthen macroprudential communication. In the medium term, this approach could support the resilience of the Moroccan financial system and consolidate the institutional credibility of the stability framework, in line with recent recommendations from the IMF (2024) and the Basel Committee (2017).

Conclusion

The development of the Aggregate Financial Stability Index (AFSI) for Morocco over the period 2000–2023 has enabled the construction of a comprehensive, multidimensional tool for measuring the resilience of the national financial system. Structured around four pillars—financial development, financial vulnerability, financial soundness, and the global economic climate—this index provides an integrated view of Morocco's financial dynamics over more than two decades. The methodology adopted, based on Min-Max normalization, differentiated weighting, and volatility analysis, is consistent with the methodological standards of the IMF (2021) and the World Bank (2023).

The results highlight the overall solid structural stability of the Moroccan financial system. The aggregate index shows a positive trend between 2000 and 2023, with remarkable resilience following the crises of 2008 and 2020. Despite some episodes of fragility linked to external shocks, the index remains above 0.5 for most of the period, indicating sustained resilience. This robustness can be explained by the strength of the banking sector, proactive regulation by Bank Al-Maghrib, and effective prudential policies. However, rising financial vulnerability and the growing influence of the global economic climate reflect increased sensitivity to external factors, underscoring the need for continued strengthening of the macroprudential framework and better coordination between monetary and fiscal policies.

We can therefore conclude that Morocco remains broadly stable in financial terms, although this stability rests on a delicate balance between financial development and systemic risk management. The index highlights a resilient system that is nevertheless exposed to international cycles and global shocks. These findings are consistent with those of Dehmej and Mikou (2020) and Bank Al-Maghrib (2023), which emphasize the decisive role of structural reforms and macroprudential supervision in maintaining stability. Ultimately, the AFSI is an

operational tool for assessing and anticipating systemic risks, capable of improving policy coordination and supporting strategic decision-making. By integrating it into the official macroprudential framework, the Moroccan authorities could strengthen financial stability, promote sustainable growth, and consolidate institutional credibility in an environment marked by persistent uncertainty.

Despite its methodological robustness, this study presents certain limitations. First, the index construction is based on secondary data whose periodicity and availability may affect indicator precision. Second, the weighting system—though theoretically justified—remains partly subjective and may not capture nonlinear interactions among sub-indices. Third, the analysis is limited to Morocco, restricting cross-country comparability and external validity. Finally, while the volatility decomposition highlights sources of instability, it does not explicitly model causal relationships, which could be explored through econometric or dynamic panel approaches in future research.

From a managerial and policy perspective, the AFSI provides an actionable framework for macroprudential oversight and financial risk monitoring. For policymakers, the index offers an early-warning mechanism to detect rising vulnerabilities and guide preventive interventions. For Bank Al-Maghrib and the Systemic Risk Coordination and Oversight Committee (CCSRS), it can serve as a strategic tool for calibrating capital buffers, liquidity requirements, and countercyclical measures. Financial institutions can also use it to align internal risk management with macroprudential objectives and anticipate systemic pressures. By institutionalizing the AFSI as a component of financial stability reports, Moroccan authorities can enhance transparency, foster investor confidence, and strengthen resilience in the face of external shocks.

Appendix

Table 4: Normalization and weighting of data for calculating sub-indices, indicators, and aggregates

Indice	Indicateur	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
IDF	Id1	0,10	0,15	0,20	0,25	0,31	0,00	0,68	1,00	0,23	0,28	0,38	0,50	0,53	0,50	0,41	0,33	0,25	0,11	0,38	0,38	0,46	0,31	0,36	0,23
	Id2	0,12	0,07	0,00	0,06	0,28	0,37	0,69	1,00	0,77	0,69	0,79	0,63	0,48	0,45	0,46	0,38	0,56	0,58	0,48	0,51	0,53	0,58	0,41	0,44
	Id3	0,00	0,14	0,28	0,43	0,57	0,65	0,66	0,66	0,77	0,79	1,00	0,74	0,76	0,76	0,68	0,79	0,73	0,78	0,82	0,80	0,83	0,83	0,86	0,86
	Id4	0,00	0,41	0,51	0,53	0,50	0,26	0,25	0,59	0,63	1,00	0,95	0,69	0,49	0,51	0,87	0,50	0,37	0,37	0,32	0,29	0,32	0,44	0,37	0,38
	Ω IDF	**0,06**	**0,19**	**0,25**	**0,32**	**0,41**	**0,32**	**0,57**	**0,81**	**0,60**	**0,69**	**0,78**	**0,64**	**0,57**	**0,56**	**0,61**	**0,50**	**0,47**	**0,46**	**0,50**	**0,50**	**0,53**	**0,54**	**0,50**	**0,48**
IVF	Iv1	0,68	0,87	0,52	0,79	0,73	0,79	0,46	0,65	0,37	1,00	0,81	0,81	0,76	0,68	0,89	0,71	0,73	0,84	0,71	0,94	0,86	0,75	0,02	0,00
	Iv2	0,12	0,67	0,80	1,00	0,92	0,72	0,83	0,70	0,28	0,49	0,45	0,12	0,00	0,06	0,07	0,30	0,32	0,27	0,13	0,21	0,68	0,38	0,13	0,22
	Iv3	0,62	1,00	0,96	0,92	0,83	0,83	0,86	0,70	0,36	0,32	0,40	0,13	0,00	0,17	0,27	0,55	0,41	0,46	0,32	0,44	0,62	0,52	0,48	0,51
	Iv4	0,00	0,24	0,26	0,31	0,40	0,56	0,53	0,58	0,59	0,52	0,76	0,89	1,00	0,92	0,91	0,93	0,82	0,83	0,79	0,75	0,68	0,60	0,77	0,72
	Iv5	1,00	0,95	0,89	0,84	0,79	0,71	0,23	0,00	0,54	0,51	0,44	0,35	0,33	0,35	0,42	0,47	0,54	0,63	0,44	0,44	0,39	0,49	0,46	0,54
	Ω IVF	**0,49**	**0,75**	**0,69**	**0,77**	**0,73**	**0,72**	**0,58**	**0,53**	**0,43**	**0,57**	**0,57**	**0,46**	**0,42**	**0,44**	**0,51**	**0,59**	**0,56**	**0,61**	**0,48**	**0,55**	**0,65**	**0,55**	**0,37**	**0,40**
ISF	Is1	0,87	0,54	0,48	0,21	0,21	0,24	0,15	0,00	0,00	0,09	0,42	0,36	0,48	0,51	0,60	0,64	0,69	0,73	0,78	0,82	0,87	0,91	0,96	1,00
	Is2	0,13	0,18	0,15	0,05	0,00	0,25	0,58	0,79	0,92	0,95	1,00	1,00	0,99	0,92	0,86	0,78	0,71	0,64	0,57	0,50	0,42	0,35	0,28	0,21
	Is3	0,86	0,77	0,67	0,63	0,59	0,44	0,67	0,56	0,64	0,76	0,80	0,72	0,81	0,81	0,91	0,89	0,95	0,90	0,89	1,00	0,88	0,91	0,00	0,00
	Is4	0,70	0,65	0,60	0,88	1,00	0,88	0,78	0,75	0,53	0,28	0,18	0,12	0,06	0,07	0,00	0,04	0,11	0,08	0,10	0,08	0,10	0,12	0,10	0,03
	Ω ISF	**0,64**	**0,53**	**0,47**	**0,44**	**0,45**	**0,45**	**0,54**	**0,53**	**0,52**	**0,52**	**0,60**	**0,55**	**0,59**	**0,58**	**0,59**	**0,59**	**0,61**	**0,59**	**0,58**	**0,60**	**0,57**	**0,57**	**0,33**	**0,31**
ICE	Iw1	0,80	0,53	0,56	0,64	0,79	0,74	0,79	0,78	0,53	0,17	0,80	0,67	0,60	0,62	0,65	0,65	0,61	0,68	0,66	0,60	0,00	1,00	0,67	0,62
	Iw2	0,40	0,60	0,67	0,82	0,78	0,80	0,78	0,78	0,75	0,38	1,00	0,83	0,62	0,77	0,85	0,90	0,98	0,98	0,90	0,83	0,85	0,88	0,65	0,00
	Iw3	1,00	0,80	0,94	0,87	0,15	0,00	0,71	0,60	0,40	0,56	0,67	0,54	0,40	0,69	0,68	0,28	0,42	0,44	0,46	0,48	0,47	0,47	0,47	0,47
Ω ICE		**0,73**	**0,64**	**0,72**	**0,78**	**0,57**	**0,51**	**0,76**	**0,72**	**0,56**	**0,37**	**0,82**	**0,68**	**0,54**	**0,69**	**0,72**	**0,61**	**0,67**	**0,70**	**0,67**	**0,64**	**0,44**	**0,78**	**0,60**	**0,36**
IASB		**0,43**	**0,51**	**0,50**	**0,54**	**0,54**	**0,50**	**0,58**	**0,63**	**0,52**	**0,57**	**0,67**	**0,56**	**0,52**	**0,54**	**0,58**	**0,57**	**0,56**	**0,57**	**0,54**	**0,56**	**0,57**	**0,58**	**0,42**	**0,39**

Table 5: Contribution of the growth rate of each sub-index

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
IDF		2,48	0,28	0,27	0,30	-0,22	0,77	0,43	-0,26	0,15	0,13	-0,18	-0,12	-0,01	0,08	-0,17	-0,05	-0,03	0,09	-0,01	0,08	0,01	-0,07	-0,04
IVF		0,54	-0,08	0,12	-0,05	-0,02	-0,20	-0,09	-0,19	0,33	0,01	-0,19	-0,09	0,04	0,17	0,16	-0,05	0,08	-0,21	0,16	0,16	-0,15	-0,32	0,07
ISF		-0,16	-0,11	-0,07	0,02	0,004	0,20	-0,03	-0,07	-0,05	0,15	-0,08	0,06	-0,01	0,023	-0,06	0,045	-0,04	-0,09	0,028	-0,05	0,010	-0,41	-0,06
ICEM		-0,12	0,12	0,08	-0,26	-0,10	0,48	-0,05	-0,22	-0,34	1,23	-0,17	-0,21	0,29	0,05	-0,16	0,10	0,05	-0,04	-0,06	-0,31	0,78	-0,24	-0,39
IASB		0,18	-0,02	0,08	0,00	-0,07	0,17	0,08	-0,17	0,09	0,17	-0,16	-0,07	0,03	0,08	-0,03	-0,01	0,01	-0,05	0,04	0,02	0,01	-0,27	-0,07

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