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UNVEILING THE NEXUS BETWEEN CENTRAL BANK AUTONOMY AND FREE MARKET DYNAMICS: A STRUCTURAL EQUATION MODELING APPROACH

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Abstract: The interaction between the independence of the Central Bank (CBI) and the principle of the open market plays a major role in shaping policy performance at the international level. The CBI ensures monetary stability by insulating central banks from political pressures, while open markets promote economic freedom and growth through regulatory efficiency and openness. This study aims to fill the gap in the existing literature by examining the combined effects of these factors on national policy outcomes. Using Structural Equation Modeling (SEM) estimated by second-order Confirmatory Factor Analysis (CFA), the study analyzes data from 143 countries including indicators for open markets such as trade freedom, investment freedom and financial freedom, as well as dimensions of CBI such as policy autonomy and legal frameworks. The results reveal that open market indicators, especially financial and investment freedom, significantly affect policy performance, often exceeding the direct effect of CBI. European countries with robust regulatory frameworks and open markets are ranked highly, highlighting the complementary nature of economic openness and institutional autonomy. Furthermore, the study finds that although central bank independence is crucial for economic stability, it does not by itself guarantee superior policy outcomes, especially in regions where economic freedoms are limited.

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1. Introduction

The interconnection between central bank independence (CBI) and the open market concept has long been a discussion topic in the economics literature, mainly to understand how these dynamics affect monetary policy performance. Central banks play the main role in making monetary policy decisions, and thus their autonomy from the political structures is usually seen as fundamental to warranting solid and successful supervision. At the same time, characteristics of open markets, such as regulatory efficiency and open markets, are major handlers of freedom and growth in economic activities.

The CBI and the concept of open markets represent two main pillars in contemporary economic thinking, especially concerning their impact on macroeconomic stability and policy effectiveness. While central banks have significant authority over monetary policy, their independence from political, and government pressures is generally considered necessary to maintain stable inflation rates, increase confidence in monetary institutions, and ensure long-term economic growth (Romelli, 2022). On the other hand, the efficiency of open markets, characterized by low trade barriers, free movement of capital and minimal government intervention, is central to the theory of economic liberalization. Open markets play a crucial role in driving economic prosperity and innovation and thus are often associated with economic freedom as pointed out by the Heritage Foundation (2023). Nevertheless, the interaction between the CBI and the open market principles has not been decently explored, especially in terms of their collective impact on policy performance.

This study aims to fill this gap by analyzing the relationship between central bank independence and open markets through Structural Equation Modeling (SEM) which is a sophisticated multivariate analysis technique that allows the study of latent indicators and their relationships with the observed data (Anderson & Gerbing, 1988). It is especially suitable for evaluating multidimensional structures such as regulatory frameworks, market dynamics, and corporate performance (Ruge, 2010, Hall & Kanaan, 2021, Tanwar & Agarwal, 2024).

As defined by Romelli (2022), the CBI covers various dimensions, including the autonomy of central bank boards, monetary policy objectives, and restrictions on government borrowing. The main idea behind the CBI is that thanks to the CBI monetary authorities can focus on long-term economic goals such as price stability without being exposed to short-term political pressures (Cukierman, 1992). It has been shown that countries with higher CBI levels experience lower inflation rates and more stable economic environments (Garriga & Rodriguez, 2020). However, the extent to which the CBI alone drives effective policy outcomes remains controversial, especially when viewed separately from other economic indicators such as market openness.

Open markets, as measured by the Heritage Foundation's Index of Economic Freedom (2023), are similarly multifaceted and encompass trade freedom, investment freedom, and financial freedom. Proponents of market liberalization argue that open markets promote competition, encourage innovation and lead to greater economic efficiency (Altintas, 2021). By reducing barriers to trade and investment, countries can enjoy comparative advantages, attract foreign direct investment, and promote economic growth. However, the benefits of open markets depend on sound institutional frameworks that can maintain free competition and regulatory efficiency (Mohamad Anwar et al., 2021). Both the open markets and central bank independence represent different aspects of economic governance. One is based on institutional autonomy, and the other on market liberalization. Thus, the interaction between open markets and central bank independence is of particular interest in the literature.

Despite their individual importance, studies that integrate both the CBI and the open market frameworks remain insufficient to assess their common impact on policy performance. Most analyses in the literature have focused on one dimension at a time. For example, Romelli (2022; 2024) examined how central bank independence affects inflation control and macroeconomic stability, while Raghutla (2020), Awokuse (2008) and Hossain (2016) evaluated how open market policies guide economic growth and development. Combining these two aspects in a unified framework has the potential to provide deeper insights into the mechanisms that underpin successful economic policies. Taking advantage of the second-order CFA, a subset of the SEM, this study examines the latent structures of the CBI and open markets by integrating multiple indicators to assess their impact on policy effectiveness. Specifically, this research explores how the various dimensions of the CBI (such as policy autonomy and legal frameworks) interact with the key components of open markets (trade freedom, investment freedom and financial freedom) to influence national policy outcomes in 143 countries. With this model, it will be possible to measure the strength of these relationships and determine which aspects of the CBI and open markets are the most critical to achieving policy success.

While conducting this analysis, we aim to contribute to the growing body of literature that tries to decipher the complex interaction between institutional autonomy and market liberalization. Through a comprehensive assessment of how the CBI and open markets collectively impact policy effectiveness, the findings will provide valuable information for policymakers trying to improve governance and economic performance. The results of this study are particularly timely as countries grapple with the dual challenges of maintaining economic growth while maintaining macroeconomic stability in an increasingly interconnected global economy.

In summary, this paper seeks to provide an in-depth analysis of how central bank independence and open market principles interact to shape policy performance, employing advanced SEM techniques to offer a nuanced understanding of these critical economic relationships. The findings will offer fresh perspectives for both scholars and policymakers aiming to enhance the effectiveness of economic governance.

2. Theoretical Background and Related Literature

SEM is a robust statistical approach to investigate and confirm complex causal relationships between observed and latent indicators. It provides a comprehensive framework for hypothesis testing and model verification by integrating various statistical techniques such as regression, factor analysis, and path analysis (Anderson & Gerbing, 1988). Due to its flexibility in the processing of multivariate data, SEM is ideal for research areas including social sciences, where understanding both indirect and direct relationships between indicators is very important (Chin & Newsted, 1999). Tarka (2018) provides an in-depth overview of the historical development of SEM, traces its evolution from Spearman's factor analysis to its current use in causal analysis, and highlights both its strengths and limitations in analyzing complex social phenomena.

SEM can be broadly divided into two main approaches: Covariance-Based SEM (CB-SEM) and Partial Least Squares SEM (PLS-SEM) (Hair et al., 2014). Each of these methods has different aspects and methodological requirements. Thus, the choice between them is highly dependent on the research context and objectives. CB-SEM is usually preferred when the primary goal is theory testing or validation. This approach is advantageous for research involving well-established theories and structures. Even though it is more demanding in terms of its assumptions as it requires large sample sizes and normally distributed data, it provides powerful tools for verifying models and testing hypotheses with precision (Afthanorhan, 2013). In contrast, PLS-SEM is more flexible and is especially well-suited for exploratory research (Fallahnejad et al., 2023). This method is usually used in cases where research aims to explain the variance in dependent indicators, which makes it quite effective for predictive models (Hair et al., 2011).

One of the main strengths of SEM, including both CB-SEM and PLS-SEM, is the ability to include latent indicators that cannot be measured directly but are inferred from observable indicators. For example, researchers often use SEM to investigate constructs represented by multiple observed indicators, such as customer satisfaction, quality management, or organizational commitment (Afthanorhan, 2013; Bazrkar et al., 2022). By integrating measurement models (to identify latent indicators) and structural models (to interpret relationships between structures), SEM allows the testing of complex models that include both direct and indirect effects (Anderson and Gerbing, 1988). The versatility of SEM extends to more than one area. In economics, SEM is used to test causal hypotheses of financial development models (Nageri, 2020), to measure aspects of economic development's dependence on social capital (Borkowski, 2023), or to accurately capture the relationship between social trust and accelerating economic development (Borkowski, 2024).

Numerous studies highlight the breadth and flexibility of SEM, especially in assessing complex economic relationships. For example, Altintaş (2021) applied SEM to investigate the impact of regulatory efficiency on open markets by using the Heritage Foundation's Index of Economic Freedom. Their findings revealed that regulatory efficiency significantly affects open markets, and that investment freedom is a stronger contributor to market dynamics compared to other factors, such as freedom of work and labor. Similarly, Şahinoğlu and Yakut (2019) used SEM to examine the direct and indirect effects of economic freedoms and democracy on economic performance. Focusing on 45 European countries, his work showed that democracy mediates the relationship between economic freedom and performance, implying that economic freedom alone does not directly improve performance without a solid democratic framework. Polat et al. (2013) investigated the effect of economic freedom on stock market development in developing economies using SEM. In the measurement model estimates, economic freedom does not provide a significant variation in stock market development; however, in the iterative model estimates, it is found that market capitalization, turnover, and stock market trading make a significant contribution to stock market development. In the structural model estimates, it is found that business freedom has a very strong effect on stock market development compared to other economic indicators.

Pei (2024) examined the role of green microfinance institutions in shaping economic freedom using SEM. It found that green microfinance policies and services promote economic freedom. Amoh et al. (2023) evaluated the effects of tax revenues on economic development using SEM and maximum likelihood estimation techniques. In the study, it was stated that SEM is a very good choice for examining economic development indicators, especially in terms of eliminating the endogeneity problems that characterize traditional regression approaches. Jiao et al. (2016) provided another compelling example of the usefulness of SEM in modeling complex relationships. They used SEM to assess sustainable urbanization by combining latent indicators to capture the complex relationships between economic, social, environmental and resource sustainability. Considering both direct and indirect effects, it revealed deeper insights into the dynamics of sustainable development that may have been latent by simpler statistical approaches. Vashisht et al. (2025) used SEM to investigate the relationship between financial performance and environmental performance of firms operating in different sectors. Using non-recursive SEMs in a dynamic panel data environment, they found that only firms that perform better financially can also improve their environmental performance.

All the studies presented above demonstrate the robustness of SEM in assessing causal relationships in complex models. Indeed, when analyzing the role of economic freedom or central bank independence on policy effectiveness, SEM offers a holistic approach to assessing the causal relationships of multivariate structures. The ability to simultaneously interpret complex relationships among indicators makes this approach an indispensable tool for investigating the interdependencies in complex systems involving economic freedoms, governance structures and market dynamics. Nyandwe et al. (2024) assessed the role of economic growth in achieving sustainable development goals using SEM. The SEM findings show a strong relationship between economic factors and sustainable development. They stated that this is consistent with the idea that the economy can make a positive contribution to sustainable development initiatives.

The process of executing the SEM follows a stepwise process (Gudergan et al., 2025): First, a functional model is determined based on the theoretical framework. This functional model provides the baseline by determining the indicators and structures that show causal-predictive relationships. Then, the model definition is evaluated to test whether the data provides sufficient information for parameter estimation. After the model is predicted, fit indices such as RMSEA (Root Mean Square Error of the Approach) and CFI (Comparative Fit Index) are used to assess how well the model fits the observed data. If necessary, changes can be made, such as adding or removing ways to improve the fit of the model (Afthanorhan, 2013). An example of this process is seen in customer satisfaction studies where PLS-SEM is used to evaluate the effect of perceived usefulness, convenience and interest on customer satisfaction and then its effect on behavioral intentions (Gye-Soo, 2016). As another example, studies where PLS-SEM is used to analyze the contextual factors affecting the application of artificial intelligence in the execution of recruitment processes or to analyze the effects of career path development performance criteria on the job performance of employees can be given (Bazrkar et al., 2024; Fallahnejad et al., 2023). In these contexts, PLS-SEM offers clear advantages, especially when processing non-normal data and small sample sizes. Its flexibility allows researchers to obtain reliable and valid results, even if data constraints exist. Despite the many advantages of SEM, it also has limitations. For example, small sample sizes in CB-SEM can lead to identification problems and unreliable parameter estimates, while PLS-SEM may encounter problems such as multi-linearity and biased estimates due to inconsistencies in scores on latent indicators (Chin & Newsted, 1999). Researchers should carefully choose between reflective and formative measurement models, as each requires different assessment techniques to ensure reliability and validity (Afthanorhan, 2013). However, SEM's ability to integrate multiple statistical techniques makes it a powerful tool in many disciplines. Its application continues to grow, especially in areas requiring the analysis of complex, multivariate relationships. Although it is used for theory testing in CB-SEM or exploratory research in PLS-SEM, SEM remains an important technique in advancing empirical research in various academic fields (Ajayi & Adebayo, 2021).

As a result, SEM offers a complex approach to understanding and testing the complex relationships between indicators. Whether through Covariance-Based SEM to validate the theory or PLS-SEM for exploratory research, this method provides researchers with a versatile tool to both validate theoretical models and explore new relationships in their data.

3. Research Design and Model

3.1. Second-Order Confirmatory Factor Analysis

In this study we employ a special form of SEM, called the quadratic CFA model, to evaluate policy performance through CBI and open market indicators. The CBI is generally seen as a key factor in ensuring effective monetary policy and economic stability. In addition, the CBI allows a comprehensive assessment of the contribution of these factors to overall policy success by analyzing them together with open market principles such as economic freedom and regulatory efficiency. The intersection of these two concepts offers a unique perspective that shows how nations drive macroeconomic stability and market efficiency. The use of second-order CFA

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allows for more complex analysis by deciphering not only the direct relationships between observable indicators but also the basic latent structures representing CBI and open market principles. This advanced SEM technique allows the model to measure the impact of various dimensions of the CBI, such as policy autonomy, financial independence, and legal frameworks. It also helps to explain the broader effects of open market dynamics, such as trade freedom, investment freedom, and regulatory performance. Using the second-order CFA, the study understands in detail how these critical economic factors interact and contribute to the overall effectiveness of policy implementation. This method provides valuable information for both policymakers and economists by more accurately assessing the impact of central bank autonomy and market freedom on their economic outcomes. Moreover, the approach increases the robustness of analysis by taking into account the relationship between complex economic indicators within a comprehensive framework and makes it a valuable tool for evaluating policy performance in various economic environments.

In the context of SEM, the measurement model describes how latent indicators are measured or represented by observable indicators. In particular, for external indicators (indicators that are not affected by other indicators within the model), the measurement model describes how these latent structures appear through observable indicators. The measurement model for external indicators in SEM describes how latent indicators are represented by observable indicators. The measurement model for external indicators is expressed by equation (1) as follows (Tanwar and Agarwal, 2024):

$$(\xi):\ x_1 = \lambda_{11}\xi_1 + \delta_1 x_2 = \lambda_{21}\xi_1 + \delta_2 \ldots x_p = \lambda_{p1}\xi_1 + \delta_p \quad (1)$$

where $x_1, x_2, \ldots, x_p$ are the observed indicators for exogenous latent variables, $\xi_1, \xi_2, \ldots, \xi_n$ are the exogenous latent variables. Besides, $\lambda_{11}, \lambda_{21}, \ldots, \lambda_{p1}$ represent the factor loadings. The measurement model detailed for exogenous variables in equation (1) can be generalized as $X = \Lambda_x \xi + \delta$.

The measurement model for endogenous indicators in SEM describes how latent endogenous structures are reflected in the observed indicators. This model has a structure similar to that of exogenous indicators, as shown in equation (2) (Tanwar & Agarwal, 2024):

$$(\eta):\ y_1 = \lambda_{11}\eta_1 + \varepsilon_1 y_2 = \lambda_{21}\eta_1 + \varepsilon_2 \ldots y_p = \lambda_{s1}\eta_1 + \varepsilon_s \quad (2)$$

where $y_1, y_2, \dots, y_p$ are the observed indicators for endogenous latent variables, $\eta_1, \eta_2, \dots, \eta_m$ are the endogenous latent variables. $\lambda_{11}, \lambda_{21}, \dots, \lambda_{s1}$ represent the factor loadings. The measurement model detailed for endogenous variables in equation (2) can be generalized as $Y = \Lambda_y \eta + \varepsilon$.

The system of equations for the structural model in SEM is derived by expressing the theoretical relationships among endogenous and exogenous latent indicators. The structural model is constructed, as shown in equation (3) (Tanwar & Agarwal, 2024):

$$\begin{aligned}
\eta_1 &= \beta_{11}\eta_1 + \beta_{12}\eta_2 + \cdots \beta_{1m}\eta_m + \gamma_{11}\xi_1 + \gamma_{12}\xi_2 + \cdots \gamma_{1n}\xi_n + \zeta_1 \\
\eta_2 &= \beta_{21}\eta_1 + \beta_{22}\eta_2 + \cdots \beta_{2m}\eta_m + \gamma_{21}\xi_1 + \gamma_{22}\xi_2 + \cdots \gamma_{2n}\xi_n + \zeta_2 \\
&\vdots \\
\eta_m &= \beta_{m1}\eta_1 + \beta_{m2}\eta_2 + \cdots \beta_{mm}\eta_m + \gamma_{m1}\xi_1 + \gamma_{m2}\xi_2 + \cdots \gamma_{mn}\xi_n + \zeta_m
\end{aligned} \tag{3}$$

where $\beta_{11}, \beta_{12}, \dots, \beta_{mm}$ are the path coefficients that represent the relationships among endogenous variables, $\gamma_{11}, \gamma_{12}, \dots, \gamma_{mm}$ are the path coefficients that represent the relationships between exogenous and endogenous variables. $\zeta_1, \zeta_2, \dots, \zeta_m$ are the structural errors. The structural model detailed in equation (3) can be generalized as $\eta = \beta\eta + \Gamma\xi + \zeta$.

By following these steps, a system of equations is derived. This system mathematically represents the theoretical relationships between the latent indicators in the model. This derivation transforms conceptual hypotheses into a form that can be tested empirically. The structural model provides a comprehensive analytical framework by integrating measurement models that relate latent indicators to observable indicators with structural equations.

This framework allows us to run a comprehensive analysis of the relationships between multiple indicators, helping to understand the basic structure of complex systems. Thanks to the second-order CFA model, latent structures and their direct and indirect effects on the overall system can be detected, thus providing a better understanding of theoretical structures and experimental observations.

3.2. Data

Built upon the second-order CFA model, we use CBI-related indicators and open market indicators to assess the policy performance of various countries. The CBI is analyzed alongside open market principles to provide a comprehensive assessment of how these factors contribute to overall policy success. To support this analysis, a comprehensive set of indicators has been compiled that reflect both the independence of central banks and the extent of market freedom in each country. Firstly, Romelli's (2022, 2024) 2023 data on CBI were used in this study. This data set is an integral part of assessing how independent central banks are in various countries, which is a key factor in ensuring the effectiveness and reliability of monetary policy. The CBI is often associated with the reduction of political interference and leads to better control of inflation, more stable macroeconomic environments and more effective long-term economic policies. Romelli's dataset provides a detailed assessment of the governance structures of central banks, their policy autonomy and limitations on lending, providing valuable information on how these institutions operate in different countries. In addition to the CBI data, the study also includes open market data from the Heritage Foundation's 2023 Index of Economic Freedom. These indicators form the basis of the second-order CFA model and are very important in understanding the structural relationships between central bank independence, market dynamics and policy performance.

Table 1 provides descriptive statistics for the indicators used to measure two basic latent structures: OM and CBI. Indicators include the number of observations, minimum and maximum values, and mean and standard deviation for each measurement indicator. Three measurement indicators are reported for the latent structure OM. There are a total of 143 observations of trade freedom with a minimum value of 0.423 and a maximum value of 0.950. The average value for trade freedom is 0.707 and the standard deviation is 0.104, indicating a moderate level of trade freedom and relatively low variability between countries in the dataset. The investment freedom ranges from 0.000 to 0.950, with an average of 0.594 and a standard deviation of 0.198. This suggests that investment freedom varies more significantly between countries. The minimum value of financial freedom is 0.100 and the maximum value is 0.900, the average value is 0.510 and the standard deviation is 0.185, which indicates moderate financial freedom and a significant degree of discrepancy between countries.

Table 1 Descriptive statistics of indicators

Latent indicator	Measurement indicator	N	Min.	Max.	Mean	Std. dev.
Open markets (OM)	Trade freedom (x_1)	143	0.423	0.950	0.707	0.104
	Investment freedom (x_2)	143	0.000	0.950	0.594	0.198
	Financial freedom (x_3)	143	0.100	0.900	0.510	0.185
Central bank independence (CBI)	Governor and central bank board (x_4)	143	0.000	0.940	0.588	0.205
	Monetary policy and conflict resolution (x_5)	143	0.200	0.800	0.595	0.153
	Objectives (x_6)	143	0.000	1.000	0.712	0.293

	Limitations on lending to the government (x_7)	143	0.000	1.000	0.713	0.332
	Financial independence (x_8)	143	0.000	1.000	0.730	0.159
	Reporting and disclosure (x_9)	143	0.000	1.000	0.863	0.191

Source: Own compilation.

For the latent indicator CBI, six measurement indicators are included. Governor and central bank boards exhibit a range from 0.000 to 0.940, with a mean of 0.588 and a standard deviation of 0.205, showing moderate independence in terms of governance across the countries. Monetary policy and conflict resolution show less variability, with values between 0.200 and 0.800, a mean of 0.595, and a standard deviation of 0.153. Objectives, with a minimum of 0.000 and a maximum of 1.000, have a mean of 0.712 and a relatively high standard deviation of 0.293, suggesting that the objectives of central banks differ considerably between countries. Government lending restrictions also show a wide value range between 0.713 on average and 0.332 on 0.000 and 1.000 with a standard deviation, showing a significant discrepancy in legal restrictions on central bank loans. The government lending restrictions also show a significant discrepancy in the legal restrictions on central bank loans. Financial independence has a slightly thinner range between 0.730 and 0.000 with an average of 0.159 and a lower standard deviation of 1.000, indicating a greater stability in this direction of the CBI. Finally, another important aspect of central bank transparency includes the reporting and disclosure policies, which range between 0.000 and 1.000, with an average standard deviation of 0.863 and 0.191, offering a resounding advocacy for transparency in most countries.

3.3. Second-Order Confirmatory Factor Analysis Model

The path diagram of the model created using the indicators presented in Table 1 is shown in Figure 1. The diagram visually shows the relationships between latent indicators and their corresponding measured indicators. On the left side of the diagram, a large number of observed indicators can be seen, which are measured directly with empirical data (depicted as rectangles). These observed indicators are divided into two groups. The first set, representing open markets, includes indicators such as trade freedom, investment freedom and financial freedom. The second set represents the CBI and consists of the governor and the central bank board, monetary policy, targets, limits on lending to the government, financial independence and indicators such as reporting and disclosure.

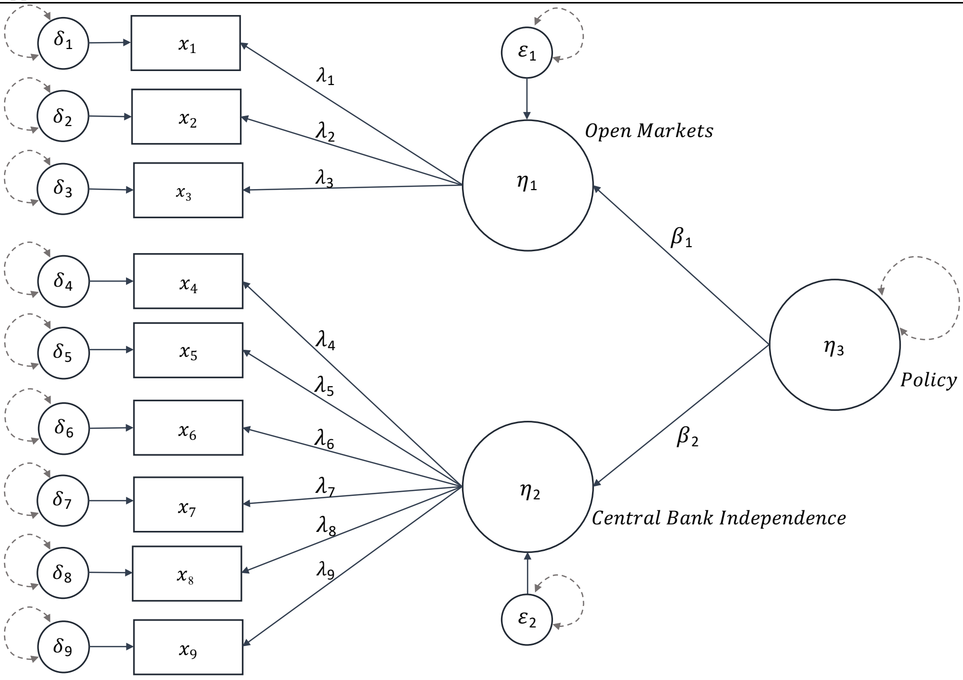

Figure 1 Second-order CFA model
Source: Own construction.

Circles represent latent indicators that are not directly observed but are inferred through measured indicators. There are two main latent indicators in this diagram: OM and CBI, which are depicted as larger circles that connect to their observed indicators. The arrows connecting the observed indicators to the latent indicators show the factor loads, which represent how well each observed indicator reflects its corresponding latent structure. For example, trade freedom is one of the indicators uploaded to the "Open Markets" latent indicators. The last latent indicator on the right side of the diagram represents policy performance (or a similar structure), which is the result of interest. The arrows leading from both Open Markets and the Central Bank Independence to this last latent indicator indicate hypothetical relationships or path coefficients between structures. These arrows indicate that policy performance is influenced by both open market principles and the independence of the central bank.

3.4. Normalization of the Indicators

It is essential to consider the variety and differences in the units of measurement while evaluating the policy performance of countries via various indicators. This miscellany emerges due to the variety of data sources, besides suggesting multidimensionality in regard to economic, political, or institutional dynamics. Without addressing this issue, direct comparisons between indicators will be latent, since the impact of an indicator can be exaggerated or underestimated simply due to scale differences. Standardization is used to reduce these inequalities and to ensure that the indicator can be compared and interpreted in a meaningful way within a unified framework. Standardization is applied to reduce these differences and to ensure that the indicator is compared and interpreted meaningfully within a unified framework. Standardization deconstructs the data into a common scale, allowing a more accurate representation of the relationships between indicators and guarantees that no indicator disproportionately affects the results due to the unit of measurement. In this context, min-max normalization is an effective method, especially for indicators where it is intended to rescale data to a certain range, usually between 0 and 1. This technique is especially valuable when working with composite indices such as Economic Freedom - Open Markets data, which involve multiple dimensions that may differ naturally in their range of value. The min-max normalization method takes the observed minimum and maximum values for a given indicator and rescales all the values to fit within the specified range, usually between 0 and 1. In this way, the highest value of the indicator is converted to 1 and the lowest value is converted to 0, while all other values are adjusted proportionally to fall between these two endpoints. This approach decouples the relative distances between the data points, and ensures the standardized values to reflect the original distribution.

This method offers us two kinds of advantages. First, all indicators provide an equal contribution to the analysis, thus preventing any particular indicator from dominating the results due to differences in scale. Second, since the rescaled values are easier to apprehend and compare across countries or regions, the understanding of the results will be more straightforward. For example, in the context of Economic Freedom – Open Markets, the standardized values allow for a direct comparison of countries' trade freedom, investment freedom, and financial freedom, even though these dimensions might have been measured on different scales initially. The detailed calculation process for min-max normalization is presented below. This method ensures a robust and consistent framework for analyzing the policy performance of countries, providing valuable insights into how different factors, when standardized, interact to shape national outcomes. Standardization, therefore, is not merely a technical requirement but a fundamental step in ensuring the validity and reliability of the comparative analysis of complex, multidimensional datasets. For indicators where larger values are better in terms of performance, the standardization formula is:

$$p_{ij} = \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}}, \; i = 1, 2, \ldots, m; j = 1, 2, \ldots, n \quad (4)$$

For indicators where smaller values are better, the formula is:

$$p_{ij} = \frac{\max_i x_{ij} - x_{ij}}{\max_i x_{ij} - \min_i x_{ij}}, \; i = 1, 2, \ldots, m; j = 1, 2, \ldots, n \quad (5)$$

where p_{ij} represents the standardized value of indicator i for a given country, $\max_i x_{ij}$ and $\min_i x_{ij}$ are the maximum and minimum values of indicator i across all countries, m is the number of indicators, and n is the number of countries in the study. On the other hand, standardization is not required for this indicator as the CBI is already measured on a scale between 0 and 1. Thus the original scale can be preserved and its interpretation across the countries would be more consistent [1].

3.5. Model Performance Criteria

Drawing upon the study by Jiao et al. (2016), the standardized data were employed in a second-order CFA model to assess the goodness-of-fit of the proposed model. In order to evaluate the model's performance and ensure its suitability, we employ a variety of indices such as the Root Mean Square Residual (RMR), Standardized Root Mean Square Residual (SRMR), Goodness-of-Fit Index (GFI), Adjusted Goodness-of-Fit Index (AGFI), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA). These indices provide unique insights into different aspects of the model's performance, serve different roles in determining the model's soundness and consistency, and collectively provide a robust and comprehensive framework for assessing the second-order CFA model, ensuring that it not only fits the observed data well but also meets broader statistical and theoretical expectations. For example, RMR and SRMR deliver measures of the residuals or discrepancies between the observed and predicted data, with lower values indicating a better fit. CFI ensures that the model performs significantly better than one assuming no relationships between the indicators. RMSEA offers an assessment of the model's fit based on the complexity of the model, with lower values indicating a closer fit to the data. Meanwhile, GFI and AGFI evaluate the proportion of variance accounted for by the model, with higher values reflecting a stronger model fit.

3.6. Weights for the Indicators

Following the construction of an appropriate model and obtaining the necessary factor loadings (ω), we calculate the weights used in the analysis in order to evaluate policy performance. The relative importance of each indicator within the model is represented by the weights of the indicators and is calculated using the factor loadings from the SEM framework. In this context, the higher the factor loading values, the more strongly the observed endogenous indicators align with the latent indicators they are intended to measure (Jiao, 2016: 6).

It is assumed that the factor loadings, denoted as ω, obtained from the SEM represent the relative importance of each indicator within the latent constructs they are intended to measure. These factor loadings measure the proximity of each observed indicator to its corresponding latent indicator. As the values of factor loading increase the observed indicator becomes a better representative of the latent construct. We calculate the normalized weights for each indicator to make their contributions to the overall score proportionate to their relative importance. For this purpose, the raw factor loadings are converted into weights q. Each weight sums to one within each group of indicators. Normalization ensures that the indicators with higher factor loadings have a greater influence on the final composite score.

The weights are calculated by dividing each factor loading by the sum of all factor loadings within this group. This normalization process is expressed mathematically as:

$$q_{OM_i} = \frac{\omega_{OM_i}}{\sum_{i=1}^{3} \omega_{OM_i}} \tag{6}$$

where ω_{OM_i} denotes the open market indicators where $i = 1$ to 3 and q_{OM_i} denotes their weights.

Similarly, the weights for the CBI indicators are calculated using the same normalization method, by assuming that the indices for CBI indicators start from 4 to avoid overlap with the OM indicators:

$$q_{CBI_i} = \frac{\omega_{CBI_i}}{\sum_{i=4}^{9} \omega_{CBI_i}} \tag{7}$$

where ω_{CBI_i} denotes the CBI indicators where i = 4 to 9 and q_{CBI_i} denotes their weights.

We obtain weights that accurately reflect the relative importance of each indicator by dividing each factor loading by the total sum of factor loadings within its respective group. Indicators with higher factor loadings contribute more to the final score because their weights are proportionally larger after normalization. In the context of policy performance evaluation, these weights are crucial for constructing composite indices that measure complex constructs like open market principles (OM score) and central bank independence (CBI score). The OM score assesses a country's adherence to open market principles by aggregating indicators related to open markets. The CBI score evaluates how effectively a country maintains an independent central bank by aggregating relevant indicators. By using the factor loadings from the SEM framework to derive the weights, the analysis ensures that the most significant indicators, as determined by the data, have a greater influence on the composite scores. This method aligns the statistical significance of the indicators with their contribution to the policy performance measures, resulting in a more accurate and meaningful assessment.

3.7. Performance Scores on the Second-Order CFA Model

The next step is to calculate the overall performance scores for each country on these two dimensions after determining the weights for the open markets and CBI indicators based on their respective factor loadings. Assuming that the overall performance on a dimension such as OM or CBI can be represented as the weighted sum of the performance values of the individual indicators, each indicator contributes to the total score proportionally to its weight, which reflects its relative importance within the dimension as determined by the factor loadings from the SEM framework.

Summing the products of each indicator's weight q_{x_i} and the corresponding observed performance value p_{x_i} for that country gives the overall score for country j as follows:

$$OM = \sum_{i=1}^{3} q_{OM_i} \times p_{OM_{ij}} \quad (8)$$

and

$$CBI = \sum_{i=4}^{9} q_{CBI_i} \times p_{CBI_{ij}} \quad (9)$$

where products of each indicator's weights are denoted by q_{OM_i} and q_{CBI_i} while performance values are denoted by p_{OM_i} and p_{CBI_i} for the OM and CBI dimensions respectively. Here, the observed performance values $p_{OM_{ij}}$ and $p_{CBI_{ij}}$ represent the actual data collected for each indicator and country. Note that, the derivation of equations (8) and (9) is based on the principle of weighted averages, in which the contribution of each component is scaled according to its importance. Multiplying these values by their respective weights ensures that indicators of higher importance (as indicated by higher factor loads and therefore higher weights) have a greater impact on the overall score.

Equation (10) represents the final step in calculating the overall policy performance of countries by combining the contributions from both CBI and OM. The CBI score measures a country's performance in maintaining an independent central bank, which is essential for controlling inflation and ensuring monetary stability. The OM score assesses a country's adherence to open market principles, influencing economic efficiency and competitiveness.

$$\text{Policy} = (\text{CBI} \times p_{CBI}) + (\text{OM} \times p_{OM}) \qquad (10)$$

This approach aligns with the method of constructing composite indices, where multiple dimensions are aggregated into a single measure using weights that represent their relative importance. Besides, this approach ensures that the final policy performance score reflects both the individual contributions of CBI and open market principles, as well as their significance within the context of the analysis. The resulting composite score provides a comprehensive assessment of a country's economic policy effectiveness, enabling comparisons across countries and facilitating policy evaluation.

Applying equation (10) enables the model to capture the multifaceted nature of policy performance effectively, thus acknowledging that both monetary stability and market openness are pivotal for economic success. This integrated approach allows researchers and policymakers to assess the combined impact of these dimensions on a country's economic outcomes, offering valuable insights for strategic decision-making and international benchmarking. A higher policy value indicates a country with superior policy performance. This method not only quantifies performance based on CBI and open market practices but also accounts for the relative importance of each indicator in shaping these dimensions.

4. Research Findings

We built the analyses upon the second-order CFA model and we employed the R software package (Version 4.3.2) and the package lavaan (Rosseel, 2024) for the analysis. Table 2 presents the goodness-of-fit indices for the proposed model and compares them with the commonly recommended values used in SEM. Note that even well-fitting models with large sample sizes can produce a low p-value as in our case. On the other hand, the chi-square to the degree of freedom ratio is 2.41, which is below the recommended threshold of 3, indicating that the model fits the data reasonably well. The RMR value of 0.00 fits perfectly with the recommended value, confirming that there are no residual errors in the model and a good fit. The SRMR value is 0.09, slightly higher than the recommended maximum value of 0.08, which indicates that there are small differences between the observed and predicted data. Although this suggests that there is room for improvement, the deviation is relatively small. The GFI for the proposed model is 0.92, which exceeds the recommended value of 0.90 and indicates that a large part of the variance in the observed data is explained by the model. The AGFI stands at 0.85, and this crosses the minimum threshold of 0.80, which indicates an adequate fit after adjusting for model complexity. The CFI is 0.92, meets the recommended value of greater than 0.90, and this indicates that the proposed model has a strong fit relative to the zero model, which has no relationship between the indicators. Finally, the RMSEA is 0.10, which is at the upper threshold of the recommended value and suggests that the model could be improved for a better approximation of the population covariance matrix. Thus, although the SRMR slightly exceeds the recommended value and the p-value shows a significant deviation from the perfect fit, the ratios of RMSEA and chi-square to the degree of freedom and the GFI, AGFI and CFI values show strong performance. Overall, the proposed model demonstrates a generally good fit based on most of the indices but could benefit from minor adjustments to reduce residuals and improve overall fit.

Table 2 Goodness of fit indices

	p	χ^2/df	RMR	SRMR	GFI	AGFI	CFI	RMSEA
Recommended value	>0.05	<3	~0	<0.08	>0.9	>0.8	>0.90	<0.10
Proposed model	0.00	2.41	0.00	0.09	0.92	0.85	0.92	0.10

Proposed Model Source: Own computation.
Recommended Value Source: Kline (2023), Guiné et al. (2021), Huang et al. (2023).

Table 3 presents the coefficients, standard errors, composite reliability (CR) and average variance disclosure (AVE) values of the predicted quadratic CFA model. The second-order CFA model evaluates two latent indicators along with the corresponding measurement indicators: OM and CBI. For the OM latent indicator, the composite reliability is 0.904, which indicates a high level of internal consistency for the observed indicators (trade freedom, investment freedom, and financial freedom). The AVE for OM is 0.775 and this shows that a significant part of the variance in the measurement indicators is explained by the latent indicator. The square root of AVE, which is 0.880, further supports the adequacy of the measurement model, as it indicates the differential validity. The coefficients for investment freedom and financial freedom are 2.284 and 2.322, respectively, both have statistically significant p-values at the level of 0.05, confirming their strong contribution to the OM latent indicator. The coefficients for the CBI measurement indicators include values such as 1.947 for government lending restrictions and 1.592 for targets, both of which are meaningful at the level of 0.05. Other indicators such as monetary policy and conflict resolution (0.637) and financial independence (0.535) also contribute to the latent indicator, but their coefficients are relatively lower. The second-order CFA model shows strong reliability and validity for the OM latent indicator, while the CBI latent indicator shows a sufficient but slightly weaker reliability. The significant coefficients confirm that both sets of observed indicators significantly contribute to their own latent structure, but improvements can be made in the development of the CBI measurement.

Table 3 Findings of the estimated second-order CFA model

Latent indicator	Measurement indicator	Est.	Std. error	Composite reliability	AVE	AVE square root	p
OM				0.904	0.775	0.880	
	Trade freedom	1.000					
	Investment Freedom	2.284	0.270				***
	Financial freedom	2.322	0.229				***
CBI				0.796	0.456	0.675	
	Governor and Central Bank board	1.000					
	Monetary Policy and Conflicts Resolution	0.637	0.131				***
	Objectives	1.592	0.295				***

	Limitations on lending to the government	1.947	0.349	***
	Financial independence	0.535	0.120	***
	Reporting and disclosure	0.448	0.149	***

Source: Own computation.
*** Significant at the 0.05 confidence level.

Table 4 presents the weights of the latent indicators and the corresponding measurement indicators. This table shows which aspects of open markets and CBI are the most critical for the model, highlighting the relative contributions of each measurement indicator according to its latent structure. The first latent indicator, OM, has a total weight of 0.642, which indicates that it is the dominant factor in the model compared to the CBI, which has a total weight of 0.358. Here, the measurement indicators are trade freedom, investment freedom and financial freedom. Among them, financial freedom has the highest weight with 0.372, suggesting that it plays the most important role in defining the structure of open markets. Investment freedom follows with a weight of 0.344, while trade freedom is the least effective one among the three indicators, contributing 0.285. The second latent indicator, the CBI, consists of six measurement indicators with varying levels of importance. Restrictions on lending to the government have the highest weight with 0.224, indicating that this is the most critical factor in determining the CBI. Among the other measurements, the targets contribute 0.210, while the governor and the central bank board have a weight of 0.187. Monetary policy and conflict resolution have a relatively lower weight with 0.161, followed by financial independence with 0.129. Finally, reporting and disclosure have the smallest weight with 0.089, suggesting that it is the least important in explaining the structure of the CBI.

Table 4 Weights of the indicators

Latent indicator	Latent indicator weight	Measurement indicator	Measurement indicator weight
OM	0.642	Trade freedom	0.285
		Investment Freedom	0.344
		Financial freedom	0.372
CBI	0.358	Governor and Central Bank board	0.187

	Monetary Policy and Conflicts Resolution	0.161
	Objectives	0.210
	Limitations on lending to the government	0.224
	Financial independence	0.129
	Reporting and disclosure	0.089

Source: Own computation.

Table 5 presents the performance ranking of countries based on a score reflecting the policy performance related to economic or institutional factors such as the CBI or open markets in different regions. The score indicates the relative performance of each country, higher scores represent better performance. European countries dominate the top of the table, with Luxembourg, the Netherlands and Finland achieving the highest scores with 1.767, 1.733 and 1.732 respectively. These European countries are closely followed by other European countries such as Switzerland, Estonia and Ireland. This shows that European countries, especially those from Northern and Western Europe, tend to perform better according to the factors taken into account in the study. In contrast, countries in the Sub-Saharan African region, such as Gabon (1.385) and Kenya (1.160), and Asia-Pacific countries, such as Indonesia (1.373) and Malaysia (1.156), show moderate performance. A few Middle Eastern and North African countries such as Jordan (1.316) and Tunisia (1.144) also rank in the middle, along with some American countries such as Canada (1.355) and Panama (1.120).
Countries at the bottom of the table are the lowest performers, suggesting that there are significant difficulties in these countries. These countries are spread across different regions such as sub-Saharan Africa, the Middle East/North Africa and Asia-Pacific, which indicates that the underperformance is not limited to a single geographical region. The scores show that European countries generally outperform their counterparts in sub-Saharan Africa, Asia-Pacific and the Americas, indicating important discrepancy at the regional and country level. These differences may be due to differences in economic policies, governance structures and institutional capacities between regions.

Table 5 Performance scores of the countries

Country	Score	Country	Score	Country	Score
Luxembourg	1.767	Gabon	1.385	Kenya	1.160
Netherlands	1.733	Indonesia	1.373	Zambia	1.156

Finland	1.732	Mali	1.372	Malaysia	1.156
Switzerland	1.716	Burkina Faso	1.364	Sri Lanka	1.150
Estonia	1.712	Chad	1.363	United Kingdom	1.148
Ireland	1.696	Senegal	1.359	Angola	1.145
Belgium	1.695	Canada	1.355	Tunisia	1.144
Spain	1.693	Singapore	1.351	Liberia	1.139
Austria	1.678	Benin	1.349	Guinea	1.138
Germany	1.678	Kyrgyzstan	1.335	Kuwait	1.132
Sweden	1.677	Niger	1.335	Saudi Arabia	1.128
Georgia	1.672	Brunei	1.334	Ecuador	1.127
France	1.661	Ghana	1.332	Mauritania	1.121
Latvia	1.658	Togo	1.327	Panama	1.120
Slovakia	1.645	Jordan	1.316	Seychelles	1.117
Lithuania	1.643	Cameroon	1.314	Nigeria	1.115
Poland	1.617	Mexico	1.303	Sierra Leone	1.113
Croatia	1.607	Paraguay	1.299	Taiwan	1.113
Cyprus	1.607	South Korea	1.285	Argentina	1.097
Portugal	1.590	Kazakhstan	1.275	Rwanda	1.077
Italy	1.587	Cambodia	1.271	Trinidad and Tobago	1.074
Czechia	1.574	Gambia	1.268	Saint Vincent and the Grenadines	1.049
Malta	1.569	Central African Rep.	1.267	Dominica	1.041
Slovenia	1.553	Pakistan	1.266	Saint Lucia	1.029
Peru	1.536	Congo, Rep.	1.265	Thailand	1.015
Bosnia and Herzegovina	1.534	Botswana	1.265	India	1.014
Macedonia	1.508	Equatorial Guinea	1.261	China	1.006
Hungary	1.506	Bahrain	1.258	Belarus	1.001
Albania	1.505	Tanzania	1.257	Venezuela	0.980
Türkiye	1.505	Mongolia	1.254	Bangladesh	0.978
Greece	1.501	Philippines	1.252	South Africa	0.968
Mauritius	1.497	Jamaica	1.250	Algeria	0.949
Colombia	1.484	Congo, Dem. Rep.	1.249	Japan	0.948
Costa Rica	1.481	Burundi	1.248	Nepal	0.935
Bulgaria	1.474	Malawi	1.246	Uganda	0.931
Ivory Coast	1.471	United Arab Emirates	1.246	Russia	0.920
Uzbekistan	1.467	Uruguay	1.242	Laos	0.882
Moldova	1.465	Oman	1.239	Maldives	0.857
Iceland	1.460	Bolivia	1.231	Comoros	0.853

Morocco	1.445	Qatar	1.230	Lebanon	0.843
Chile	1.442	Guatemala	1.221	Vietnam	0.813
Norway	1.440	Australia	1.217	Zimbabwe	0.791
Montenegro	1.438	The Bahamas	1.217	Haiti	0.777
Romania	1.435	New Zealand	1.198	Ethiopia	0.771
Dominican Rep.	1.412	Egypt	1.185	Turkmenistan	0.637
USA	1.405	Brazil	1.177	Cuba	0.632
Azerbaijan	1.392	Guinea Bissau	1.177	Iran	0.593
Denmark	1.388	Namibia	1.175		

Source: Own computation.

Table 6 presents the average performance scores of different regions and reflects their general policy or economic performance according to the factors taken into account in the study. The scores reflect a clear divergence in regional performance, with Europe emerging as the leading region. Europe has the highest average score with 1.540, indicating that countries in this region perform significantly better on average compared to other regions. This suggests that European countries are in a leading position in indicators such as economic freedom, institutional stability and CBI. In contrast, the Americas and Sub-Saharan Africa regions with average scores of 1.199 and 1.204 respectively, have a moderate level of policy performance on average. These regions are lagging behind Europe in terms of policy effectiveness or institutional performance or are facing further challenges.

Table 6 Performance of regions

Region	Score
Americas	1.199
Asia-Pacific	1.130
Europe	1.540
Middle East/North Africa	1.132
Sub-Saharan Africa	1.204

Source: Own computation.

5. Conclusions, Limitations and Future Directions

5.1. Conclusions

This study aimed to evaluate the interaction between CBI and open market dynamics. The contributions of these dynamics to policy effectiveness in different countries have been evaluated. Using second-order CFA, a comprehensive model that relates the latent structures of the CBI and open markets to policy outcomes was built. The findings show that open market dynamics, especially financial freedom and investment freedom, are strong indicators of successful policy outcomes. Countries with higher scores in these areas perform better in terms of economic stability and overall governance. This is especially evident in the European countries that occupy the top positions in the performance ranking. Countries such as Luxembourg, the Netherlands and Finland have shown the strongest results, in line with previous research linking strong regulatory frameworks and economic openness with positive policy outcomes (Gwartney & Lawson, 2003). These countries benefit from a combination of strong central bank independence and market freedom, emphasizing the complementary nature of these indicators in sound economic management (Crowe & Meade, 2008).

The study found that the CBI plays a more moderate role in overall policy performance compared to open markets. This finding suggests that while central bank autonomy is crucial for maintaining long-term economic stability, it may not be sufficient to drive successful policy outcomes on its own. Countries with a higher level of economic freedom in financial and investment tend to perform better than other countries, even if their central banks are not fully autonomous. This finding has important implications for policymakers, both in developing and developed countries.

The study also highlighted significant regional differences in terms of the relationship between the CBI, open markets and policy performance. European countries scored significantly higher on average than their counterparts in the Asia-Pacific, Middle East and Sub-Saharan African regions. These results are in line with historical trends, where European countries have long traditions of CBI and economic freedom, enabling more efficient governance and economic management. In contrast, countries in sub-Saharan Africa and parts of the Middle East, living under different structures in terms of political, economic and cultural institutions and traditions, have lower scores in market freedom and the autonomy of central banks. Surprisingly, the United States did not rank as highly as expected and lagged behind some European countries in terms of overall policy performance. This finding may be the reason for the recent fluctuations in central bank autonomy and trade policies, especially with the increasing customs duties and protectionism trends in recent years. This shows that even in developed economies, changes in economic and institutional frameworks can have measurable effects on policy performance.

This research contributes to the broader literature on the intersection of governance, economic freedom and monetary policy, providing a more nuanced understanding of how CBI and market dynamics affect national policy performance. Previous studies have often focused on these indicators separately, but this study demonstrates the value of considering them together, demonstrating their value when taken together.

For example, Altıntaş (2021) found that regulatory efficiency significantly affects open markets, while Şahinoğlu and Giray (2019) showed how democracy affects the relationship between economic freedoms and performance. Polat et al. (2013) investigated the causal chain between economic freedom and stock market development, showing that open markets and regulatory efficiency support robust stock market development. On the other hand, Shen and Williamson (2005) drew attention to the potential role of economic freedom in the development of democratic institutions. In this study, unlike the existing studies mentioned here, the important role played by both CBI and open market dynamics in determining the policy performance of countries has been evaluated in a robust statistical framework using SEM. It is particularly evident that increasing market freedom and CBI can lead to more effective governance and better economic outcomes. It provides valuable information for policymakers in developing regions. Indeed, evolving global economic conditions highlight the need for further investigation of these relationships and their implications for policy and governance.

5.2. Limitations and Future Directions

Despite its sound methodological approach, this study has its limitations. Firstly, the second-order CFA model is based on data for the year 2023 and therefore it doesn't capture the potential impacts of more recent global economic disruptions, such as those brought about by the COVID-19 pandemic or geopolitical tensions. Future research may incorporate more recent data sets to better assess how the relationship between the CBI, open markets and policy performance has evolved. Also, although widely recognized, reliance on the Heritage Foundation's Index of Economic Freedom may be supplemented by other indices to provide a more comprehensive measurement of economic freedom. Finally, the generalization of the results is open to discussion. While the study is a diverse sample involving 143 countries, regional differences suggest that the relationships between CBI, open markets and policy performance may differ according to specific institutional or cultural contexts. Future studies may explore these relationships within more narrowly defined regions or focus on special case studies to reveal unique dynamics in different countries.

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Author Contributions

UE designed the study and wrote the introduction, literature review and discussion of results. DK was responsible for data collection, data analysis and wrote the original draft manuscript.

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Notes:
[1] The responses to the 42 questions that make up the CBI index range from 0 (no independence) to 1 (full independence). The six dimensions of the index are obtained by assigning equal weights to the questions within each dimension. The final index is then calculated by averaging these six dimensions (Romelli, 2024: 2).