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Stability of financial inclusion determinants in emerging market economies: A dynamic coefficients approach

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Abstract

This paper addresses a significant gap in the existing literature on financial inclusion — namely, the dynamic instability of the impacts generated by its determinants in four major emerging market economies: Brazil, Russia, India, and China. A time-varying coefficients framework is applied to examine whether the factors shaping financial inclusion at the aggregate level produce nonlinear effects over time. The analysis covers the period from 2000–2001 to 2022–2023. A composite financial inclusion index is constructed to capture inclusion across three key dimensions — availability, access, and usage — using the distance function approach. Three classes of determinants are modeled: socio-demographic, infrastructural, and macroeconomic variables. Evidence indicates structural instability in the financial inclusion process for the BRIC economies, with several determinants exerting nonlinear impacts over time. The findings challenge the conventional assumption of time-invariant relationships between financial inclusion and its dominant determinants. The results reveal considerable temporal volatility in the effects of macroeconomic factors, including growth and inflation, on financial inclusion across emerging markets. Policymakers should adjust strategies, moving beyond assumptions of linear processes and managing dynamic, nonlinear factors more effectively to achieve universal financial inclusion.

Keywords: BRIC economies, dynamic econometrics, financial inclusion, macroeconomics, stability analysis, time-varying parameters.
JEL classification: E00, E10, G21, O11.

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1. Introduction

Financial inclusion is a pressing policy concern in many emerging market economies. The literature is replete with evidence on the extent of financial exclusion, its implications, and the factors that promote inclusion. The determinants of financial inclusion can broadly be categorized into micro and macroeconomic factors. The micro-level factors manifest themselves in socio-demographic forces such as literacy, population growth, and gender, while the macro-level factors exert their influence through infrastructural elements such as internet penetration and mobile availability, or through macroeconomic variables such as growth, inflation, and related indicators.

From a time-series perspective, the determinants of financial inclusion pose a unique problem: is the impact of these factors stable over time? This fundamental question challenges the largely time-invariant estimates produced by the existing literature. If the factors determining financial inclusion produce a linear impact over time, then the underlying data-generating process (DGP) can be presumed stable and can thus be captured by linear models. However, if the impact is not stable, linear models that assume time-invariant effects would be inadequate to represent the underlying DGP.

Financial inclusion in emerging markets has long been a focus of attention for scholars and policymakers. The BRIC economies, with their diversified economic structures and rapid development trajectories, provide a unique perspective from which to study the determinants of formal financial activity. Previous research has examined these determinants extensively, often emphasizing strong correlations and linear causality. Yet an important dimension remains underexplored — the dynamic instability of the determinants' impact over time.

This issue is of particular concern because of the temporally nonlinear nature of the financial inclusion process. The macroeconomic, infrastructural, and institutional determinants of inclusion evolve dynamically in response to policy, market conditions, and socioeconomic settings. To capture these processes meaningfully, the analysis must reflect such dynamic instability, enabling interpretation of interactions and time-varying relationships whose effects differ across temporal and regional contexts. Standard econometric techniques — typically reliant on temporal stability — are not equipped to capture this complexity adequately. Even dynamic multi-equation models such as vector autoregression (VAR) and structural VAR (SVAR) assume a stable economic process before estimating underlying interactions. The existing literature has not yet examined the time variation of impact coefficients, which are generally assumed to remain constant. Consequently, a framework for analyzing the unstable behavior of inclusion determinants over time is lacking.

This study addresses that critical gap through the application of Schlicht (2021) time-varying coefficients methodology — a path-breaking econometric technique not yet used in financial-inclusion research. By combining this method with high-quality time-series data, the study reveals the temporal dynamics of the financial inclusion process in the BRIC countries. The findings highlight the dynamic nature of the determinants' effects and provide new insights into their substitutable and complementary roles over time, thereby illuminating the evolving character of financial systems in emerging markets.

The research contributes to the literature in at least two ways. First, it applies time-varying econometric models to financial inclusion research, introducing an innovative methodological approach. Second, it provides policymakers with concrete evidence of temporal dynamics in the determinants of inclusion, enabling a more flexible and effective policy matrix to address grassroots credit gaps. Together, these contributions help bridge theoretical and practical gaps in understanding financial inclusion in the BRIC economies.

Naturally, accounting for time variance in impact coefficients requires adopting a dynamic regression-coefficients approach, allowing the factors shaping inclusion to produce time-dependent effects. Introducing this feature into the econometric framework creates complications that traditional linear models cannot handle. However, according to Schlicht (2021), it is possible to study such dynamics within linearized models using the time-varying coefficients algorithm.

This paper employs that algorithm to test the fundamental hypothesis raised above: Is the impact of financial inclusion determinants at the aggregate level for BRIC economies time-variant during 2000–2001 to 2022–2023? In brief, the study finds that macroeconomic determinants have exerted temporally nonlinear effects on financial inclusion during the study period. In the case of Russia, for example, financial inclusion has been pulled in divergent directions over time by economic growth and internet penetration, revealing complexities that traditional policy instruments cannot easily address. The average time-varying impact of economic growth is estimated at 0.77 for Russia, while the average temporal impact of internet penetration is −0.45, suggesting strong substitutability and divergence between growth momentum and digitalization in improving financial access. The volatility in the time-varying effect of digitalization, proxied by internet penetration, is also much higher, with its coefficient of variation (CV) reaching 116.32% compared with only 33.18% for economic growth. The traditional view that digitalization invariably improves financial access is thus challenged by the detrimental effect of internet penetration on inclusion during the study period. Clearly, more complex substitution and complementarity relationships operate within the financial inclusion process of emerging market economies than have been revealed by the existing time-invariant literature.

2. Literature review

The literature addressing financial inclusion in emerging market economies is extensive and spans diverse sources. The determinants of financial inclusion are generally categorized into two groups: micro- and macro-level factors. The microeconomic factors are primarily reflected in socioeconomic variables such as literacy (including financial literacy), gender, population, culture, and related attributes (Ali et al., 2020; Khan et al., 2022; Martínez et al., 2022; Mossie, 2022; Nokulunga and Klara, 2023; Rambaud et al., 2022; Rashdan and Eissa, 2020; Tsouli, 2022; Uddin et al., 2017, 2023). Another line of research emphasizes macroeconomic factors, including infrastructural elements such as internet availability and mobile penetration (Burguillos and Cassimon, 2021; Chakrabarti and Sanyal, 2016; Gebrehiwot and Makina, 2019; Ngo, 2019; Pandey et al., 2023), and broader macroeconomic variables such as growth and inflation (Altarawneh et al., 2020; Chithra and Selvam, 2013; Girón et al., 2022; Le et al., 2019; Pandey et al., 2023).

Surprisingly, none of these studies have explored the dynamic relationship between financial inclusion and its determinants — whether micro or macro. An implicit assumption of structural stability dominates much of the empirical literature. While cross-sectional studies cannot be expected to address economic dynamics, even time-series and panel data analyses have largely ignored this crucial issue. Despite the vast body of research on financial inclusion in emerging market economies, one important limitation persists: a lack of attention to the dynamic and unstable context of its determinants. Earlier studies have mainly employed static approaches, using cross-sectional, time-series, or panel data frameworks that implicitly assume structural constancy in the inclusion process. This prevailing trend overlooks the nonlinearities that arise over time in the causal links between financial inclusion and its macroeconomic or microeconomic drivers.

For instance, macroeconomic determinants such as growth and inflation are typically examined under the assumption of uniform influence, disregarding their time-varying effects across different economic cycles or policy regimes. Similarly, socioeconomic determinants such as literacy, gender, and population density are often analyzed using static indicators, without considering how their influence may evolve over time due to technological progress, social transformation, or policy changes. This oversight is especially critical in emerging market economies such as the BRIC nations, where economic and infrastructural landscapes are evolving with unprecedented speed. Assuming linearity and stability obscures the complexity of these relationships, thereby limiting the ability to design adaptive and effective policies. The failure to incorporate instability and temporal dynamics in the existing literature risks overlooking subtle yet important trends that are vital for sustaining financial inclusion.

Therefore, analytical strategies must evolve moving beyond conventional econometric approaches toward methods capable of capturing both nonlinearities and temporal variation in the determinants of financial inclusion. Such approaches can offer deeper insights into macroeconomic and socioeconomic dynamics, allowing policymakers to design goal-oriented and timely interventions that advance inclusive finance. This paper aims to address this important gap in the literature.

3. Methodology

This study measures financial inclusion at the aggregate level for the BRIC economies and then examines the dynamic impact of the modeled determinants on the aggregate measure of financial inclusion. Accordingly, high-quality secondary data from official sources are employed. The composite financial inclusion index is constructed using the distance function approach following Sarma (2012). Equation (1) shows the normalization procedure, making all variables in the financial inclusion index comparable for further aggregation. This methodology incorporates information from six different variables representing three distinct dimensions of financial inclusion — availability, access, and usage.

The availability dimension is captured by the number of branches and automated teller machines (ATMs) per 100,000 adults. The access dimension is measured by the number of deposit accounts and loan accounts with commercial banks, and the usage dimension is proxied by the ratios of aggregate deposits and loans to gross domestic product (GDP). Data for these variables are drawn from official

sources such as the Financial Access Survey (FAS) of the International Monetary Fund (IMF), the World Development Indicators (WDI) of the World Bank, and the official databases of the central banks of each of the BRIC economies.

The use of official data offers the advantage of minimal statistical noise due to robust data collection mechanisms and well-defined reporting protocols, making these datasets more suitable for international comparisons than country-specific data from regulatory bodies. However, potential limitations remain, such as missing observations, aggregation inconsistencies, and other possible biases arising from the initial data-collection process. Nevertheless, large-scale aggregation tends to offset these sampling errors, yielding robust and reliable information.

Each variable is assigned equal weight within its respective subindex of availability, access, and usage. Hence, the weight w is 0.5 for normalization and initial aggregation into each dimension-specific index. This procedure yields three subindices of financial inclusion — availability, access, and usage. These subindices are then aggregated into the composite inclusion index, with availability, access, and usage weighted at 0.15, 0.35, and 0.5, respectively. The weighting scheme emphasizes the usage dimension, which is a critical policy concern in emerging market economies, and assigns a lower weight to availability, which is less problematic given the already extensive physical banking infrastructure in the BRIC economies.

The rationale behind this weighting pattern is to give primacy to actual grassroots utilization of financial services rather than their mere availability. Although the BRIC nations have made substantial progress in improving the physical availability and accessibility of financial services, issues such as dormant accounts, transactions within the same customer's multiple bank accounts, nominal ATM availability without active use, and duplicate accounts indicate that expanded infrastructure may not translate into effective utilization. The gap between availability and usage motivated the weighting scheme adopted in this study for constructing the composite financial inclusion index.

$$I_i^t = w_i^t \frac{act_i^t - min_i^t}{max_i^t - min_i^t}, \tag{1}$$

were: I_i^t — index value of variable i at time t; w_i^t — weight assigned to variable i at time t, ranging between 0 and 1; act_i^t — actual value of the vatriable i at time t; min_i^t — minimum value of the variable i at time t; and max_i^t — maximum value of the variable i at time t.

After normalization into three subindices, the distance function approach is used to aggregate all three into a composite financial inclusion index, as shown in Equation (2). This provides the final composite measure of financial inclusion encompassing six variables across three dimensions. This composite index serves as the dependent variable in both the static and dynamic empirical models described in the subsequent sections.

$$FII^T = 1 - \left[\frac{\sqrt{(1 - FI_{AV}^T)^2 + (1 - FI_{AC}^T)^2 + (1 - FI_{USE}^T)^2}}{\sqrt{N}} \right], \tag{2}$$

were: FII^T is the composite financial inclusion index at time T; FI_{AV}, FI_{AC}, and FI_{USE} represent the subindex values for availability, access, and usage, respectively; and N is the number of variables used in each dimension, as described above.

The determinants of financial inclusion were identified through an exhaustive review of empirical evidence. The literature on financial inclusion covers diverse regions, econometric approaches, and theoretical perspectives. The factors dominating micro-level studies with disaggregated data are primarily socioeconomic — such as literacy, gender, and income. Accordingly, three sets of determinants are identified:

(1) *Socioeconomic factors* — represented by literacy and population dynamics.

(2) *Infrastructural factors* — capturing digital access to financial products and services, proxied by internet penetration and mobile subscriptions.

(3) *Macroeconomic factors* — including GDP growth rate, inflation, and unemployment, reflecting how the broader macroeconomic environment affects financial inclusion in the BRIC economies.

The determinants are first analyzed using a linear regression framework under the ordinary least squares (OLS) approach (see Section 4.3). All variables are time series and were transformed into stationary form prior to estimation. The assumption of fixed or time-invariant regression coefficients is then relaxed through a time-varying coefficients (TVC) approach following Schlicht (2022). The resulting estimates are presented in Section 4.4.

The TVC approach provides a genuinely dynamic extension of the linear regression framework. Coefficients are assumed to follow a random-walk process; that is, they vary slowly over time and are therefore highly autocorrelated. The key principle of this approach is that external or unobserved factors may influence not only the disturbance term but also the coefficients themselves (Schlicht, 2021, 2022). In contrast to the traditional assumption that unaccounted-for influences are fully absorbed by the disturbance term, the TVC framework explicitly models such dynamics. The starting point is the conventional regression model shown in Equation (3):

$$Y_t = a_1 X_{1,t} + a_2 X_{2,t} + \ldots + a_N X_{N,t} + \varepsilon_t. \tag{3}$$

In Equation (3), Y_t is the value of the dependent variable at time t, and a_n is the regression coefficient corresponding to regressor X_n at time t. The term ε_t represents a white-noise error term characterized by $E(\varepsilon_t) = 0$ and $E(\varepsilon_t^2) = \sigma^2$. The coefficients a_n are assumed to be time-invariant, implying structural stability in the underlying DGP. However, shifts in policy, socioeconomic structure, or technology can lead to either discrete structural breaks or continuous structural changes.

Such complexities cannot be addressed by conventional approaches such as rolling regressions, which assume linearity within each estimation window and allow only limited nonlinearity across windows. Likewise, advanced methods such as the Kalman filter impose restrictive assumptions on the disturbance term and entail significant methodological complexity that may outweigh empirical benefits.

These challenges are overcome by the *Varying Coefficients* (*VC*) *method* developed by Schlicht (2021), which traces the time path of regression coefficients under the assumption of gradual but continuous change. The regression coefficients are modeled as a random-walk process, as expressed in Equation (4):

$$a_{i,t+1} = a_{i,t} + \mu_{i,t}. \tag{4}$$

Equation (4) describes the mechanism through which the VC algorithm estimates the evolution of regression coefficients. An autoregressive process of the first order, AR(1), is assumed, where $E(\mu_{i,t}) = 0$ and $E(\mu_i^2) = \sigma_i^2$. This implies continuous change and high autocorrelation in the coefficients over time.

According to Schlicht (2021, p. 1167), the VC method "selects estimates that minimize the sum of squared disturbances in the equation and a weighted sum of squared disturbances in the coefficients." The resulting time-varying estimates are the generalized least squares (GLS) equivalents of the corresponding fixed-coefficient regression. This method is superior to alternatives such as Kalman filtering, rolling regressions, and the CUSUM test because it can accommodate non-Gaussian disturbances, requires no initial values for state and variance parameters, and can be estimated using a standard linear OLS framework — widely employed in the financial inclusion literature.

The study period, 2000–2001 to 2022–2023, was selected to capture the most recent and relevant evolution of financial inclusion in emerging markets, subject to data availability.

4. Empirical results

4.1. Theoretical model

Before presenting the empirical results, it is necessary to clarify the theoretical basis of the model specification strategy. The literature on financial inclusion is extensive, and multiple theoretical frameworks can explain the underlying DGP modeled in this study. Two major theoretical strands dominate recent analyses: the *microeconomic theory* of financial inclusion and the *macroeconomic theory* of financial inclusion.

The microeconomic theory focuses on individual-level factors — such as socioeconomic and demographic characteristics — to understand how financial access can be improved for vulnerable populations (Sethy et al., 2023; Singh and Mallick, 2024). This approach has several extensions, including the financial intermediation theory, the user-cost theory, and the public choice theory of financial inclusion.

In contrast, the macroeconomic theory examines financial inclusion as a process shaped by aggregate economic forces, emphasizing the role of the broader economic environment in fostering inclusivity. Extensions of this macro approach include the financial development, institutional, and systems theories of financial inclusion. This study adopts the financial development and systems approaches within the macroeconomic strand, following Gebrehiwot and Makina (2019) and Manasseh et al. (2024), to analyze the determinants of financial inclusion and their dynamic instability in the BRIC economies.

The theoretical model adopted in this study is conceptualized in Fig. 1 and formalized in Equation (5). Socioeconomic factors are represented by the literacy rate (*LITR*) and population density (*POP*). Infrastructural factors focus on the growing phenomenon of digital financial inclusion and are captured by internet penetration (*INT*) and mobile subscriptions (*MOB*). Lastly, macroeconomic factors are represented by the aggregate income growth rate (*EGR*), price stability (*INF*), and macroeconomic conditions and macroeconomic conditions including economic sentiments proxied by aggregate unemployment (*UNMP*)

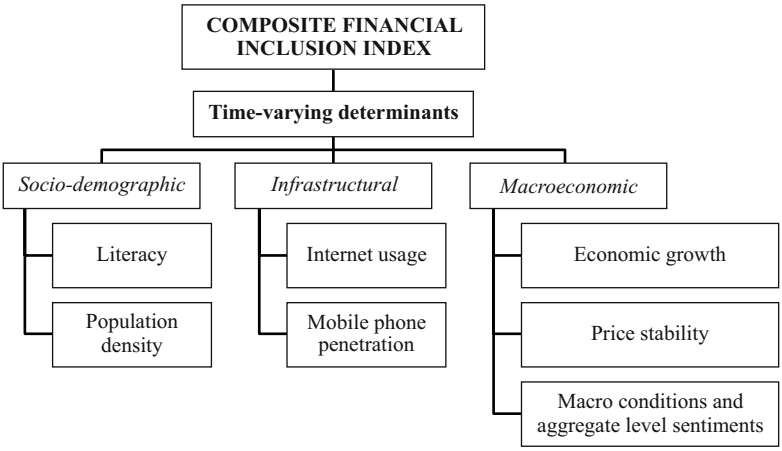

Fig. 1. Conceptual framework of the financial inclusion process.

Source: Compiled by the authors.

As described in Section 3, all variables were transformed into stationary form prior to estimation. Accordingly, the model is specified in log-difference form unless the variable was integrated of order zero, $I(0)$. The underlying null hypothesis tested in this study is that the selected determinants of financial inclusion do *not* exhibit time-varying impacts. In other words, the null assumes zero temporal instability in the effects of these factors on financial inclusion during the study period.

$$FII^T = f(LITR,\ POP,\ INT,\ MOB,\ EGR,\ INF,\ UNMP,\ \varepsilon), \tag{5}$$

were ε is the error term with standard econometric properties.

4.2. Econometric models

Equation (5) is operationalized as shown in Equation (6) within a time-invariant framework. This specification allows estimation of how the selected determinants affect financial inclusion in the BRIC economies, assuming that the structure of the inclusion process remains fixed over time. The estimated results for this model are presented in Section 4.3.

$$\begin{aligned}\Delta\ln FII^T = {} & \beta_0 + \beta_1\Delta\ln LITR_t + \beta_2\Delta\ln POP_t + \beta_3\Delta\ln INT_t + \\ & + \beta_4\Delta\ln MOB_t + \beta_5\Delta\ln EGR_t + \beta_6\Delta\ln UNMP_t + \beta_7\Delta\ln INF_t + \varepsilon_t,\end{aligned} \tag{6}$$

were: ε_t is the error term with standard econometric properties.

The time-invariant assumption is then relaxed to incorporate dynamic coefficients — that is, regression coefficients that may vary stochastically over time. The time-varying coefficients (TVC) method offers two possible approaches. In the first, all coefficients are allowed to vary over time, enabling estimation of the time-dependent effects of every regressor on financial inclusion. In the second, only selected coefficients are permitted to be dynamic.

The latter approach requires strong theoretical justification regarding which factors might exhibit temporally nonlinear impacts — justification that may

not always be feasible. Unless there are well-grounded reasons for assuming only certain regressors behave dynamically, it is more prudent to assume that *all* regression coefficients may vary with time. Consequently, Equation (7) is estimated to capture the nonlinear behavior of regression coefficients and their evolving influence on financial inclusion in the BRIC economies.

$$\Delta \ln FII^T = \beta_0 + \beta_{1,t}\Delta \ln LITR_t + \beta_{2,t}\Delta \ln POP_t + \beta_{3,t}\Delta \ln INT_t + \\ + \beta_{4,t}\Delta \ln MOB_t + \beta_{5,t}\Delta \ln EGR_t + \beta_{6,t}\Delta \ln UNMP_t + \beta_{7,t}\Delta \ln INF_t + \varepsilon_t. \quad (7)$$

As shown in Equation (7), each regressor is permitted to vary over time, indicating that the impact of every determinant on financial inclusion is not stable. Instead, the effects are endogenous to time. This modification of Equation (6) introduces *structural dynamism* into the model, allowing the very structure of the financial inclusion process to shift over time in a complex manner determined by the time path of the varying regression coefficients.

4.3. Estimated results — time-invariant coefficients

Before examining the dynamic impact of the determinants on aggregate financial inclusion in the BRIC economies, it is useful to first consider the results from the traditional regression model. These estimates are reported in Table 1, which quantifies the impact of the selected variables on the composite financial inclu-

Table 1
Time-invariant regression results for BRIC economies on determinants of financial inclusion.

Variable	Brazil	Russia	India	China
Constant	−0.540***	0.190**	−0.220**	0.120**
	(−3.634)	(2.732)	(−2.562)	(2.215)
LITR (+)	19.820***	98.910	4.610*	–
	(3.400)	(0.773)	(1.938)	
EGR (+)	–	1.160**	1.880***	−3.050**
		(2.456)	(3.420)	(−2.541)
POP (+)	74.780***	22.580**	142.530**	–
	(3.950)	(2.970)	(64.380)^	
INT (+)	−1.460***	−1.600***	0.310*	0.520*
	(−6.517)	(−5.086)	(1.992)	(2.060)
MOB (+)	0.490**	0.630***	–	0.450*
	(2.392)	(4.490)		(1.976)
UNMP (−)	–	0.430	0.500***	−1.010#
		(1.286)	(3.115)	(−1.520)
INF (−)	−0.098**	0.150*	−0.020**	−0.040**
	(−2.185)	(−1.831)	(−2.165)	(−2.584)
RI	0.830	0.760	0.630	0.770
F-statistic	13.810***	6.010***	3.680**	10.830***

Note: Signs in parentheses under variable names indicate expected directions of effect. Numbers in parentheses indicate standard errors. *LITR* for Brazil is lagged one period; *INF* for Brazil is lagged two periods. For Russia, all variables except literacy are lagged one period. For India, nonlinear effects of some regressors were identified through squared-term tests. Missing coefficients reflect data or econometric constraints. Diagnostic tests for autocorrelation, heteroskedasticity, and multicollinearity confirm robustness. ^ indicates the second lag of the variable; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, # $p < 0.15$.
Source: Authors' calculations.

sion index. Although direct comparison across countries is limited by differing model specifications and data availability, several broad patterns emerge.

Literacy remains a key factor enhancing participation in the formal financial system across the BRIC economies. Economic growth (*EGR*) is also an important driver, exerting a positive influence on inclusion in all cases except China. In China, higher growth appears to coincide with reduced inclusivity, possibly due to growth-induced income inequality, which may offset the positive effects of expansion.

Population density (*POP*) is another significant determinant. Higher population density lowers the per capita cost of providing banking services, thereby encouraging financial institutions to expand outreach. This supply-side effect — often discussed in the literature as an economy-of-scale mechanism (Kuleshov and Marshak, 2007; Yarasheva and Makar, 2021; Yarasheva et al., 2020) — explains why regions with denser populations tend to exhibit greater financial inclusion.

Mobile subscriptions (*MOB*) also show a positive and significant relationship with inclusion, indicating the role of mobile technology in advancing digital access. However, internet availability (*INT*) produces a more complex pattern. For Brazil and Russia, it negatively affects inclusion, contrary to expectations, whereas for India and China, the effect is positive. This divergence suggests that internet penetration alone does not guarantee effective digital inclusion. Differences in service quality, digital finance availability, and user engagement likely shape these contrasting outcomes, warranting further investigation.

Inflation (*INF*) generally acts as a deterrent to financial inclusion in all economies except Russia. Inflation typically harms inclusivity by eroding real savings and discouraging participation among lower-income groups. However, in Russia, the positive coefficient implies that income adjustments or interest rate responses may have offset inflationary pressures. When nominal incomes at the lower end of the distribution rise faster than prices — or when deposit rates adjust efficiently — higher inflation can temporarily enhance financial inclusion by encouraging formal saving and lending activity.

Overall, the time-invariant results highlight that literacy, economic growth, and mobile connectivity tend to promote financial inclusion, while inflation and, in some contexts, internet penetration can hinder it. The next section examines how these relationships evolve over time once structural dynamism is introduced.

4.4. Estimated results — time-variant coefficients

Descriptive estimates of the yearly time series of regression coefficients derived from the TVC filter, using the methodology of Schlicht (2021), are presented in Table 2. The primary statistic of interest is the coefficient of variation (CV), which would be zero if time invariance were present. However, for each of the BRIC economies, several determinants exhibit time-varying impacts on financial inclusion at the macroeconomic level.

Internet availability and mobile penetration exhibit significant time dependency in Brazil. The mean impact is negative for *INT* and positive for *MOB*. Mobile penetration shows considerable variability over time, signaling its potential instability as a policy lever for enhancing financial inclusion.

Table 2
Descriptive statistics for the time path of the regression coefficients for the BRIC economies.

Statistics	Brazil		Russia		India		China
	BRZ_ INT	BRZ_ MOB	RUS_ EGR	RUS_ INT	IND_ EGR	IND_ UNMP	CHN_ INF
Mean	−1.13	0.49	0.77	−0.45	0.36	0.09	−0.01
SD	0.26	0.48	0.25	0.53	0.39	0.02	0.01
CV (%)	23.29	96.55	33.18	116.32	108.29	27.24	95.95

Note: SD — standard deviation, CV — coefficient of variation (absolute percentage). Statistics refer to time-varying regression coefficients. INT — internet usage, MOB — mobile subscriptions, EGR — GDP growth rate, UNMP — unemployment rate, and INF — CPI growth rate.
Source: Authors' calculations.

Despite its variability, *MOB* maintains a positive effect throughout the sample period, indicating its potential as an important policy instrument for promoting inclusivity — provided that policymakers manage its instability carefully.

In Russia, economic growth (*EGR*) remains a positive force for inclusion, although its magnitude has fluctuated over time. Internet availability again shows a negative mean effect, suggesting more complex interactions between internet access and the use of formal financial services. While *EGR* exerts a generally positive but unstable influence, the contrasting behavior of *INT* points to shifting structural relationships between macroeconomic and infrastructural drivers.

For India, *EGR* also demonstrates a positive time-varying effect throughout the period, while the effect of unemployment (*UNMP*) is largely negligible, as reflected in its low mean coefficient in Table 2. In China, financial inclusion is negatively affected by inflation (*INF*), the only factor displaying significant temporal instability. The time trajectories of these impacts are illustrated in Fig. 2, which reveals the evolution of the time-varying regression coefficients for each economy. Compared with Table 2, it provides a clearer depiction of the partial-equilibrium impacts of unstable determinants.

In Brazil, the influence of internet usage (*INT*) has worsened over time, transforming from an enabler into a barrier to inclusion. This finding contradicts the conventional expectation that internet penetration promotes digital financial inclusion. One explanation may lie in how the composite financial inclusion index (*FII*) is measured. The index captures aggregate inclusion through traditional indicators — such as deposits and credit — rather than specifically digital finance. Thus, internet expansion might be negatively associated with traditional inclusion if it reflects a shift from branch-based to online financial channels. Another possible reason is that while internet availability increased, actual usage may not have grown proportionately, producing a negative link with aggregate inclusion. Further research is needed to investigate this finding.

Mobile subscriptions (*MOB*) in Brazil exhibited a weakening effect up to 2019–2020, followed by a rebound thereafter. The COVID-19 pandemic may have accelerated mobile adoption and encouraged previously unbanked individuals to access formal financial services digitally. However, the contrasting negative result for internet availability suggests that the underlying mechanisms differ and merit further country-specific analysis.

In Russia, the impact of economic growth has declined over time but remained positive overall, partially offset by the increasing influence of internet access.

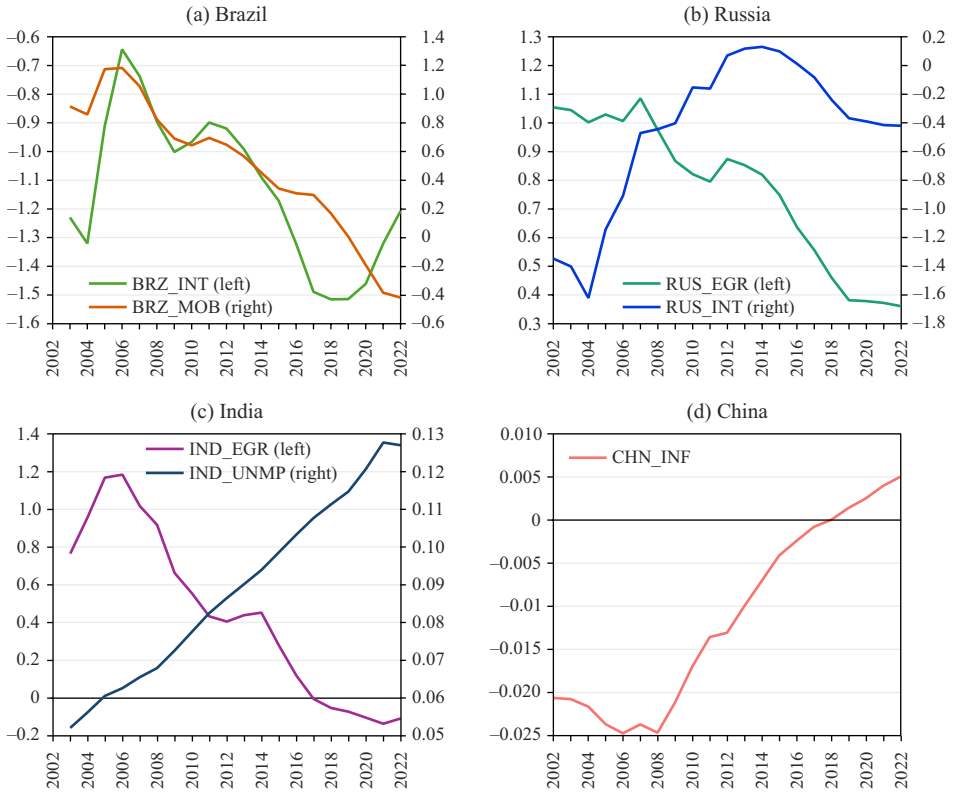

Fig. 2. Visualizing the time-varying regression coefficients of the determinants of financial inclusion for the BRIC economies.

Note: INT — internet usage, *MOB* — mobile subscriptions, *EGR* — GDP growth rate, *LITR* — literacy rate, *INF* — CPI growth rate, *UNMP* — unemployment rate. The figures show the time paths of the regression coefficients. The 95% confidence intervals for the estimated time-varying coefficients are not reported here but are available from the authors upon request.
Source: Authors' calculations.

This pattern suggests a shift in the inclusion process from being driven primarily by macroeconomic fundamentals to being shaped by infrastructural factors, as discussed in Section 4.1.

India presents a unique dynamics. The effect of economic growth on *FII* has weakened slightly but remains positive on average. Interestingly, unemployment shows a small but increasing positive effect — an apparent anomaly. One possible explanation is a structural shift in employment composition, with more individuals moving from wage employment to self-employment or business activities. Such transitions could raise demand for formal financial products, as self-employed workers rely more on external finance. If so, the measured rise in unemployment may partly reflect a reclassification effect rather than genuine job loss. Testing this hypothesis would require more granular labor-market data.

In China, inflation (*INF*) has consistently hindered financial inclusion, though its adverse effect has weakened over time and even turned slightly positive in recent years. Inflation generally constrains inclusivity by eroding real savings, disproportionately affecting vulnerable groups (Kesaite and Greve, 2023; Madanizade et al., 2017). It also tends to skew income distribution toward higher earners (Birchenall, 2007; Fang and Hung, 2016; Lu and Zheng, 2013).

However, the attenuation of this negative effect suggests that income adjustments may have become more equitable, possibly offsetting inflation's redistributive impact. If real incomes now rise in proportion to, or faster than, inflation, the net result could be stable or even higher real savings — thus fostering inclusion. A richer econometric framework, such as two-stage least squares, could formally test this conjecture.

Finally, the robustness of these results was verified through sensitivity analyses employing alternative model specifications for each BRIC economy. These included additional potential determinants and alternative proxies for key variables, identified through a systematic literature review. The findings remained largely consistent, confirming the main conclusion: *the determinants of financial inclusion exhibit temporal instability and nonlinear behavior.* The dynamics documented here are robust to alternative specifications, including different functional forms and nonlinear regressors. Detailed estimation results for the sensitivity tests are available from the authors upon request.

5. Limitations

The primary aim of this study was to assess whether the determinants of financial inclusion exert a temporally stable impact on inclusion outcomes. Inevitably, certain constraints accompany this analysis and should be considered when interpreting the results. This work employs a dynamic framework to analyze the causal relationships underlying the financial inclusion process.

The literature offers several alternative approaches for capturing dynamic relationships, including Kalman filters, structural break analysis, intervention analysis, and the flexible least squares technique (Enders, 2015; Lucchetti and Valentini, 2024). Exploring how the results compare across these methods would be an interesting direction for future research.

The time-varying coefficients (TVC) model used here rests on an important assumption — namely, that there is sufficient information to trace the evolution of the dynamic impact coefficients. As noted by Schlicht (2021), limited information may lead to erroneous conclusions. However, the dataset employed in this study satisfies the adequacy criteria established in Schlicht (2021, 2022), ensuring that the results are robust in this regard.

Another consideration concerns the flexibility of the algorithm. Allowing a fully universal time-varying model — where all determinant factors are permitted to have nonlinear effects over time — can potentially lead to estimation errors or algorithmic failure (Schlicht, 2021). No such issue arose in the present analysis; the algorithm performed without difficulty.

A related methodological debate centers on whether to adopt a universally dynamic varying-coefficients model or to restrict time variation to only selected factors. Imposing such restrictions without strong theoretical justification risks collapsing the underlying DGP in the dynamic space and introducing subjective, non-scientific assumptions. For this reason, the present study adopts a universally dynamic specification.

Another dimension of limitation lies in the assumption of a common financial inclusion DGP across the BRIC economies. While the theoretical structure of financial inclusion may be broadly similar over time and space, policy and insti-

tutional environments differ significantly. Modeling these heterogeneities could yield further insights into the evolving dynamics of inclusion.

Data constraints also shape the scope of this analysis. The study period begins in 2000–2001, but the use of higher-frequency time-series data could allow for a more finely grained dynamic analysis with greater degrees of freedom. Expanding the sample by incorporating individual-level, granular data would also be valuable, though testing macroeconomic hypotheses with micro-level data remains methodologically challenging. A more disaggregated yet large-scale dataset — ideally with continuous and comparable time-series observations at the sectoral level — could enhance future studies. Given existing data limitations, however, this study employs the best available information set.

6. Implications

In this study, financial inclusion was measured using a composite financial inclusion index. While single-equation linear econometric frameworks assume stable impacts of regressors on the dependent variable, violations of this assumption lead to inconsistent, biased, and unreliable estimates. To the best of the authors' knowledge, no previous study has captured the dynamically nonlinear nature of the financial inclusion process in emerging market economies. A further research gap arises from the absence of studies explicitly examining the time-invariance assumption of the determinants of financial inclusion. The prevailing notion in the literature — that financial inclusion is a temporally stable process implying a stable underlying data-generating process — is inconsistent with the empirical evidence presented here. The results demonstrate structural instability at the aggregate level, with several determinants exhibiting time-varying effects, thus offering richer insights into the inclusion process. These findings have multiple policy and practical implications.

First, within the conventional time-invariant linear framework, improvements in literacy play a consistently positive role in advancing financial inclusion. The BRIC nations have significant potential to improve educational outcomes not only through traditional education but also through enhanced financial literacy. The emphasis on Sustainable Development Goal (SDG) 4 — universal primary education — appears to yield positive effects, particularly in Brazil and India. For Russia and China, however, the results are less conclusive, possibly due to data limitations or the need for more refined proxies for literacy.

Second, emerging market economies must reconsider the finance — growth nexus in light of the findings. The causal relationship between financial inclusion and economic growth is a central element of this debate (Tandon et al., 2023). Leveraging this relationship for inclusive growth should be a policy priority. The results show that higher growth enhances inclusion in India and Russia but diminishes it in China. This divergence may reflect the mediating role of income inequality or other structural factors. Although confidence intervals for the time-varying coefficients are not reported here due to software limitations, they were estimated using alternative econometric tools and are available from the authors upon request.

Further research with more disaggregated and longer data series could explore these dynamics in greater detail. Overall, the results indicate that economic growth has a broadly positive impact on financial inclusion.

Third, population density positively affects inclusion, consistent with prior evidence (Banerjee et al., 2021; Grishina, 2021; Makina and Walle, 2019). From the supply-side perspective, higher population density reduces the average cost of providing banking services, thereby encouraging financial institutions to expand outreach. In emerging market economies, where physical modes of banking still dominate, this scale effect remains particularly important. Higher density may also increase demand for financial services, offering stronger incentives for banks and other institutions to reach unbanked populations.

Fourth, digitalization does not automatically translate into improved financial access. In India and China, internet penetration supports inclusion, whereas in Brazil and Russia it appears to have an adverse effect. Several factors may explain this contradiction. Internet penetration may increase unevenly, benefiting already well-served, higher-income regions while bypassing underserved rural or low-income areas. Consequently, inclusivity does not rise proportionately with overall connectivity. Targeting internet expansion toward rural and lower-income regions would likely yield greater benefits than focusing solely on urban areas.

Fifth, mobile penetration clearly enhances financial inclusion. Access to mobile technology remains a strong driver of digital financial inclusion (Andrianaivo and Kpodar, 2012; Banerjee et al., 2021; Lashitew et al., 2019; Radcliffe and Voorhies, 2012).

Finally, inflation continues to be a largely detrimental factor for inclusion. Containing inflation is essential for emerging market economies to safeguard real incomes — especially among lower-income groups — and to sustain the savings needed to channel funds into the formal banking system.

A particularly important concern is the instability in the impact of key macroeconomic forces such as growth and inflation. While growth consistently provides a positive impulse to inclusion, seeking to maximize this effect may risk higher inflation, in line with the Phillips curve framework. Inflation has proven both unstable in its influence and broadly harmful to inclusion. The inflation-targeting regimes adopted in the BRIC economies may therefore be misaligned with the goal of financial inclusion. Incorporating explicit inclusion objectives into inflation management frameworks could advance both inclusivity and sustainable growth. The evidence presented here underscores that the growth — inflation trade-off has become more complex.

A major policy implication emerging from this study is the need to leverage fiscal policy alongside, and in some cases more actively than monetary policy to foster financial inclusion. The empirical results show that macroeconomic forces such as growth, employment, and digitalization play a greater role in driving inclusion than inflation, which remains primarily a monetary policy target. Consequently, fiscal instruments could be employed more assertively in the BRIC economies to promote inclusive and equitable growth. While monetary policy remains relevant, the findings suggest that fiscal interventions may transmit positive, dynamic effects on inclusion more effectively than monetary adjustments alone.

The macroeconomic theory of financial inclusion has yet to incorporate explicitly either structural stability considerations or the fiscal — monetary nexus. The findings of this study strongly suggest the need to integrate these dimensions into a revised macroeconomic framework for financial inclusion. A more comprehensive future study could develop and empirically test this proposed modification.

7. Concluding remarks and policy challenges

From the dynamic coefficients perspective, macroeconomic determinants have displayed temporal instability across all the economies in the sample—except Brazil, where infrastructural factors have shown a nonlinear impact on financial inclusion. Emerging economies thus face the dual challenge of advancing financial inclusivity while containing the unstable effects of macroeconomic forces such as growth and inflation. The ability of policymakers to leverage these nonlinear determinants will shape not only the level of inclusion attainable over the next decade but also the pace at which universal financial inclusion can be achieved. The long-held assumption of a temporally stable financial inclusion process is therefore unreliable. In reality, the process underlying efforts to achieve inclusion in emerging market economies is dynamic and constantly evolving.

Emerging economies are characterized by active policy interventions in financial markets aimed at expanding formal finance and closing the credit gap at the grassroots level. Despite significant progress toward financial inclusion in the BRIC economies, persistent shortcomings remain in the formal credit market. This continuing reliance on informal credit—and the resulting dualism in credit structures—suggests that existing policy frameworks have not been fully effective. One reason may be the assumption of structural stability and temporal linearity in the inclusion process.

Incorporating the nonlinear dimensions identified in this study could help optimize the policy matrix and improve inclusion outcomes over time. This would involve recognizing and managing the substitutability and complementarity among key macroeconomic determinants of inclusion. Because the inclusion process itself evolves in time, driven by both macroeconomic and infrastructural factors, its effective management requires policies that adapt dynamically to these shifts.

The central policy challenge for emerging market economies, therefore, lies in designing financial inclusion strategies that enable the gradual transmission of complementarity and substitutability among determinants into the formal credit system. This transmission—from a time-dependent inclusion process to tangible grassroots improvements—calls for flexible, adaptive policy frameworks rather than the rigid structures implied by traditional linear analysis.

Such policymaking will require a nuanced, iterative approach that recognizes the evolving character of financial inclusion. The BRIC governments, in particular, must cultivate this adaptive capacity to harness the dynamic nature of inclusion processes and, in doing so, promote both economic growth and social well-being. Ultimately, the underlying philosophy for achieving comprehensive financial inclusion in the emerging world must be recalibrated to avoid the "linearity trap" that has long prevailed in the literature.

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