

Asymmetric trajectories and shock persistence: A time series evaluation of consumption in the BRICS Plus countries



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Background: Analysing the persistence of consumption patterns is fundamental to identifying latent economic dynamics and the underlying factors of market fluctuations. In the BRICS Plus countries, this involves a complex interplay of socioeconomic, cultural and political conditions.

Aim: To study the degree of consumption persistence in 11 countries to determine whether shocks have transitory or permanent effects. Additionally, we examined how external shocks may have impacted spending patterns there.

Setting: The data used are 'Final Consumption Expenditure of Households and NPISH' from the World Bank and are annual (1960–2022).

Method: Fractional integration techniques. These econometric methods analyse time series with long-term memory, meaning that past events influence the future over an extended time horizon, although they fade over time.

Results: There are substantial differences. The most significant positive trends are in Brazil, Iran and Russia, as well as Ethiopia and Saudi Arabia. Only Iran and Saudi Arabia show evidence of mean reversion and temporary shocks. For the other countries, we cannot rule out the possibility that the shocks are permanent, as the unit root hypothesis is not rejected.

Conclusion: Each country exhibits distinct strengths and weaknesses. The methodology helps us analyse past consumption and its persistence to understand future consumption. Policy recommendations include fiscal stimulus, increased disposable income, investment in infrastructure, among others.

Contribution: No articles or books were found that analyse this topic with fragmented integration in Brazil, Russia, India and China (BRICS) Plus countries. Furthermore, the results are heterogeneous between countries, implying that the same policy recommendations cannot be generalised.

Keywords: consumption persistence; BRICS Plus; shocks; fractional integration; policy recommendations.

Introduction

The comprehension of consumption behaviour dynamics holds paramount significance for various stakeholders, including researchers, economists and policymakers committed to unravelling the intricacies underlying long-term economic growth and macroeconomic fluctuations. As a crucial element of aggregate demand, consumption reflects household purchasing power while simultaneously playing a primary role in determining the macroeconomic performance of a country or territory. Consequently, analysing the stability and continuity of consumer spending habits is vital for identifying hidden economic forces and understanding the underlying causes of economic fluctuations (Kearney 2010; Warde 2014; etc.) This study concentrates on an inquiry into the durability of consumption behaviour throughout the diverse landscapes of the different countries that constitute the BRICS Plus, marked by varying socioeconomic conditions, cultural influences and policy frameworks.

The term 'BRIC', originally excluding South Africa, was coined by O'neill (2001), then the chief economist at Goldman Sachs. In 2009, these four countries (China, India, Russia and Brazil), proposing to reach and equal the North American and Western countries in the global order, came together to form a semi-institutionalised political outfit. We should note that BRICS is not a formal international organisation like the World Bank, Organization of the Petroleum Exporting

Countries (OPEC), or the United Nations. The leaders of these countries, including heads of state and government, gather annually, with each nation taking a 1-year turn as the rotating chair of the group. They discuss matters of mutual interest, and their collective influence has grown in areas such as trade, investment and global governance. South Africa, despite being the smallest member in terms of economic strength and population, became the first addition to the BRIC group in 2010, leading to the new acronym, BRICS. Together, these five countries contribute 25% of the global economy's output and represent over 40% of the population in the world (Stuenkel 2020). In August 2023, during the Johannesburg convention, it was decided that another six countries could join the organisation. These were: United Arab Emirates (UAE), Saudi Arabia, Iran, Ethiopia, Egypt and Argentina (Reuters 2023b). The new name for the 11 countries is BRICS Plus as China proposed and their membership began in 2024 (The Business Standard 2023).

The main objective of this work is to analyse the degree of persistence in consumption in these 11 countries to understand if shocks have transitory or permanent effects. For this analysis, we use fractional integration techniques, which are quite flexible and more general than the standard methods based on unit roots or stationarity tests.

To present an economic study with theoretical foundations, we cannot overlook the great thinkers who contributed their knowledge to our current understanding of persistence in consumption. Their contributions are summarised in Table 1.

The theories mentioned in Table 1 will be briefly described in the literature review section.

The subsequent parts of this article are organised in this way: after outlining the *Contextual setting* to the BRICS Plus countries, we provide a comprehensive *Literature review* of the pertinent and most recent articles concerning

consumption behaviour in general, consumption in the BRICS nations, external shocks in the BRICS countries and fractional integration. We then elucidate the chosen *Methodology*, offering a detailed exposition of the fractional integration framework, before delineating the dataset, encompassing the 11 different countries that form the basis of our analysis. Through the *Results* section we present the empirical findings, delving into the persistence characteristics of consumption while identifying potential variations specific to each country. In the *Conclusion* we recapitulate the key findings and proffer recommendations with regard to policy implications across the BRICS Plus nations.

Contextual setting

The BRICS countries formed the alliance to enhance cooperation on economic, political and strategic issues.

While each BRICS country has its unique challenges and opportunities, they as a collective configure an important section of the world's population, geopolitical influence and economic output, as we can see in Figure 1.

Relevant data for these countries are summarised in Table 2, showing that these countries are still developing, but they can bring together synergies that help their growth.

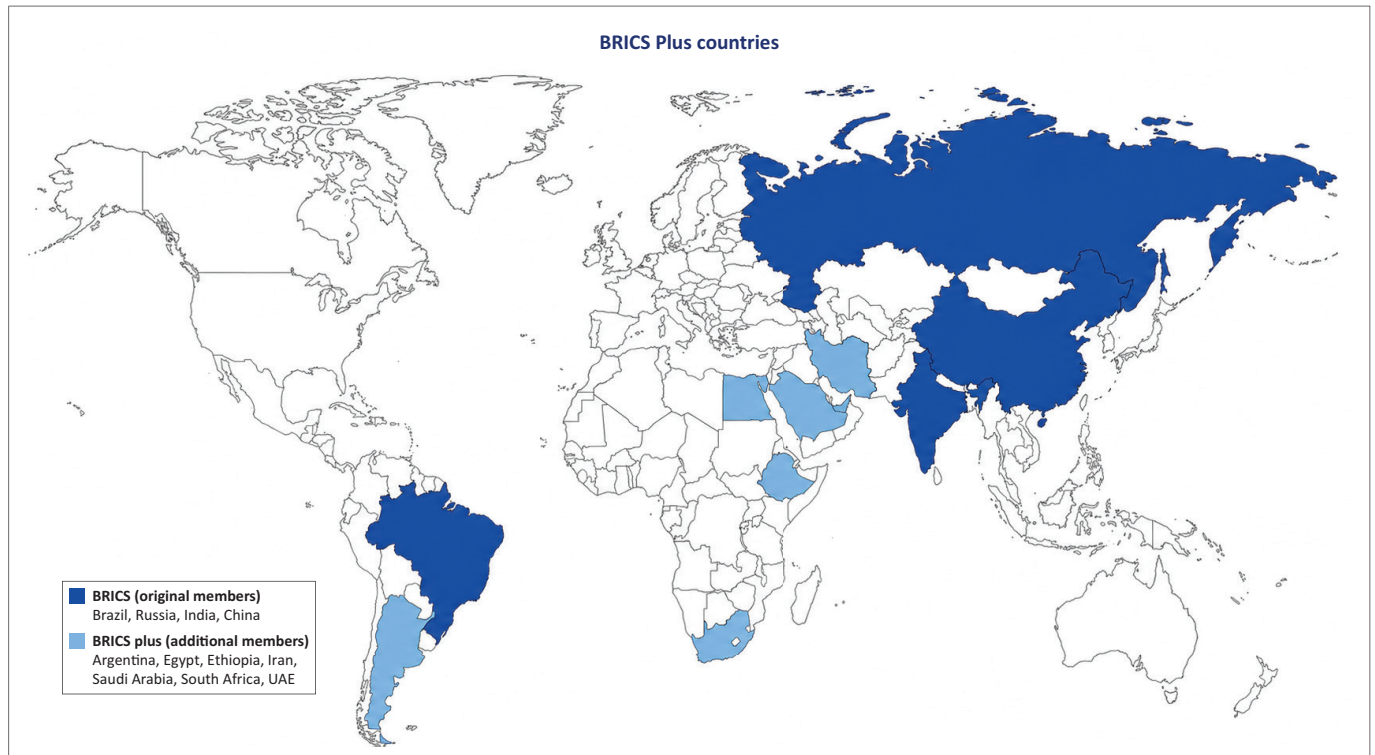
The data indicate that Saudi Arabia boasts the most favourable conditions among the countries analysed, ranking first in NMW salary, GDP and standard of living. It holds the second position in CPI, following China, and secures the fourth spot in the economy ranking, trailing behind China, India and Russia – all significantly larger nations. On the contrary, Ethiopia, as per the data, exhibits concerning indicators of underdevelopment.

Examining the member countries of BRICS Plus, it is noteworthy that many of them are major oil producers, with six of them ranking among the top 10, as it is showed in Table 3.

TABLE 1: Comparative summary of seven theories of consumption.

Author and year	Core theory	Primary mechanism of persistence	Implied time-series and/or shock behaviour
Keynes (1937)	Fundamental Psychological Law	Habitual rigidity: Consumers prioritise their established standard of life, adjusting to income changes only after a short-term temporal lag.	Short memory: Short-term lags; shocks cause temporary, brief friction before consumption adjusts.
Boulding (1945)	Stock-Asset Definition of Consumption	Physical durability: Consumption is the physical depreciation or destruction of capital stocks over time, rather than a continuous flow.	Structural lag: Spending dynamics are bound to the lifespan and persistence of accumulated physical goods.
Duesenberry (1948)	Relative Income Hypothesis	The ratchet effect: Consumers fiercely protect and anchor their spending to their historical peak income, resisting downward adjustments.	Asymmetric persistence: High persistence when income falls (rigid downward), but immediate adjustment when income rises.
Brown (1952)	Habit Persistence	Behavioural inertia: Past consumption experiences cast a continuous psychological shadow on current spending; customs erode slowly.	Long memory and fractional $I(d)$: Hyperbolic decay; shocks linger for a very long time before eventual mean reversion.
Friedman (1957)	Permanent Income Hypothesis	Expectation smoothing: Households base current spending on long-term expected wealth, decoupling consumption from short-term income.	Smooth continuity: Consumption tracks a gradually updated permanent income trend, dampening temporary shocks.
Hall (1978)	Random Walk Hypothesis	Rational expectations: Forward-looking consumers instantly embed all available information into current spending, making future changes unpredictable.	Pure unit root $I(1)$: Strict non-stationarity; shocks shift the consumption path immediately and permanently (no mean reversion).
Browning and Crossley (2001)	Modern Life-Cycle Framework	Optimal intertemporal allocation: Apparent inertia is a rational smoothing response driven by lifestyle adjustment costs and market frictions.	Delayed smoothing: Shocks trigger a highly managed, protracted expenditure response to prevent costly disruptions.

Note: Please see the full reference list of the article, Gil-Alana, L.A. & Lopez G., 2026, 'Asymmetric trajectories and shock persistence: A time series evaluation of consumption in the BRICS Plus countries', *South African Journal of Economic and Management Sciences* 29(1), a6769. <https://doi.org/10.4102/sajems.v29i1.6769>, for more information.



Source: OpenAI, 2026, 'BRICS original members and BRICS plus additional members' [AI-generated image], Generated using ChatGPT (image generation model) from a structured prompt, viewed n.d., from <https://chatgpt.com>

Note: World map highlighting the five original BRICS countries and the six new BRICS Plus member countries, coded in two distinct colours (original vs. additional members).

FIGURE 1: Map of the original BRICS members and the additional members.

TABLE 2: Data for the BRICS Plus countries in 2022.

Country	NMW salary	CPI (%) [†]	GDP growth (annual %)	Standard of living ^{‡‡}	Economy ranking ^{§§}
Argentina	€310.8	138.3 [†]	5.2	Low	23
Brazil	€192.1	4.5 [†]	2.9	Very low	11
China	€268.3	-0.2 [‡]	3	Low	2
Egypt	€168.5	8 [§]	6.6	Very low	33
Ethiopia	€19.1	-	5.3	Very low	62
India	€55.0	4.7 [†]	7	Very low	< 10
Iran	€557.7	48.5 [¶]	2.7	Very low	43
Russia	€169.4	16.7 ^{††}	-2.1	Low	< 10
Saudi Arabia	€707.9	1.7 [†]	8.7	Very high	17
South Africa	€224.7	5.5 [†]	2.0	Very low	39
United Arab Emirates	-	-	7.4	Very high	29

Note: Data derived from Expansión (2023). Please see the full reference list of the article, Gil-Alana, L.A. & Lopez, G., 2026, 'Asymmetric trajectories and shock persistence: A time series evaluation of consumption in the BRICS Plus countries', *South African Journal of Economic and Management Sciences* 29(1), a6769. <https://doi.org/10.4102/sajems.v29i1.6769>, for more information.

NMW, national minimum wage; CPI, consumer price index; GDP, gross domestic product.

[†], Interannual in September 2023; [‡], Interannual in October 2023; [§], Interannual in January 2022; [¶], Interannual in June 2023; ^{††}, Interannual in March 2022; ^{‡‡}, According to the GDP, the standard of living in relation to the rest of the 196 countries in the GDP per capita ranking; ^{§§}, By volume of GDP.

These data led to an incorrect conclusion when new members joined, as it was initially believed that they could collectively reach 80% of the global petroleum production. However, the actual scenario indicates that this figure will remain below 50%, which, nevertheless, remains a noteworthy statistic (Reuters 2023c). This circumstance may entail economic influence, influence on market dynamics, reduced dependency on other countries (in terms of energy), and also have environmental implications.

In the future, the possibility exists for additional countries to join the organisation. As reported by the 2023 summit chair, South Africa, over 40 countries, including Algeria, Bolivia, Indonesia, Cuba, the Democratic Republic of

Congo, Comoros, Gabon and Kazakhstan, have conveyed their interest in participating in the organisation (Reuters 2023a).

By employing fractional integration techniques, our objective is to elucidate the enduring memory characteristics of consumption conduct, thus providing invaluable insights into the evolution of household expenditures across the years.

In order to ensure thorough coverage and enable cross-country comparisons, our study examines an extensive dataset spanning 11 countries. This wide-ranging approach allows us to include a diverse variety of cultural characteristics, economic configurations and regulatory

TABLE 3: The top 10 oil† producers and share of total world oil production‡ in 2022§.

Country	Million barrels per day	Share of world total (%)
Brazil	3.17	3
Canada	5.83	6
China	4.45	5
Iran	3.67	4
Iraq	4.61	5
Kuwait	3.01	3
Russia	10.13	10
Saudi Arabia	12.44	13
United Arab Emirates	4.23	4
United States	20.3	21
Total top 10	-	74
Total BRICS top 10	-	39

Source: U.S. Energy Information Administration, 2023, *What countries are the top producers and consumers of oil?* viewed from <https://www.eia.gov/tools/faqs/faq.php?id=709&t=6>

†, Oil includes crude oil, all other petroleum liquids and biofuels; ‡, Production includes domestic production of crude oil, all other petroleum liquids and biofuels and refinery processing gain; §, Data source: U.S. Energy Information Administration, International Energy Statistics, Total oil (petroleum and other liquids) production, as of 11 April 2024.

environments, which provides a solid empirical base for studying how persistently consumption behaves across these jurisdictions. Consequently, we are able to analyse potential differences in consumer habits that stem from country-specific factors, including societal values, income tiers and institutional structures.

The outcomes of our research bear substantial implications for policymakers, offering valuable insights into the resilience and adaptability of consumption trends throughout the BRICS Plus territory. Moreover, it sheds light on the efficacy of policy measures aimed at invigorating economic growth, mitigating income disparities and promoting sustainable development (De Haan, Lundström & Sturm 2006; Rodrik 2005). Our overarching objective is to gain a comprehensive understanding of prospective shifts in these countries' consumption patterns and ascertain whether enduring patterns exist within the data series under examination.

Literature review

The examination of consumption is far from a recent endeavour, and there exists a substantial body of research on this subject. Regarding the specific topics, in 2023 alone, we find papers dealing with the following issues: energy consumption and carbon emissions forecasting (Hu & Man 2023); energy consumption and potential renewable sources (Hassan et al. 2023); meat consumption and risk of ischaemic heart disease (Papier et al. 2023); the transaction behaviour of cryptocurrency and electricity consumption (Zheng et al. 2023); the influence of economic factors on sustainable energy consumption (Sadiq et al. 2023); future warming from global food consumption (Ivanovich et al. 2023); climate change impacts on future residential electricity consumption and energy burden (Jones et al. 2023); energy consumption and its influence on the policy drive towards Sustainable Development Goal 7 (Elavarasan et al. 2023); inflation with Covid Consumption Baskets (Cavallo 2024), to mention only a few.

Focusing on theories that justify persistence in consumption, there are different studies. Keynes (1937) provided an early foundation for consumption persistence through his 'fundamental psychological law', noting that a household's habitual standard of living has the primary claim on its income. This behavioural rigidity implies that consumers do not alter their spending immediately following income fluctuations, but only after a notable lapse of time. By establishing that consumption is inherently sticky and lags behind sudden economic shifts, he provided the core theoretical rationale for short-term momentum, explaining why aggregate spending patterns persist over time rather than adjusting instantaneously to shocks. A few years later, Boulding (1945) reminded us that consumption is fundamentally the depreciation of an accumulated stock of goods. Because durable goods physically persist across multiple time periods, the utility they provide is inherently distributed over time, establishing a foundational structural reason for why consumer behaviour cannot be analysed purely as a series of isolated, short-term transactions. Duesenberry (1948) formalised consumption persistence through the 'ratchet effect' within his relative income hypothesis. He argued that current expenditure is heavily driven by a household's historical peak income rather than just its current earnings. Because consumers adapt to and fiercely protect their highest attained standard of living, they resist scaling back their spending during economic downturns, choosing instead to absorb negative income shocks by reducing their savings. This asymmetric behaviour creates a powerful structural momentum, demonstrating how past peak consumption acts as a historical anchor that prevents immediate mean reversion and locks in high expenditure patterns over time. Brown (1952) introduced the concept of 'habit persistence' into aggregate consumption functions. Moving away from static framework models, Brown theorised that past consumption experiences cast a continuous psychological shadow over current expenditure decisions. By structurally incorporating lagged consumption as an explanatory variable, his framework demonstrated that customs, traditions and acquired standards of living create a 'hysteresis' effect. This seminal contribution provided the foundational econometric justification for time lags in consumer behaviour, establishing that current consumption is inherently a path-dependent process heavily dictated by historical consumption trajectories. Friedman (1957) rationalised consumption persistence through his permanent income hypothesis, which posits that households base their spending on long-term expected wealth rather than current income. Because consumers use savings and credit to smooth out transitory income shocks, aggregate consumption remains highly stable and decoupled from temporary fluctuations. This forward-looking behaviour imparts a structural momentum to the data, as current consumption is anchored to a gradually updated measure of permanent income, explaining why spending patterns exhibit strong continuity and resist immediate changes following economic disturbances. Hall (1978) provided a foundational, albeit contrasting, framework for consumption persistence by

introducing the rational expectations 'random walk' hypothesis. He demonstrated that if consumers optimally smooth their spending based on all available information, current consumption incorporates all past knowledge, making its future changes completely unpredictable. Under this strict theoretical framework, consumption does not exhibit a slow, lagged adjustment to past events; rather, any shock to permanent income shifts the consumption path immediately and permanently. Hall's model thus formalises persistence in its most extreme statistical form – a pure unit root ($I(1)$) process – where the level of consumption inherits the entire history of past structural shocks, which never fade or revert to a mean.

Browning and Crossley (2001) justified consumption persistence by evaluating the modern, microfounded life cycle model, emphasising that apparent behavioural inertia often reflects rational, forward-looking smoothing under market frictions. They highlighted that when households face adjustment costs, habit formation or liquidity constraints, the marginal utility of consumption becomes linked across time periods.

Rather than adjusting expenditures instantly to every economic disturbance, consumers deliberately smooth their spending path to avoid costly disruptions to their lifestyle. Consequently, their framework demonstrates that persistence is not merely an irrational delay, but a structural feature of optimal intertemporal allocation, explaining why aggregate consumption patterns exhibit long-term continuity and a delayed response to shocks.

Based on the above theories and focusing on the methodology, the fractional integration techniques used in this work capture long-memory processes and hyperbolic shock decay. This econometric behaviour finds its closest theoretical counterpart in Brown's (1952) Habit Persistence framework, which posits that acquired living standards create an enduring behavioural inertia, causing aggregate consumption to adjust to economic shocks at a gradual, protracted pace.

Shifting our attention to articles addressing household consumption in BRICS, we have not identified any publications on this subject. Despite this, our research reveals that over the past 5 years, there has been a notable trend in the discussion of energy consumption (Ibrahim et al. 2022; Muhammad et al. 2021; Nawaz et al. 2021; Sachan et al. 2023; Samour et al. 2023; Wang, Bui & Zhang 2020; etc.).

There are studies of the impact of external shocks on different topics in the BRICS nations. An et al. (2022) assessed the probability of an external liquidity crisis by evaluating the early warning system (EWS) metric via an ARMA-Generalized Autoregressive Conditional Heteroskedasticity (GARCH) modelling approach. The results reported that South Africa, India and Brazil are highly vulnerable to shocks, whereas Russia and China present a more reasonable level of risk in the near future. Batondo and Uwilingiye (2022) examined the co-movement of stock markets in BRICS

countries and the United States (US) using daily close price indices of selected stock markets from 2000 to 2021. They applied a wavelet decomposition on stock return series. The results showed that most of the majority of preceding shocks were transmitted through mutual reliance resulting from trade channels and advancements in economic integration.

In conclusion and from the perspectives of risk management and portfolio diversification, the Chinese market offered highly profitable opportunities for short-term investors from the remaining nations examined in this research. Wen et al. (2022) examined the asymmetric and heterogeneous effects of monetary policy uncertainty (MPU) on stock returns in the BRICS countries and in the Group of Seven (G7) countries using a quantile-on-quantile (QQ) approach. The conclusion reveals that the market reactions to MPU shocks across the G7 nations appear more erratic than those observed within the BRICS economies. Al-Mohamad, Jreisat and Sraieb (2023), using Diebold and Yilmaz's (2012) approach, measured the spillover transmission and the financial connectedness among stock markets between BRICS economies and the rest of the world in the wake of the Ukrainian crisis with Russia. The outcomes of the volatility transmission demonstrated that stock markets in BRICS became less resilient to external shocks (volatility shock) as compared to the past. Su et al. (2021) explored the effect of crude oil price (COP) shocks on the economic policy uncertainty (EPU) in BRICS countries using the quantile Granger causality test. The empirical findings of the causal relationship exhibited asymmetrical characteristics, meaning that when supply shocks occur in the oil markets, they have a beneficial impact on the EPU in Brazil, China and India. Furthermore, a decreasing COP affects the EPU in South Africa and Russia.

Regarding our chosen methodology, fractional integration, it should be noted that several different studies can be found that have employed this approach to investigate a wide range of subjects. These include, but are not limited to: analysing US aggregate output dynamics (Diebold & Rudebusch 1989); examining interest rates on long-term government bonds issued by central governments in the US, Canada, Germany, the United Kingdom and Japan (Barkoulas, Baum & Oguz 1996); investigating inflation patterns in 10 different countries (Baillie, Chung & Tieslau 1996); studying the stochastic behaviour of unemployment in 11 African nations (Caporale & Gil-Alana 2018); assessing the efficiency and persistence of volatility in 12 cryptocurrencies (Yaya et al. 2021); understanding the impact of coronavirus disease 2019 (COVID-19) on Turkey's tourism sector (Yucel et al. 2022); analysing US car sales (Lopez & Gil-Alana 2023); among others. These examples illustrate the versatility and effectiveness of fractional integration as a research method across diverse fields and topics.

In all the literature presented above, we have not found any single article or book that analyses the topic examined in this work with fractional integration, which makes this

investigation in the BRICS Plus countries potentially of interest in the field.

Methods

In our context, we designate L as the lag operator, signifying that $L^k x(t)$ equals $x(t-k)$. A series is considered to be integrated of order 1, denoted as $I(1)$, if it can be formulated in this manner (Equation 1):

$$(1 - L)x(t) = u(t), \quad t = 1, 2, \dots, \quad [\text{Eqn 1}]$$

In this context, $x(t)$ denotes a time series, and $u(t)$ is a covariance stationary process with short memory, also denominated integrated of order 0. Short memory processes exhibit a distinctive trait – the infinite sums of their autocovariances, expressed as $\gamma(u) = E[(x(t) - \mu)(x(t+u) - \mu)]$, are finite, signifying that (Equation 2):

$$\sum_{j=-\infty}^{\infty} |\gamma(u)| < \infty \quad [\text{Eqn 2}]$$

Within the category of short memory processes, we can encompass the traditional AutoRegressive Moving Average (ARMA) processes. Specifically, if $u(t)$ follows an ARMA (p, q) pattern, then $x(t)$ is characterised as ARIMA ($p, 1, q$). As detailed in the preceding section, numerous statistical testing methods exist to ascertain whether a series is $I(1)$ or $I(0)$, also known as short memory. These methods include ADF (Dickey & Fuller 1979), PP (Phillips & Perron 1988), KPSS (Kwiatkowski et al. 1992), ERS (Elliot, Rothenberg & Stock 1996) and NP (Ng & Perron 2001), yet they all exclusively consider integer orders of integration (i.e. 1 for non-stationary series and 0 for stationary ones).

Conversely, scholars like Diebold and Rudebusch (1991), Hassler and Wolters (1994), Lee and Schmidt (1996), among others, have demonstrated that many of the aforementioned approaches exhibit limited effectiveness when the true data generating process adheres to $I(d)$ where d represents a fractional value. If the differencing parameter d is fractional, Equation (1) is expressed in the following way (Equation 3):

$$(1 - L)^d x(t) = u(t) \quad t = 0, \pm 1, \dots \quad [\text{Eqn 3}]$$

Moreover, when d takes on a positive value in Equation (3), $x(t)$ in (3) transforms into a long-memory process. This implies that the infinite sum of autocorrelations becomes unbounded, that is (Equation 4):

$$\sum_{j=-\infty}^{\infty} |\gamma(u)| = \infty \quad [\text{Eqn 4}]$$

In alternation, we can characterise the two categories of processes: short memory and long memory, in the frequency domain. By formulating the spectral density function, $f(\lambda)$, as the Fourier transform of the autocovariances, that is (Equation 5):

$$f(\lambda) = \sum_{j=-\infty}^{\infty} \gamma(u) e^{i\lambda u} = \sum_{j=-\infty}^{\infty} \gamma(u) \cos(\lambda u) \quad [\text{Eqn 5}]$$

we categorise $x(t)$ as having long memory when the spectrum extends to infinity at least at one point within the frequency range $[0, \pi)$ (Equation 6):

$$f(\lambda) \rightarrow \infty, \quad \text{for some } \lambda \in [0, \pi). \quad [\text{Eqn 6}]$$

Conversely, it is classified as short memory if the spectral density function, $f(\lambda)$, is positive and limited across all frequencies (Equation 7):

$$0 < f(\lambda) < \infty, \quad [\text{Eqn 7}]$$

Similar to the scenario of white noise, where $f(\lambda)$ remains constant across all values of λ , it can be demonstrated in the context of Equation (3) that the spectral density function of $x(t)$ is (Equation 8):

$$f(\lambda) = \frac{\sigma^2}{2\pi} \left| \frac{1}{1 - e^{i\lambda}} \right|^d, \quad [\text{Eqn 8}]$$

and it tends to infinity as $\lambda \rightarrow 0^+$ with $d > 0$ justifying its long memory property.

The fractional integrated process outlined in Equation (3) provides a diverse range of specifications, encompassing, among other possibilities:

- anti-persistence, if $d < 0$
- short memory, if $d = 0$
- long memory, though covariance stationary processes, if $0 < d < 0.5$
- non-stationary mean reverting processes, if $0.5 \leq d < 1$
- unit roots if $d = 1$
- and explosive processes if $d > 1$.

Furthermore, the model in Equation (3) can be expanded to accommodate linear, or even non-linear, trends. In a conventional approach, aligning with established unit roots literature (Bhargava 1986; Schmidt & Phillips 1992), we incorporate a linear time trend model structured as follows (Equation 9):

$$y(t) = \alpha + \beta t + x(t), \quad t = 1, 2, \dots, \quad [\text{Eqn 9}]$$

Here, α and β denote the parameters requiring statistical estimation – specifically, an intercept and a linear time trend, respectively. The variable $x(t)$ is determined by equation (3).

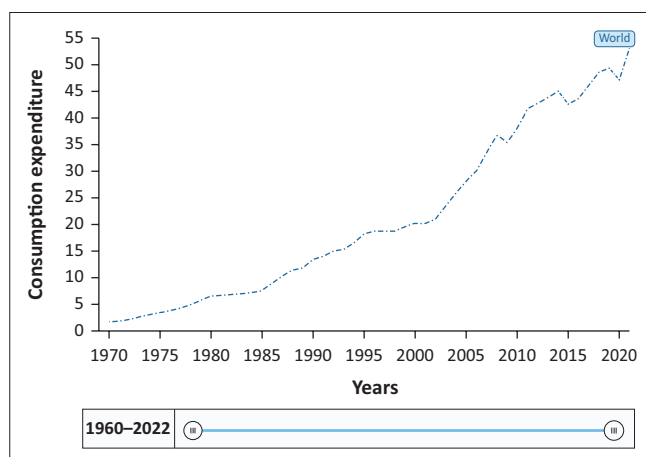
In the practical application discussed in the subsequent section, our preliminary analysis relies on a framework delineated by Equations (9) and (3). We start from the premise that the error term $u(t)$ follows a white noise process, with zero mean and constant variance.

The estimation of the parameters is conducted via maximum likelihood in the frequency domain and using a simple version of a testing procedure developed in Robinson (1994). It tests the null hypothesis: $H_0: d = d_0$, in the model given by the Equations (9) and (3), where d_0 can be any real value. Using this procedure, which has a standard $N(0, 1)$ limit distribution, we are able to compute a confidence band of values where d_0 cannot be rejected (see, e.g. Gil-Alana & Robinson 1997 for the description of the functional form of the test statistic used in this application).

Data

The data utilised in this analysis are sourced from The World Bank (2023b) and pertains to 'Households and NPISHs Final consumption expenditure' measured in current US dollars. NPISHs stands for Non-Profit Institutions Serving Households. In simpler terms, the data represent the total spending by NPISHs and households on various goods and services that they use for themselves, such as housing, food, healthcare, transportation, leisure activities and education. It is worth noting that the data are not corrected for inflationary effects or temporal shifts in purchasing power, and it offers insights into the spending patterns and trends of households across BRICS Plus countries from 1960 to 2022.

Additionally, NPISHs constitute institutional units that are separate from public sector bodies and commercial enterprises. These entities are engaged in non-profit actions and supply various services and goods to households and also communities. Non-Profit Institutions Serving Households are charities, NGOs, religious institutions, foundations, volunteer organisations and community centres. They perform a critical function in meeting societal demands, advancing public well-being and fostering the development of communities.



Source: The World Bank, 2023b, *Households and NPISHs Final consumption expenditure (current US\$)*, viewed from <https://data.worldbank.org/indicator/NE.CON.PRVT.CD>

FIGURE 2: Households and Non-Profit Institutions Serving Households final global consumption expenditure (current US\$).

In the realm of economics and demographics, households denote collectives of individuals who live all together in a shared home and engage in economic and social activities collectively. Understanding households, including aspects like their income levels, spending habits, demographics and socioeconomic conditions, is crucial for researchers, policymakers and businesses across different fields, ranging from sociology and economics to public policy and marketing.

Figure 2 illustrates a significant positive trend in the data for the World in general, indicating substantial development over time. This development is evident in the increase in total expenditure from US\$1.75 trillion in 1970 to US\$53.1 trillion in 2021. However, not all countries follow the same trend, and it is important to analyse and compare these results to understand the differences between them and the degree of persistence in their expenditure patterns. The data include information about 11 countries: Argentina, Brazil, China, Egypt, Ethiopia, India, Iran, Russia, Saudi Arabia, South Africa and United Arab Emirates. Certain nations lack data extending back to 1960, and this limitation is explicitly documented in Table 4.

Ethical considerations

This article followed all ethical standards for research without direct contact with human or animal subjects.

Results

The model under consideration is the one outlined by Equations (9) and (3), specifically (Equation 10):

$$y(t) = \alpha + \beta t + x(t); \quad (1 - L)^d x(t) = u(t) \quad t = 1, 2, \dots, \quad [\text{Eqn 10}]$$

The results are presented in Table 5 and Table 6. Table 5 presents the estimations of the parameter d in three traditional scenarios from the unit root literature:

- Without deterministic terms, assuming both unknown coefficients, α and β , are pre-set to zero in (10).
- With an intercept ($\beta = 0$).
- With both an intercept and a linear time trend.

The values highlighted in bold in Table 5 correspond to the chosen specifications for each regressor type, and the estimated coefficients of these selected models are detailed in Table 6.

The first thing we observe in Table 5 and Table 6 is that the time trend coefficient is required in various cases: Argentina, Brazil, China, Egypt, Ethiopia, India, Russia, Saudi Arabia, South Africa and UAE, and, in all these countries, the parameter for the time trend exhibits a positive value, the highest one corresponding to Ethiopia (0.0499) followed by China (0.0384); for the remaining three countries (i.e. Brazil, Iran and Russia), the time trend coefficient is statistically insignificant. On the other hand, if we focus on the magnitude

TABLE 4: Descriptive statistics.

Series	Start date	Max.	Min.	Mean	SD
Argentina	1962	11.7352	10.1757	11.0639	0.4520
Brazil	1960	12.3150	10.0789	11.4597	0.6381
China	1960	12.9827	10.5747	11.6186	0.7425
Egypt	1965	11.6315	9.6296	10.6942	0.5564
Ethiopia	2011	11.0311	10.4223	10.8114	0.1390
India	1960	12.3811	10.5415	11.4397	0.5283
Iran	1960	11.5952	9.5886	10.8138	0.5705
Russia	1988	12.2167	11.1253	11.7496	0.3412
Saudi Arabia	1968	11.7930	9.3153	11.0051	0.5816
South Africa	1960	11.5702	9.7772	10.9032	0.5279
United Arab Emirates	2001	11.3325	10.8533	11.2075	0.1096

Note: Data derived from World Bank (2023b). Please see the full reference list of the article, Gil-Alana, L.A. & Lopez, G., 2026, 'Asymmetric trajectories and shock persistence: A time series evaluation of consumption in the BRICS Plus countries', *South African Journal of Economic and Management Sciences* 29(1), a6769. <https://doi.org/10.4102/sajems.v29i1.6769>, for more information.

SD, standard deviation.

TABLE 5: Estimates of the fractional differencing parameter.

Series	No terms		An intercept		An intercept + time trend	
	d	95% CI	Intercept	t -value	Time trend	t -value
Argentina	0.94	0.77–1.17	0.76	0.64–1.03	0.73	0.52–1.03
Brazil	0.92	0.76–1.15	1.27	1.05–1.56	1.25	1.03–1.55
China	0.94	0.77–1.17	1.12	1.02–1.33	1.16	1.03–1.37
Egypt	0.94	0.77–1.18	1.19	0.86–1.54	1.17	0.89–1.52
Ethiopia	0.51	-0.86–1.30	0.37	-0.44–2.16	0.08	-0.57–1.61
India	0.95	0.77–1.17	0.97	0.87–1.18	0.97	0.81–1.19
Iran	0.71	0.48–1.04	0.44	0.19–0.91	0.42	0.14–0.91
Russia	0.88	0.66–1.22	1.20	0.98–1.62	1.21	0.97–1.62
Saudi Arabia	0.91	0.72–1.16	0.64	0.53–0.94	0.63	0.46–0.95
South Africa	0.94	0.78–1.17	1.15	0.92–1.49	1.13	0.93–1.46
United Arab Emirates	0.78	0.38–1.26	0.97	0.42–1.54	0.97	0.63–1.48

Note: We report the estimates of d for the three cases of no terms (column 2), with an intercept (column 3) and with an intercept and a linear time trend (column 4). Values in bold are the selected specification for each country.

CI, confidence interval.

TABLE 6: Estimated coefficients of the selected models.

Series	No terms		Intercept		Time trend	
	d	95% CI	Intercept	t -value	Time trend	t -value
Argentina	0.73	0.52–1.03	10.242	101.98	0.0242	4.66
Brazil	1.27	1.05–1.56	10.071	161.32	-	-
China	1.16	1.03–1.37	10.541	311.72	0.0384	4.89
Egypt	1.17	0.89–1.52	9.593	225.24	0.0355	3.38
Ethiopia	0.08	-0.57–1.61	10.431	607.60	0.0499	21.85
India	0.97	0.81–1.19	10.511	300.65	0.0296	7.52
Iran	0.44	0.19–0.91	10.185	10.78	-	-
Russia	1.20	0.98–1.62	11.612	138.52	-	-
Saudi Arabia	0.63	0.46–0.95	0.000004	39.98	0.00005	4.04
South Africa	1.13	0.93–1.46	9.748	188.35	0.0279	2.62
United Arab Emirates	0.97	0.63–1.48	10.832	203.20	0.0225	2.04

Note: The values in column 2 are the estimates of d . In columns 3 and 4, we report the estimates of the intercept and the time trend coefficients with their associated t -values.

CI, confidence interval.

of the persistence by evaluating the estimated differencing parameter d , we find that reversion to the mean only takes place in two cases: Iran, with an estimate of d equal to 0.44, and Saudi Arabia ($d = 0.66$); in these two cases, the values of d in the 95% confidence intervals are all below 1, implying transitory shocks. In all the other cases, though the values of d are smaller than 1 in some cases, the interval includes the value 1, implying that the presence of a unit root cannot be ruled out. In the case of Ethiopia, the estimated value of d is 0.08, but the confidence interval is sufficiently broad that neither hypothesis can be rejected, the $I(0)$ or the $I(1)$ hypotheses.

Conclusion

We have investigated in this study the persistence in the series corresponding to consumption levels in the BRICS Plus nations. For this purpose, we have looked at data corresponding to spending by individuals and NPISHs in a set of 11 countries: Argentina, Brazil, China, Egypt, Ethiopia, India, Iran, Russia, Saudi Arabia, South Africa, and UAE.

The data periods span from 1960 to 2022, annually. The results reveal some differences across countries. Thus,

positive time trends are detected in all countries except Brazil, Iran and Russia, and the highest trends are observed in Ethiopia and Saudi Arabia for households and NPISHs final consumption expenditure. More importantly, empirical support for mean-reverting behaviour and transitory innovations is exclusively detected in the instances of Iran and Saudi Arabia; for the remaining nations, the null hypothesis of permanency of shocks cannot be rejected.

The lack of significance trends in Brazil, Iran and Russia could be caused by economic factors (economic downturns, recessions or unfavourable economic policies), political instability (political uncertainties, corruption issues or policy changes), social factors (societal issues, demographic changes or cultural factors) and external shocks (events like natural hazards, global economic crises or geopolitical tensions).

Correlating this conclusion with certain aspects of the literature we have reviewed reveals that diverse topics yield varied conclusions. In our analysis, we consider the inclusion of new members, yet in comparison with the established ones (BRICS), Brazil and Russia appear to be at a disadvantage in terms of consumption.

Notably, according to the study by An et al. (2022), for the examination of external liquidity shocks, India, South Africa and Brazil are implicated, while for COP shocks, South Africa and Russia are the focal points (Su et al. 2021). Each country exhibits distinct strengths and weaknesses across different domains, as discerned through the various analyses. Other analyses in this vein are recommended to explore additional topics where the BRICS Plus countries may be sensitive to shocks.

The direct integration of our findings on fractional integration with the historical chronology of consumption theories provides a mathematical synthesis that validates Brown's (1952) persistence of habit theory.

Consumption today and tomorrow depends on its past. Studying historical data allows us to make decisions today about what might happen tomorrow, thus eliminating uncertainty, enabling efficient decision-making and

providing market measurement. By utilising a fractional integration framework, this study moves beyond the restrictive binary choice of treating consumption as either stationary ($d = 0$) or non-stationary ($d = 1$). Instead, analysing consumption across the spectrum of d -values allows for a deeper and clearer reconciliation of macroeconomic theory and policy. If empirical estimations yield a parameter within the stationary long-memory range ($0 < d < 0.5$), it provides empirical validation for a mild interpretation of Brown's (1952) habit persistence. In this scenario, consumption displays behavioural memory, meaning fiscal policies will possess an extended transmission mechanism, trickling through aggregate demand over an elongated horizon rather than exhausting their impact immediately. Critically, if the data reveal a non-stationary but mean-reverting process ($0.5 \leq d < 1$), the analytical interpretation shifts profoundly. This range indicates a severe structural inertia that aligns closely with Duesenberry's (1948) 'ratchet effect' and an intense manifestation of Brown's habit persistence. Households do not smooth consumption evenly as Hall (1978) suggests ($d = 1$); instead, they experience a prolonged, non-stationary drift, aggressively maintaining their peak living standards in the wake of negative shocks by depleting savings or accumulating debt. For policymakers, an economy characterised by $0.5 \leq d < 1$ warns that temporary stabilisation policies are fundamentally inadequate. Because the behavioural habits of consumers cause economic shocks to persist deeply and decay at a hyperbolic, glacially slow rate, any fiscal intervention must be structurally sustained. Temporary relief checks will merely be swallowed up by households trying to patch over their accumulated deficits to maintain their baseline habits, whereas sustained policy adjustments are required to safely guide the economy back to its long-run equilibrium mean. For details on the integration of theories, findings and policies, see Table 7.

For countries experiencing a lack of time trends and in particular those with evidence of permanent shocks, it is crucial for authorities to implement robust measures aimed at restoring the initial consumption patterns. The causes of reduced consumption can be diverse, necessitating a comprehensive approach. Here are various suggestions and policy implications for enhancing consumption:

TABLE 7: Summary of the integration of theories, findings and policies.

Parameter range (d)	Statistical property	Closest consumption theory	Real-world consumer behaviour	Macroeconomic policy implication
$d = 0$	Short Memory	Keynes (1937)	Immediate, rigid adjustment to income changes after a minor lag.	High policy precision: Stimulus or tax cuts have a predictable, immediate impact on aggregate demand with no lingering lag.
$0 < d < 0.5$	Long Memory (Stationary)	Brown (1952) (<i>Mild Habit</i>)	Households possess a memory of past living standards; shocks decay slowly but consumption stays within a steady long-run band.	Extended transmission: Fiscal interventions have a 'long tail'. The policy's effect will ripple through the economy over several quarters before fading.
$0.5 \leq d < 1$	Non-stationary, Mean-Reverting	Brown (1952) (<i>Strong Habit</i>) & Duesenberry (1948) (<i>Ratchet</i>)	Extreme behavioural inertia. Consumers fiercely resist lifestyle changes during shocks, causing consumption to drift far from its baseline before eventually returning.	Policy delay & vulnerability: Short-term stimulus is insufficient. Because consumers absorb shocks via savings/debt to protect habits, policy must be sustained to prevent structural insolvency.
$d = 1$	Unit Root (Non-stationary)	Hall (1978) (<i>Rational Expectations</i>)	Forward-looking smoothing. Any shock permanently changes the consumption path; consumers never look back or return to old baselines.	Permanent structural shifts: Transitory policies (like one-time checks) fail entirely because rational consumers spread the gains over their lifetimes. Only permanent structural tax/wage changes shift the aggregate

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- Fiscal stimulus: Deploy expansionary fiscal policies such as tax cuts (value added tax for vital goods and services) or direct cash transfers to augment disposable income, fostering increased consumer spending (Kaplan & Violante 2014; Lyssiotou & Savva 2021).
- Enhancing disposable income: Pursue policies focusing on wage improvement, employment boosting measures and job creation to elevate household income, resulting in heightened consumption levels (Banker, Byzalov & Chen 2013; Yasar 2017).
- Infrastructure investment: Invest in infrastructure projects to generate jobs, improve transportation networks and stimulate overall economic activity, consequently impacting consumption positively (Ramey 2020).
- Access to credit: Facilitate access to credit for households, enabling them to make more significant purchases and investments, thereby stimulating consumption (Kus 2013).
- Education and financial literacy: Promote financial literacy programmes and educational initiatives to empower individuals in making informed financial decisions, leading to improved consumption patterns (Dinkova, Kalwij & Alessie 2021).
- Favourable business environment: Implement policies supporting entrepreneurship, innovation and a conducive business environment, fostering economic growth, job creation and increased consumer spending (Wüstenhagen et al. 2008).
- Enhancing international trade: Expand international trade to increase market access, encourage competition and provide consumers with a broader range of goods and services at competitive prices, potentially stimulating consumption (Janeba 2007).

These recommendations are offered in response to exogenous shocks, considering the elevated magnitude of persistence observed by the time series across the entire sample of nations. Finally, other approaches can be implemented to corroborate the results reported in this work. Thus, for example, other economic variables may be examined accompanying consumption in the interrelationships among variables, utilising, for instance, the fractional cointegrated vector autoregressive (FCVAR) framework developed by Johansen and Nielsen (2010, 2012), or the more recent panel fractionally integrated approach of Ergemen and Velasco (2017) might be alternative viable approaches. Research along these lines is currently underway.

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Competing interests

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CRedit authorship contribution

Luis A. Gil-Alana: Data curation, Formal analysis, Funding acquisition, Methodology, Validation, Writing – original draft, Writing – review & editing. Gema Lopez: Conceptualisation, Data curation, Investigation, Writing – original draft, Writing – review & editing. Both authors reviewed the article, contributed to the discussion of results, approved the final version for submission and publication and take responsibility for the integrity of its findings.

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Data availability

Data are available upon request from the corresponding author, Gema Lopez. Additionally, this public data related to Households and NPISHs Final consumption expenditure can be found at: <https://data.worldbank.org/indicator/NE.CON.PRVT.CD>.

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