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EXCHANGE RATE DETERMINATION: A GMM APPROACH TO SOCIAL-ECONOMIC AND GOVERNANCE FACTORS

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Abstract*: This study examines exchange rate determinants, drawing on Balassa (1964)'s critique of productivity oversight and guided by Gelb and Diofas (2016)'s framework, using the Big Mac Index as a proxy for purchasing power parity (PPP). Analysing data from 52 economies (2011-2019) with a dynamic Generalized Method of Moments (GMM) estimator, it reveals that exchange rates are inversely associated with trade deficits, effective governance, and inflation, while positively correlating with income, economic size, and population density. These findings emphasise the complex interplay of various factors influencing exchange rates, providing policymakers and financial stakeholders with invaluable insights.*

Keywords: *Exchange Rate Determination, Big Mac Index, Purchasing Power Parity, Generalized Method of Moments*

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Introduction

Understanding the factors influencing exchange rates is critical for policymakers, economists, and businesses involved in international trade and investment. Exchange rates influence economic stability, competitiveness, and inflation, which impact national economies' overall health. The Big Mac Index, introduced by The Economist in 1986, provides a unique perspective on purchasing power parity (PPP) by comparing the price of a Big Mac in various countries. This informal measure highlights differences in currency valuation and cost of living, revealing whether currencies are undervalued or overvalued relative to the US dollar. Beyond this simplistic approach, several factors influence exchange rates, including income levels, population density, economic size, effective governance, inflation, and trade deficits. This study aims to analyse these determinants using a dynamic Generalised Method of Moments (GMM) estimator, which will be applied to data from 52 economies from 2011 to 2019.

Problem Statement

This study addresses the need for a comprehensive framework for understanding currency valuation, which extends beyond conventional income and productivity biases. Inspired by the methodology of Chavez (2020), the research aims to explore the relationship between socio-economic and governance factors influencing exchange rate dynamics.

Acknowledging exchange rate determination is vital for shaping international trade, influencing investment choices, and ensuring overall economic stability. Grasping these underlying factors is essential for policymakers and stakeholders to develop effective economic strategies. Considering Balassa-Samuelson (BS) model as the sole factor is insufficient to explain the market phenomena, transitioning from the manufacturing-driven economy of the 1980s to the technology-driven economy of the 2020s, during which government engagement in construction and development cannot be overlooked.

The Balassa-Samuelson model suggests a positive and significant relationship between productivity bias and exchange rates. This relationship highlights the importance of tradable and non-tradable goods and services in assessing price levels and actual local purchasing power (Balassa, 1964; Samuelson, 1964). Studies on developed countries provide mixed evidence, with Camarero (2008) offering limited support, while Wang et al. (2016) and Njindan Iyke & Odhiambo (2017) affirm the validity of the Balassa-Samuelson hypothesis over specific periods. For developing countries, findings are more varied. Wang et al. (2016) and Hassan (2016) observed a negative and significant relationship between income-price levels and exchange rates, suggesting a failure of the Balassa-Samuelson hypothesis. In contrast, Banerjee & Goyal (2021) found support for the hypothesis in developing economies. Therefore, previous results showed mixed results when the observables and extension variables were changed.

In highlights, Gelb’s Balassa-Samuelson extension model study highlights the significant influence of the "Africa effect" on prices across all factors using OLS regression in recent years. However, it also presents extension models incorporating different countries and time frameworks, revealing that only specific factors significantly impact prices. This inconsistency in time frameworks among variables raises concerns about the reliability of the extension model, as factors may influence prices at either the level or the differences level. This study suggests that short panel datasets should not only address a concern of "multicollinearity" among variables over long period but also reevaluate each variable’s impact over time is a necessity, as t could be at the different levels of influence on prices.

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Consequently, selecting appropriate determinants is crucial in addressing the inconsistencies observed in time-series and cross-sectional such as analyses of Gelb and Diofas (2016)'s models. Thus, this study adopts a multidimensional approach, incorporating aspects of the Balassa-Samuelson model and other relevant economic theories, to investigate the complex relationships between socio-economic factors and exchange rate dynamics. Therefore, this study adopts a governmental perspective that aligns with the monetary approach and emphasizes policy implications, which could be beneficial. In conjunction with the Balassa-Samuelson (BS) model, this approach may improve the understanding of exchange rate determinants beyond the socio-economic context.

Besides the Balassa-Samuelson model, one of the earliest foundational doctrines in exchange rate determination theory is the monetary approach to the exchange rate model, which identifies the influence of relative supply and demand on a currency's movement (Cassel, 1918). This theory suggests that government actions can have long-term "knock-on effects" on local currency markets.

The real-world scenario suggests that monetary factors influence exchange rate movements, often shaped by government interventions and policy measures. For instance, during the period from 2011 to 2019, several scenarios significantly impacted currency movements over extended periods, including the pegged regime of the Singapore dollar to the Brunei dollar (1967-present), the redenomination following the launch of the European currency for union members (1998-present), and instances of hyperinflation in Turkey (2005) and Venezuela (2008), as well as the implications of Brexit (2020) and the trade war between China and the United States (2018-2019). The scenarios as mentioned above do not yet encompass local strategies and policy adjustments related to governance—such as fiscal regimes, interest rates, taxes, and subsidies—that influence long-term changes in supply and demand for currencies and purchasing power.

The significance of government roles in local markets is evident, as their actions can alter the preferences of local consumers, particularly when they perceive being "paid extra" in the current purchasing context, which may subsequently impact individual perceptions of "worthiness." The income that earners could proportionately spend has diminished as prices rise due to changing market dynamics, leading to a decrease in their purchasing power and forcing them to confront proportional reductions in what they were accustomed to affording. This indicates a misalignment between the income received by local low-wage earners and the local price increases over time.

Despite the difficulty of extensive research on exchange rate determination, a significant gap persists in comprehending the intricate interactions between socio-economic factors and governmental policies across various economic contexts. This study aims to analyse socio-economic factors such as income, economy size, and population density (as emphasized in Gelb's research), alongside governmental factors like effective governance, trade deficits, and inflation. Exploring these elements within the framework of historical market dynamics may yield valuable insights for current market evaluations.

This study explores various factors that significantly influence exchange rate determination. From a socio-economic perspective, income emerges as a crucial factor, as it reflects individuals' purchasing power, which aligns with the Balassa-Samuelson (BS) model. This model suggests that an individual's earnings depend on their ability to efficiently produce goods

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and services. Additionally, the size of the economy is vital for understanding a country's economic capacity and output, reflecting its effectiveness in managing resources such as labour, capital, and technology. A larger economy is typically associated with higher prices and improved living standards. Furthermore, population density may play an important role; increased density can heighten demand in a given area, subsequently raising prices for goods and services (Gelb & Diofasi, 2016). This phenomenon is evident in the migration of resources from rural to urban areas, resulting in a price transition from lower to higher levels (Usher, 1965). Such trends may contribute to unequal development among countries, driven by the mobility of income and resources toward centralized locations.

From a governmental perspective, effective governance and trade deficits significantly impact market dynamics. Policy decisions are essential for regulating market prices. For instance, contractionary monetary policy by U.S. authorities can mitigate losses in sectors affected by inflation; however, real appreciation may result from expansionary fiscal policy, leading to a skewed economic recovery and lower overall production levels relative to U.S. inflation (Frankel, 1985). Moreover, the nation's religious beliefs can influence the quality of institutions and policymakers' decisions in various countries. This factor may be overlooked, particularly in underdeveloped countries like Malaysia, where price levels may be artificially depressed due to protests or subsidies (Means, 1978). The establishment of the Eurozone aims to foster uniformity among member countries, but achieving this has proven challenging amidst structural changes within the group (Samadi & Alipourian, 2021). Additionally, inflation is intricately linked to price movements, but the interaction of policy with economic activities can disrupt market flow, especially when countries implement trade restrictions to protect local populations (Ang et al., 2021). As a result, the consequences of the government's role will cause the actual flowless of the market being interrupted. Thus, this study implied the inspection from perspective of social-economic such as income, size of economy and population density (which been included in Gelb's study). Consequently, the government's role can significantly interrupt market dynamics.

Within this framework, the Balassa-Samuelson model functions as a foundational construct that underscores key socio-economic factors such as income, economic size, and population density. Furthermore, government-related variables—such as inflation, trade deficits, and governance effectiveness—are integrated as supplementary components. Together, these elements contribute to the development of an alternative framework that enhances our understanding of the determinants influencing exchange rates and facilitates a more comprehensive analysis.

Another limitation in Gelb's extension of the BS model concerns the use of the ICP index, which warrants reconsideration due to the diverse characteristics of countries and consumer behaviours that may contribute to heterogeneity among nations (Gelb & Diofasi, 2016). Overestimation and underestimation of indices related to income disparities between poorer and wealthier countries have historically posed challenges in research, reflecting exaggerations in what people can genuinely afford (Nordhaus, 2007). These issues are also acknowledged in Gelb's study, highlighting the need to carefully consider how income and purchasing power are measured across different contexts. To minimize bias in the indexes used, this study considers employing a single food index—the Big Mac price—since it is recognized as a homogeneous index by The Economist. This approach aims to provide a more consistent and comparable measure of purchasing power across different economies.

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As a result, integrating the Big Mac Index as a proxy for purchasing power parity (PPP), the study synthesizes insights from Balassa (1964)'s critique and Gelb and Diofas (2016)'s framework. It uses a dynamic Generalised Method of Moments (GMM) estimator to dissect data from 52 economies (2011-2019) to provide nuanced insights into how factors such as income, population density, size of the economy, governance effectiveness, inflation, trade deficits, and PPP influence exchange rates. This approach contributes to a more comprehensive understanding of exchange rate dynamics, facilitating informed policy-making and economic forecasting.

Literature Review

Within the framework of the Balassa-Samuelson (BS) model for choosing extension variable criteria, this study covers both socio-economic and governmental viewpoints, emphasising their roles in economic behaviour and policy implications. The study looks at several possible factors that could affect exchange rates, such as socio-economic indicators like income, population density, and size of the economy, as well as governmental indicators like government effectiveness, inflation rates, and trade deficits.

Prominent economists such as Williams (1955), Samuelson (1964), and Officer (1976) have posited that income levels significantly influence productivity biases, resulting in elevated consumer prices in developed countries. Supposedly, higher incomes increase the demand for goods and services, raising prices and causing exchange rates to deviate from PPP. Usher (1965) and Lafrance & Schembri (2002) emphasize that demand-driven spending, in conjunction with income, exerts a multifaceted impact on exchange rates. This underscores the complexity of the relationship between income and exchange rate dynamics, suggesting that traditional models may need to account for additional demand factors to capture these relationships accurately. Click (1996), Ong (1997), Caetano, Moura, and Da Silva (2004) further support the view that productivity bias due to income differences can lead to systematic price disparities between developed and developing countries.

The size of an economy introduces market imperfections, such as transaction costs and trade barriers, which significantly influence exchange rate movements. Historical analyses by Cassel (1918), Keynes, (1923) and Angell (1925) highlight the foundational role of market frictions in PPP deviations. Further research, such as that by Alba & Papell (2007) has shown that larger economies face higher transaction costs and more substantial trade barriers, leading to exchange rate adjustments. Crucini and Yilmazkuday (2014) provide additional evidence, demonstrating that distribution shares can mitigate expenditures associated with distance, especially as unskilled labour wages rise. This suggests that the structural characteristics of an economy, including its size and labour market conditions, play a crucial role in shaping exchange rate behavior. As a result, greater productivity in the tradable sector, which propels economic growth, results in larger economies typically having greater PPP conversion factors. This productivity frequently results in higher wages, which spread into the non-tradable sector, raising overall price levels. Furthermore, larger economies' diversity and competitiveness can reduce trade barriers and transaction costs, strengthening price differentials and raising the PPP conversion factor.

Population density affects labour mobility and resource allocation, which are critical determinants of exchange rate movements. Early studies by Usher (1965) and Balassa (1964) indicated that labour migration from rural to urban areas and across national borders can influence service prices and exchange rates. Contemporary research by Fukao & Yuan (2012)

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shows that high barriers to labour migration in open economies like China prevent service price equalization, as restrictions on rural-to-urban migration and limited migrant services hinder efficient labour allocation and slow price convergence despite rising GDP per worker. This highlights that population density and migration policies can have complex and significant effects on exchange rate dynamics, particularly in economies undergoing rapid structural changes. Gelb & Diofasi (2016) also find that more open labour policies in higher-income nations are linked to lower price levels, impacting exchange rates.

Governance and institutional quality are paramount in determining economic activity and exchange rates. Effective governance fosters stability by ensuring sound economic policies and reducing uncertainty, as Schout & North (1991) and Dornbusch (1982) illustrated. Ineffective governance, as highlighted by Atal (2014) through the Big Mac Index, and in emerging market economies undergoing institutional change, as discussed by Samadi (2021) often leads to currency depreciation and increased exchange rate volatility. Thus, the appreciation of local currencies can be attributed to rational behaviour by central banks and economic agents or to increased offshore trading activity (Sohag et al., 2022). This underscores the critical role of institutions in maintaining economic stability and their influence on exchange rate behaviour.

Trade deficits impact exchange rates through their effects on the supply and demand for foreign currencies. The seminar paper by Angell (1922), Pigou (1922), and Vries (1968) shed light on how trade deficits, as part of the current account, can contribute to currency depreciation. While emphasizing historical insights, they highlight the link between current account imbalances and exchange rate movements, underscoring the importance of considering past and present factors in understanding exchange rate dynamics. Further research by Layton & Stark (1990) indicates that changes in trade flows and the balance of payments influence real exchange rates and price competitiveness. Bartovlini (1995), Mendoza (1995), Chen and Rogoff (2003), and Alcala & Ciccone (2004) provide additional evidence that trade shocks correlate with real exchange rates and productivity, highlighting the importance of trade balances in shaping exchange rate movements. The results indicate that exchange rate misalignment significantly affects current account adjustments, with countries experiencing a more appreciated exchange rate tending to have poorer current account performance, while those with a more depreciated exchange rate tend to perform better. (Vieira & MacDonald, 2020). However, Bresser-Pereira et al. (2025) demonstrate a positive relationship between the current account and currency, which contrasts with the traditional balanced account perspective.

Inflation exerts a profound influence on exchange rates by altering the purchasing power of currencies. High inflation rates typically lead to currency depreciation, as the relative value of the currency declines (Mahdavi & Zhou, 1994; Sarno, 2000; Celasun, 2006; Deka & Dube, 2021). Studies have demonstrated that PPP is more likely to hold under high inflation pressures, though structural differences between countries can complicate this relationship (Genberg, 1978; Cheung & Lai, 2000). This complexity suggests that inflation impacts exchange rate movements directly and interacts with other macroeconomic variables to influence currency valuation. Investigating how inflation influences exchange rates can provide important insights into exchange rate pass-through and its effect on inflation expectations, which is crucial for informing policy decisions. However, it is essential to recognize the limitations posed by the dynamic risks associated with changing market conditions.

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As a result, the following hypotheses have been defined from previous studies:
H_1: Income significantly influences the Purchasing Power Parity (PPP) exchange rate.
H_2: Size of the economy is significant in influencing the Purchasing Power Parity (PPP) exchange rate.
H_3: Population density significantly influences the Purchasing Power Parity (PPP) exchange rate.
H_4: Effective governance significantly influences the Purchasing Power Parity (PPP) exchange rate.
H_5: Trade deficit significantly influences the Purchasing Power Parity (PPP) exchange rate.
H_6: Inflation significantly influences the Purchasing Power Parity (PPP) exchange rate.

Methodology

This study uses dynamic Generalised Method of Moments (GMM) estimators to investigate the determinants of exchange rates, with the Big Mac Index serving as a proxy for purchasing power parity (PPP). The model specification is intended to capture the dynamic nature of exchange rate adjustments while accounting for potential endogeneity in the explanatory variables. GMM estimators are thoughtfully built in this research[1]. It is useful when applied to a short panel study.

The difference GMM provides a solution to the endogeneity problem by transforming the data to eliminate fixed effects. While it is advantageous in smaller panel datasets, it is prone to weak instrument issues, particularly with highly persistent variables. This can compromise the reliability of the estimates. In contrast, the system GMM combines the strengths of both level and difference equations, offering a robust framework for addressing endogeneity. It utilizes additional moment conditions from the level's equation, improving efficiency and providing more reliable estimates, particularly when variables are persistent. However, it is more complex to implement and requires a larger sample size for stable results. Additionally, as per earlier research like Gelb & Diofasi (2016), using log is a suitable way to increase the power of linearity.

Besides, data were collected from various sources, including the International Monetary Fund (IMF), the World Bank, The Economist, and the International Country Risk Guide. The dataset, which uses the United States as a benchmark, contains nominal exchange rates, Big Mac Index prices, socio-economic indicators (income, population density, economic size), government effectiveness from ICRG, inflation rates, and trade deficit for 52 economies (United Kingdom, Australia, Canada, Denmark, Hong Kong, Japan, Sweden, Singapore, Korea, Brazil, Hungary, Argentina, China, Russia, Malaysia, Mexico, Switzerland, Thailand, Chile, Poland, Czech Republic, New Zealand, South Africa, Indonesia, France, Belgium, Italy, Netherlands, Philippines, Spain, Turkey, Egypt, Israel, Peru, Norway, Colombia, Germany, Pakistan, Saudi Arabia, Sri Lanka, Ukraine, Uruguay, Costa Rica, Ireland, United Arab Emirates, Austria, Venezuela, Greece, Portugal, Finland, India and Estonia)[2] between 2011 and 2019.

[1] See: Note on page 14-16
[2] The economies and time periods were selected using data from "The Economists" in 2021; however, some countries were excluded from the short panel's observables due to inevitable data gaps.

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The estimation model is specified as follows:

$$In\ PPPfactor_{it} = \beta_0 + \gamma In\ PPPfactor_{it-1} + \beta_1\ In\ income_{it} + \beta_2\ In\ economy\_size_{it} + \beta_3\ In\ poplution\_density_{it} + \beta_4\ ICRG_{it} + \beta_5\ trade\_deficit_{it} + \beta_6\ CPI\_inflation_{it} + \varepsilon_{it} \quad (1)$$

where $PPPfactor$ represents the PPP conversion factor defines as (natural logarithms) relative ratio of PPP conversion factor to market exchange rate; US=100 for country i at time t, β_1, β_2, β_3 ... β_6 are the coefficients for the respective independent variables, and ε_{it} is the error term. The coefficients correspond to the following independent variables:

- $\gamma In\ PPPfactor$ defines as lag of relative ratio of PPP conversion factor to market exchange rate; US=100;
- β_1 for $In\ income$, derives from natural logarithms of relative GDP per capita (current USD); US=100;
- β_3 for $In\ economy\_size$, represents natural logarithms of total GDP;
- β_3 for $In\ poplution\_density$, denotes natural logarithms of number of people per square km;
- β_4 for $ICRG$, represents ICRG (Government Stability);
- β_5 for $trade\_deficit$ represents current account balance (% of GDP); and
- β_6 for $CPI\_inflation$, denotes inflation, consumer prices (annual %)

Findings

Table 1 shows how this study used dynamic panel analysis to assess the relationship between the PPP conversion factor, income, population density, economic size, government effectiveness, inflation rates, and trade deficit over the annual period from 2011 to 2019.

Table 1. Determinants of Exchange Rate

Estimators	One-Step Differences GMM	Two-Step Differences GMM	One-Step System GMM	Two-Step System GMM
DV: ln PPP Conversion Factor	Coef. (Robust Std.error.)			
ln PPP Conversion Factor (Lag)	0.1289 (0.1373)	0.0983 (0.0660)	0.7325 (0.0683) *	0.7372 (0.0160) *
ln Income	0.8482 (0.4081) **	0.8570 (0.1357) *	0.0611 (0.0476)	0.0622 (0.0081) *
ln Size of The Economy	-0.1814 (0.4494)	-0.1951 (0.1728)	0.0153 (0.0285)	0.0130 (0.0061) **
ln Population Density	-1.7068 (2.3223)	-1.6061 (0.8565) ***	0.0011 (0.0138)	0.0088 (0.0031) *
Effective Governance	-0.0002 (0.0109)	0.0020 (0.0053)	-0.0161 (0.0123)	-0.0146 (0.0034) *
Trade Deficit	-0.0004 (0.0080)	0.0038 (0.0047)	-0.0083 (0.0064)	-0.0078 (0.0010) *
Inflation	-0.0163 (0.0079) **	-0.0164 (0.0045) *	-0.0078 (0.0059)	-0.0074 (0.0010) *
Constant	13.5615 (3.3706)	13.6311 (1.0282)	0.5930 (0.8359)	0.6284 (0.155)
Sargan test	15.8510	23.0665	78.5523	48.7403

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	(0.4634)	(0.1120)	(0.0002)	(0.1364)
Hansen test	30.8170	24.1165	49.4530	49.4641
	(0.0142)	(0.0870)	(0.1218)	(0.1216)
AR 1	0.0689	0.0097	0.0000	0.0000
AR 2	0.6042	0.4773	0.3826	0.3794
Number of instruments	24	24	47	47
Number of observations	395	395	395	395

Note: *, **, *** represent statistical significance at the 1%, 5% and 10% levels, with Std.Error in brackets, respectively.

From the perspective of the determinant, the System GMM models exhibit a more persistent lagged PPP conversion factor (with coefficients of 0.7325 in one-step and 0.372 in two-step) than the Differences GMM models, which display an insignificance level.

Income has a significant positive effect on the one-step and two-step Differences GMM models, as well as the two-step System GMM, with coefficients of 0.8482, 0.850, and 0.0622, respectively. This suggests that higher income levels are associated with higher PPP conversion factors, with the Differences GMM models demonstrating a significantly stronger effect. While the size of the economy is not significant in most models, it has a slight positive effect in the two-step System GMM (coefficient of 0.0130). The population density has a significant negative effect in the two-step Differences GMM (coefficient of -1.6061) but a minor positive effect in the two-step System GMM (coefficient of 0.0088).

Furthermore, governance effectiveness has a negative, albeit not significant, effect, except for the two-step System GMM, where it is significant (negative coefficient of -0.0146). The trade deficit significantly affects the two-step System GMM (coefficient of -0.0078). Inflation significantly negatively affects both Differences GMM models and the two-step System GMM, with coefficients of -0.0163, -0.0164, and -0.0074, respectively.

When comparing the two estimators, the differences in GMM models demonstrate a significant impact of inflation and income, with less reliable findings for other variables. The two-step system GMM exhibits a more balanced impact of income, trade deficit, population density, governance, and inflation than the one-step model, which displays a weak persistence effect.

Aside from the one-step System GMM, all models show validity according to the Sargan test. In the Hansen Test, the p-values for the two-step Differences GMM and both System GMM models are acceptable, indicating that the instruments are valid. All models satisfy both AR(1) and AR(2). Based on diagnostic tests, it seems to offer the most reliable results with significant determinants and reliable instruments.

As a result, the two-step System GMM showed the variables that were most consistently correlated with the PPP conversion factor. It also suggested that this study is dependable and that its validation is strongly detected in the two-step System GMM.

Conclusion

This study uses a holistic approach to identify the dynamics of exchange rates with respect to the food index among 52 economies from 2011 to 2019. All the determinants have significant results from the System GMM, which offer insightful and clear guidance on how these determinants affect the PPP conversion factor. The study finds that while the exchange rate

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positively correlates with income, economic size, and population density, it is negatively correlated with trade deficits, effective governance, and inflation.

These findings highlight the importance of income, consistent with Balassa (1964)'s study, which reflects that wealthier countries exhibit higher relative prices in tradable goods. The positive relationship also suggests that larger economies have higher PPP prices, corresponding to the findings of Alba and Papell (2007) rather than those of Gelb and Diofas (2016). A nation's productivity can determine the size of its economy; larger economies tend to have higher prices due to higher transaction costs and varying currency values. An increase in population density leads to higher prices, contrasting with Gelb and Diofas (2016)'s study, which discovered that more open labour policies in higher-income nations are linked to lower price levels, impacting exchange rates.

Higher prices often result from less effective governance, perhaps because of insufficient regulation and unclear policies that affect market dynamics and restrict free trade for investors and institutions. Prices also rise because of trade deficits; when imports surpass exports, price increases can be caused by depreciating currencies, competitive pricing, and imported inflation. Higher inflation lowers the conversion factor, which is a negative effect of inflation. The inverse result may have been caused by factors in the study that were counterbalanced or could have resulted from government interventions, technological advancements, productivity gains, and cost reductions that reduced prices.

This study aims to provide policymakers and financial stakeholders with invaluable insights and risk management despite limitations, including ongoing market changes due to supply and demand fluctuations, technological advancements, and unforeseen events that may require further research.

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