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Linkage of Exchange Rate and Key Economic Indicators: A Panel Cointegration and Causality Analysis

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Abstract

This study examined the relationship between exchange rate (ER) and key economic indicators. For empirical analysis, the study took a sample of countries with equal representation from developed and emerging economies. To retrieve the data for our study, we have accessed the World Bank database, individual country reports, and other sources deemed reliable to meet study objectives. For analysis of the data, the study initially checked the basic data properties, established its normality and stationarity with the help of different diagnostic tests. The study then applied Westerlund panel cointegration for estimation of cointegration, followed by Dumitrescu-Hurlin panel causality test to determine the nature and direction of causality among the variables. The results established the association of exchange rate with majority of the economic indicators selected for the study. Based on findings, the study recommended to assign significant consideration to exchange rate management for smooth functioning of the economies. Different policy implications and interventions were also suggested.

Keywords: Exchange Rate, Economic Indicators, Panel Cointegration, Panel Causality

Introduction

Exchange Rate (ER) variations are considered important for economic activities all over the world. This indicator is considered as an important determinant in the economic performance of any country, due to its influential role in foreign trade, capital flows, spendings, savings, investments, inflation and numerous other macroeconomic factors. The exchange rate is also deemed crucial to the economic stability of the countries, regions and the world. The abundance of research studies reported that ER does not affect economic indicators solely but also it is reciprocally affected by other economic factors. For instance, ER is determined by many macroeconomic indicators or variables that play a significant role in this regard. There are many approaches to ER i.e. Purchasing Power Parity (PPP), Interest Rate Parity (IRP), Monetary Approach and Balance of Payment, however, two approaches are most commonly discussed in scholarly debate in literature known as Fundamentalism and Chartism (Bassi, Ramos, & Lang, 2023). Fundamentalists support the role of macroeconomic factors in exchange rate determination while Chartists ignore the role of macroeconomic fundamentals. Furthermore, different research evidence shows that exchange rate affects and be affected by different macroeconomic variables and thereby significantly influence the economic activities of a country (Antwi, Issah, Patience, & Antwi, 2020; Chang & Su, 2014; Dagume, 2022). In the early 1970s, there was a comprehensive scholarly debate on economic systems and the potential

role of ER system, resultantly, a new ER system was introduced called flexible ER system or in other words floating ER system. The advocates of this system opined that new system in place would be beneficial for stable economic growth and flexible economic policy (Dellas & Tavlas, 2018).

According to Dooley, Folkerts-Landau, and Garber (2004) and subsequently Dellas and Tavlas (2018), a fixed exchange rate system was prevailing in the world prior to the breakdown of Bretton Woods System in which governments were controlling and manipulating domestic currency values. Market sentiments and realities were not much considered; however, less uncertainty was involved. Once this system collapsed, floating or flexible exchange system evolved with many expectations and appreciation of the new system in place (Rafi & Ramachandran, 2018). The economic effects of the ER changes are among the most debated and controversial issues in the research because of conflicting empirical research findings to date. Significant research has been conducted to determine the impact of exchange rate changes on economic growth (Koroma, Jalloh, & Squire, 2023; Chikwira & Jahed, 2024; Zhu, Ahmad, Draz, Ozturk, & Rehman, 2022). In developing and emerging economies, the exchange rate is considered important for achieving a variety of goals including economic growth, inflation control and preservation of international competitiveness. It was, however, observed that the benefits of fixing are more for emerging economies (Aizenman & Hausmann, 2000). The relationship between the ER and economic growth (EG) is stronger in developing compared to developed economies (Habib, Mileva, & Stracca, 2017). The underlying reason behind this relationship is that economic indicators are directly affected by ER in developing countries such as inflation, investment, debt sustainability and trade. Also, most developing countries are heavily reliant on foreign remittances to boost foreign reserves and uphold ER to address current economic challenges such as inflation.

In the last few decades, the foreign exchange market has observed huge developments. Foreign trade became easier after the elimination of trade restrictions. The globalization and deployment of modern technologies facilitated cross-border investment. In the meantime, it also created a threat for capital flights. The countries also attempted to develop reserves of dollar (Hasan & Islam, 2023). The removal of trade restrictions, liberalization of investment policies, adoption of free float exchange rate system and various other economic decisions also exposed some countries to greater depreciation in the currency value. The relationship between ER and macroeconomic variables is not simple and straight forward but too complex and multifaceted. The factors which can influence or be manipulated by the ER are numerous and complex. The fluctuation of currency value could influence the macroeconomic stability of a country. In the meantime,

the macroeconomic environment and macroeconomic factors in a country could influence its currency value as compared to the rest of the countries. It is, therefore, important and relevant to understand this complex and interesting nexus of ER and economic indicators. Understanding the interplay of exchange rate and macroeconomic variables is essential for numerous stakeholders to effectively deal with the complexities of the global economies, dynamic macroeconomic environment and efficient decision making. Considering this important aspect, this study examined the nexus between ER and key economic indicators in a wider set of economically rich countries along with emerging or developing economies. The study is expected to provide valuable insights to policy makers, businesspersons, investors, academicians allowing them to make informed decisions in an overhanging economic environment. By addressing both the developed and emerging economies, the study will provide an in-depth and detailed analysis for many stakeholders. The findings could be relevant for individuals and businesses engaged in international trade and business. The findings could also be helpful for better business planning and economic forecasting in a dynamic, globalized and interconnected world.

Literature Review

The movement in exchange rate generally affects the prices of goods and services, and ultimately GDP of a country. The research indicates that flexible ER system can adversely impact inflation in poor or marginally poor countries, investment and overall economic outlook of a country. A plethora of research undertakings can be found in order to determine the impact of ER on economy of a country and potential growth (Challoumis, 2024; Ridhwan, Ismail, & Nijkamp, 2024). Ridhwan et al. (2024) reported in their research that exchange rate depreciation has a positive impact on economic growth of developing countries as compared to developed nations, hence, concluded that an undervalued ER has substantial benefits for the economies of developing countries. However, in the past, Campa and Goldberg (2005) found in their study that ER depreciation is negatively related to economic growth due to an increase in the import bill, putting pressure on inflation to rise in the economy. The depreciation in exchange rate could result in an increase in production cost, and the burden will be shifted to consumers thereby resulting in higher inflation observed in the economy.

A seminal work of Bahmani-Oskooee and Hegerty (2007) reported that trade flows and economic activities are positively influenced by volatility of currency. This implies that currency volatility can be potentially beneficial for export competitiveness and attracting FDI. However, according to Esquivel and Larraín (2002), exchange rate volatility of G-3 countries adversely affects developing countries' economies. Similarly, several other authors have paid scholarly attention towards the role of ER in the economy (Alagidede &Ibrahim,

2017; Amador & Cabral; 2016; Challoumis, 2024; Cheung & Sengupta, 2013; Ridhwan et al., 2024). In similar line of research, Fraz and Fatima (2016) collected data on the economic indicators of economically rich and emerging economies and found a stronger association of GDP with ER. Further, Ahmad, Draz, and Yang (2019) conducted a study on China and reported that economic growth of China is positively affected by lower currency value. In this context, China received a server criticism from the US over currency manipulation for economic growth (Chow, 2016). Further, Yusuf, Salaudeen, and Ogbuji (2022) observed that the interaction between inflation and ER exerts a negative influence on the economy in the short term but becomes positive in the long term. It has also been reported by the researchers that ER is positively affected by foreign remittances, current account balance, GDP, and foreign exchange reserve (Hasan & Islam, 2023; Ilyas, Ahmad, Saeed, Dilawar & Sheikh, 2024). However, contrary to these findings, Khatri (2023) has reported no significant relationship between economic growth and ER.

Foreign Direct Investment (FDI) is an important component of economic development for both developing and developed countries. According to Borensztein, De Gregorio, and Lee (1998), Song, Anees, Rahman, and Ali (2024), FDI significantly contributes in the economic growth, transferring new technology and training and developing human capital of host country. Song et al. (2024) further argued that FDI is also a potential source of green investment for developing countries. Similarly, Li and Liu (2005) also investigated and reported a positive and significant impact of FDI on economic growth (EG). However, an unstable ER can adversely affect FDI, as research indicates that a relatively stable ER can boost investors' confidence, address their fear and ultimately a source of reduction in uncertainty of the economy. Klein and Rosengren (1994) stated that the depreciation or devaluation of the local currency could attract FDI inflows whereas its appreciation could work reversely. In a similar vein, Ridhwan et al. (2024) concluded that exchange rate depreciation can yield positive outcomes in terms of economic growth and prosperity. The abundance research studied conducted on exchange rate volatility and FDI can be found (Esquivel & Larraín, 2002; Penatzer, 2024; Ridhwan et al., 2024). In addition, Adegboyo (2019), conducted a study in Nigeria and found that ER fluctuations significantly impacted FDI. Earlier, a positive relationship between ER and FDI was reported by Khandare (2016) for India, however, the author reported negative findings in terms of China. Further, Jannat (2020) conducted a study in South Asian countries context and concluded a significant negative effect of ER on FDI. Whereas, Tan, Xu, and Gashaw (2021), found a long-term stable association between exchange rate and FDI in China. More recently, Lajevardi and Chowdhury (2024) observed a significant impact of exchange rate and its volatility on FDI in Canada.

Changes in ER also affect trade balances between the countries (Ho, Nguyen, & To-The, 2023). This could happen due to effect on the expectations of importers and exporters, pricing decisions, and risk management strategies. Bacchetta and Wincoop (2006), however, didn't find any influence of ER system on trade flows. On the other hand, Bahmani-Oskooee and Aftab (2017) supported the asymmetric effect of ER volatility on trade flows, increase in ER volatility may affect some industries while decrease in volatility to others. Jadoon and Guang (2019) found a significant impact of exchange rate fluctuations on trade balance of Pakistan while Bhat and Bhat (2021) in India. More recently, Bosupeng, Naranpanawa, and Su (2024) noted a differential effect of ER volatility on trade balance, which remained negative for developed while positive for developing countries.

The income and substitution effects of ER fluctuations might have an impact on saving behavior of the individuals and institutions in the economy. Baidoo (2023) reported a significant negative association between gross domestic savings and imports. When the value of the home currency rises, households may feel wealthier and increase their consumption and prefer imported products, which could result in higher real incomes and lower savings rates. This may also work in the reverse direction. Fluctuations in the real ER can affect how resources are allocated between consumption and investment, which in turn affects overall saving rates. Depreciation in the native currency also makes imported capital goods more expensive, potentially reducing investment in physical capital. In contrast, strengthening the home currency might reduce the cost of imported capital goods, potentially encouraging investment. The researchers found a link between ER and gross fixed capital formation. For example, AC-Ogbonna (2020) found a significant positive relationship between the two variables in Nigeria.

Exchange rate movements can also influence inflation expectations through their perceived impact on future price levels and central banks' policy responses. Many researchers studied how ER changes affect prices of domestic goods and services and inflation rates over time. For example, Ahmad and Ali (1999) noted a relationship between ER and inflation dynamics in Pakistan. Clarida, Gali, and Gertler (2002) stated the exchange rate adjustment could make it possible to completely evade the change in inflation, which could be costly in welfare context. Bleaney and Francisco (2016) also reported the association of exchange rate and inflation rate in developing countries. Similarly, Lowe (2017) conducted a study in Gambian context and found a significant long-term linkage of ER and inflation in the country. Emikönel and Orhan (2023) reported the cointegration of exchange rate and inflation in a set of five countries, while Çitçi and Kaya (2023) noted a significant positive effect of ER uncertainty on inflation in a broader set of countries.

Changes in ER could have a substantial impact on the purchasing power of households, the cost of imports, and consumer behavior in general (Ridhwan et al., 2024). Changes in currency value could create preference for imported over domestically produced goods and vice versa. The import variety could affect the domestically produced variety and hence the national welfare (Broda & Weinstein, 2006). Customers may modify their purchasing habits which could significantly influence the household consumption pattern. In case of higher exchange rate volatility, families may become more apprehensive which induces them into precautionary savings and reduce consumption expenditure. Many researchers reported an association among exchange rate changes and household consumption expenditure. For example, Bahmani-Oskooee, Kutan, and Xi (2015) noticed the short run effect of exchange rate on domestic consumption on a sample of emerging economies. Habanabakize (2021) reported the presence of long run relationship between ER and consumption expenditure in South Africa. Gohar, Chang, Uche, Memon, and Bhatty (2023) supported the asymmetric impact of exchange rate movements on household consumption in emerging economies of Africa. Uche, Chang, and Effiom (2023) noted an asymmetric effect of ER changes on consumption expenditure in a sample of countries.

Furthermore, ER variations influence the relative pricing of imported and locally manufactured products and services, particularly those purchased by the government. To maintain stability and activity in the home economy, governments frequently modify their levels of consumption in reaction to shifts in the international economy, including fluctuations in exchange rates. Nations with fixed or pegged exchange rate regimes typically have less leeway in their fiscal policies than those with flexible exchange rate regimes, which could have an impact on the choices made by governments regarding public consumption. Not only does the exchange rate affect government spendings but also be affected by the government spendings. Several researchers noticed the link between these two variables. For example, Javid and Arif (2009) found an association of exchange rate and government spending in Pakistan. Cakrani, Resulaj, and Koprencka (Kabello) (2013) reported the association of exchange rate and government spending in Albania. Miyamoto, Nguyen, and Sheremirov (2019) found an effect of government spending on ER in a sample of rich and stable economies and emerging economies. The direction of effect, however, remained different for each category. Gidey and Nuru (2022) found a significant influence of government spending on currency value in Ethiopia.

Regarding exchange rate movements, two major schools of thought prevail in literature, namely Fundamentalism and Chartism (Abbas, Khan, & Rizvi, 2011). Fundamentalists accepted the role of macroeconomic factors in exchange rate determination. Such factors may

include economic growth, foreign direct investment, inflation, interest rate, balance of payments, government consumption, domestic savings, trade, etc. It was claimed that exchange rate movements can be predicted based on underlying economic conditions. Chartists, on the other hand, negated the role of macroeconomic factors in ER determination. The advocates of this approach explained the role of historical price data, trends and statistical analysis in exchange rate determination. Chartists use tools such as chart patterns, momentum indicators and moving averages to identify patterns and trends in currency markets. This issue of exchange rate determination and its role in different sectors of the economy remained under debate among economists and researchers all over the world. Considering the fundamentalists' approach, this study examined the nexus of different key economic indicators with the exchange rate, for which following hypotheses were developed.

H_1: Exchange rate and economic growth are significantly related.

H_2: Exchange rate and foreign direct investment are significantly related.

H_3: Exchange rate and trade balance are significantly related.

H_4: Exchange rate and gross domestic savings are significantly related.

H_5: Exchange rate and gross fixed capital formation are significantly related.

H_6: Exchange rate and inflation rate are significantly related.

H_7: Exchange rate and household consumption expenditure are significantly related.

H_8: Exchange rate and government consumption are significantly related.

Methodology

This study applied a quantitative approach to examine the nexus between exchange rate and different economic indicators in an exhaustive sample of developed and emerging economies. The study examined the casual links, patterns and trends of association among the variables. The sample of the study was comprised of equivalent number of countries from developed and emerging categories. In the selected sample, the representation of almost all the regions was assured to confidently generalize the results. The study collected secondary data for examining the relationship between ER and economic indicators. To ensure the reliability, accuracy and compatibility of the data, the entire data collection for the study was made from the databank of the World Bank. Only for the missing values, the statistical bulletins and central bank reports of the respective countries and some other reliable published sources were used. The annual

data of each variable was used in the analysis. The study used the following baseline model to examine the relationship between exchange rate and economic indicators.

$$n_t = \beta_0 + \beta_1 \ln EX_{jt} + \mu_i + \delta_t + \epsilon_{it}$$

In the equation, Y_{it} is the vector expressing the economic indicators selected for analysis in the study. The study took eight macroeconomic variables, i.e. GDP per capita growth (GDP), foreign direct investment (FDI), trade balance (TB), gross domestic savings (GDS), gross fixed capital formation (GFCF), inflation rate (IR), household final consumption expenditure (HC) and government consumption (GC). EX_{it} is the main predictor variable of the study, which is the exchange rate (ER). Many past studies were consulted while selecting the macroeconomic variables of the current study (Chakrabarti, 2001; Froot & Stein,1991; Giorgio, Nisticò, & Traficante, 2018; Jamil, Rasheed, Maqbool, & Mukhtar, 2023; Kaboro & Mose, 2021; Ramasamy & Abar, 2015).

For analysis of data, the study first checked and established the basic data characteristics by applying traditional descriptive statistics, correlation and multicollinearity analysis. The study then checked the data stationarity by applying panel unit root test. Following Pesaran and Yamagata (2008), Pesaran (2021), the study applied slope homogeneity test and cross-sectional dependency test. For estimation of cointegration, the study applied the Westerlund (2007) model. The study then employed the Granger non-causality test developed by Dumitrescu and Hurlin (2012) to detect the direction of causality between the study variables. The underlying assumption of the test is that all the coefficients demonstrate variation among various cross-sections. For effective deployment of the test, ascertaining the stationarity of the variables is necessary. The study deployed the test on the 1st difference of the series to fulfill the requirements. The regression model is as follows.

$$Y_{it} = \alpha_i + \sum_{k=1}^{K} \gamma_i^{(k)} Y_{it-k} + \sum_{k=1}^{K} \theta_i^{(k)} x_{it-k} + \varepsilon_{it}$$

In the equation, $\alpha_i, \gamma_i, \theta_i, n\ \varepsilon_{it}$ denoted intercept, coefficients, and residual term, respectively.

Results and Discussions

In the first step of analysis, the study examined the basic characteristics and distribution of data with the help of descriptive statistics. The study then examined the association of the variables with the help of correlation analysis. The results of descriptive statistics and correlation analysis are presented in table 1 and 2, respectively.

Table 1. Descriptive Statistics

Variable	Mean	Min	Max	Std. Dev.
(1)	3.171	0.000	11.339	2.598
(2)	1.130	-3.367	3.842	1.430
(3)	1.414	-4.281	5.153	1.163
(4)	4.848	3.316	6.786	0.598
(5)	3.822	-1.807	4.854	0.474
(6)	3.800	3.064	4.687	0.229
(7)	1.993	-2.493	9.435	1.342
(8)	4.760	3.890	5.239	0.183
(9)	3.395	1.811	4.031	0.367

(1) ER; (2) GDP; (3) FDI; (4) TB; (5) GDS; (6) GFCF; (7) IR; (8) HC; (9) GC

Table 2. Correlation Analysis

Var.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1)	1.000								
(2)	0.074	1.000							
(3)	-0.191	0.159	1.000						
(4)	-0.227	0.066	0.397	1.000					
(5)	0.076	0.116	0.119	0.348	1.000				
(6)	0.155	0.268	0.052	0.154	0.578	1.000			
(7)	0.201	0.034	-0.133	-0.308	-0.231	-0.113	1.000		
(8)	0.126	-0.065	-0.164	-0.463	-0.780	-0.478	0.347	1.000	
(9)	-0.352	-0.197	-0.024	0.059	0.039	-0.147	-0.324	-0.387	1.000

(1) ER; (2) GDP; (3) FDI; (4) TB; (5) GDS; (6) GFCF; (7) IR; (8) HC; (9) GC)

The descriptive statistics presented in table 1 show the highest value of TB while lowest of GDP. ER revealed the largest dispersion while HC depicted the lowest dispersion. The descriptive statistics conform to the absence of outliers in the dataset. The correlation analysis results presented in table 2 show a positive association of GDP, GDS, GFCF, IR and HC with ER. On the other hand, the association remains negative for FDI, TB and GC. The correlation analysis also confirmed that none of the variables is abnormally correlated.

For further confirmation, the study applied variance inflation factor and didn't find any evidence of multicollinearity among the study variables. The study then applied CIPS and CADF tests to check the panel unit root. It was noted that the variables were not stationary at level but became stationary when examined at first difference. The study further applied slope homogeneity test and based on highly significant values, the null hypothesis suggesting uniformity in slope coefficients across the observations was not accepted. For examining the interdependence of variables and to probe the underlying sources of cross-sectional dependency, the study applied cross-sectional dependency test. The results suggested that the variables exert influence across countries in the long run. The results of multicollinearity analysis, panel unit root, slope homogeneity test, and cross-sectional dependency test are not reported here but are available on demand.

For examining the presence of cointegration among the variables, the study applied the 2nd generation model proposed by Westerlund (2007), its results are presented in table 3.

Table 3. Westerlund Panel Cointegration Test

Statistic	Value
G_t	-4.101***
G_a	-12.220***
P_t	-10.393**
P_a	-15.157**

***, ** indicates significance at 1%, 5% levels, respectively.

The significant test values demonstrated the evidence of presence of cointegration among the variables of the study. The results confirmed the probability of the existence of long-run relationship between the study variables. For assessing the causality and uncovering the presence of unidirectional or bidirectional causality between the study variables, the study applied Dumitrescu-Hurlin causality test and its results are in table 4.

Table 4. Panel Causality Test

Null hypothesis	W-stat.	Conclusion
ER→GDP	4.405***	ER↔GDP
GDP→ER	3.715**	
ER→FDI	4.001**	ER↔FDI
FDI→ER	2.805*	
ER→TB	3.131***	ER→TB
TB→ER	1.639	
ER→GDS	4.010**	ER→GDS
GDS→ER	3.003	
ER→GFCF	2.465**	ER→GFCF
GFCF→ER	2.050	
ER→HC	4.402	ER←HC
HC→ER	3.357**	
ER→IR	3.015	No causality
IR→ER	2.070	
ER→GC	2.060**	ER→ GC
GC→ER	2.075	

***, **, * indicate significance at 1%, 5% and 10% levels, respectively.

The results show the presence of bidirectional causality of exchange rate with GDP per capita growth and foreign direct investment. The results further exposed the unidirectional causality from exchange rate to trade balance, gross domestic savings, gross fixed capital formation, and government consumption. Conversely, the presence of unidirectional causality from household consumption to exchange rate was observed. The study didn't find the causality with inflation rate. The results evidenced the presence of a nexus between the exchange rate and majority of the economic indicators specified in the study.

The results indicate a significant association of exchange rate with most of the economic indicators. It was observed that changes in ER lead to significant changes in various economic indicators and carry substantial implications for economies. The higher currency value could make the exports costly and less attractive for foreigners, thereby reducing export revenues and potentially decreasing the overall economic output. This could also affect domestic consumption and investment and negatively affect economic growth. Moreover, an increase in the exchange rate can worsen the trade balance. The change in the exchange rate can affect the prices of imported goods and services, including essential goods imported by the consumers and capital goods imported by the government and business firms. This could negatively affect the purchasing power of the individuals domestically. This could also build pressure on government budgets, leading to possible cuts in government consumption as authorities may need to cut spending.

Conclusion

This study examined the nexus between exchange rate and key economic indicators in developed and emerging economies. For empirical analysis, the study took a sample of countries with equal representation from developed and emerging economies. Different macroeconomic indicators were selected for analysis purposes. The selection was based on the relative importance of the indicators in the overall economic environment. Secondary data of each indicator and for each sample country were collected from reliable published sources. The collected data were arranged and transformed by taking natural log of each series. In the data analysis phase, the study initially checked the descriptive statistics and correlation analysis and confirmed the absence of outliers in the dataset. The study then checked the stationarity of the variables and confirmed data normality through basic diagnostics. The Westerlund panel cointegration model was applied to check the cointegration of variables while Dumitrescu-Hurlin (DH) panel causality test was used to check the nature and direction of association between exchange rate and key economic indicators.

The study observed the presence of bi-directional causality of exchange rate with GDP per capita growth and foreign direct investment. In the meantime, the study found a unidirectional causality ranging from ER to trade balance, gross domestic savings, gross fixed capital formation and government consumption. A unidirectional causality from household consumption to exchange rate was also found. The absence of significant causality of exchange rate with inflation rate was found. Based on findings, the study concluded that the ER is a significant variable which may affect and be affected by the other macroeconomic variables. The relationship is dynamic and multifaceted, which is illustrated by the feedback loop and interdependence.

The exchange rate holds significant implications for economic stability, competitiveness, and advancement of any country. Its understanding and effective management is, therefore, highly important and to be considered in policy formulations. Considering the dynamic and multifaceted association of exchange rate and economic indicators, the policymakers, businesses, and investors should consider adopting appropriate strategies for navigating the challenges and opportunities presented by the exchange rate fluctuations. The coordination among different sectors of the economy as well as in monetary and fiscal policy is also important for exchange rate and macroeconomic stability. The study may be extended in future by studying comparative relationships in the two categories of countries and by adding more variables for broader results.

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