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RESEARCH PAPER

Long-term interactions among food prices, exchange rate and household real income in Türkiye

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Abstract

Food inflation can be expressed as an increase in the general level of food prices in a certain period. The rate of food inflation in the total inflation in Türkiye can be expressed as 25%. While food price increases directly affect inflation, they also exert great pressure on low-income households. In particular, the COVID-19 process and panic-induced demand shocks after the Russia– Ukraine war, sudden changes in monetary policies, and disruptions in the supply chain were directly reflected in food prices. Considering that exchange rate increases and inflation increases occur all over the world, examining the current situation quantitatively is considered important in terms of food inflation and access to food. In this study, the interactions between the real disposable income of households, food inflation, and the dollar exchange rate in Türkiye between 2006 and 2022 were examined. According to the results obtained with the help of time series analysis, the increase in food inflation had a negative effect on disposable real income, whereas the dollar exchange rate had a positive effect. In the fight against food inflation, increasing the supply through productivity increases in agricultural production, adopting subsidies that will minimize costs in agriculture and agriculture-related sectors as state policy, ensuring the sustainability of all departments connected to the food supply chain, and introducing new approaches in inflation fight strategies according to income groups are medium and long term solutions. This will contribute to the economic welfare of households and to the economic growth process based on effective demand.

Keywords

Inflation, Food inflation, Dollars exchange rate, Türkiye, Welfare

Introduction

Inflation, which is divided into two as cost inflation and demand inflation; is the general increase in the prices of goods and services. High inflation is the high rate of this price increase. While cost inflation is due to the increase in the prices of the inputs used by the producer, demand inflation is due to the demand for a product being greater than the supply of that product. High inflation causes the purchasing power of those with a fixed income to decrease, causes the industrialist to be unable to make healthy pricing as a result of increasing costs and as a result causes the economic activity to weaken (Erdem 2017). In today's global economies, in a period when competition between countries is intensifying, consumer demands are constantly changing, and foreign trade is becoming increasingly

complex, understanding the interactions between economic variables is of great importance. Understanding the dynamic relationships between these economic variables is an important step in developing effective strategies in the design of economic policies, in the fight against inflation, and income inequality. Moreover, in the context of global economic challenges and uncertainties, various approaches exist on how countries can manage and balance these factors. The basis of these approaches generally includes elements such as monetary policies, financial policies, foreign trade strategies, and structural reforms. Countries often create a comprehensive strategy by combining these approaches to manage economic variables. However, because the economic structure of each country is different, the policies implemented also vary.

Türkiye has risen to an important position among G20 countries by displaying a resilient performance against global economic and political crises. Türkiye's gross domestic product (GDP) increased from 230 billion dollars in 2002 to 950 billion dollars in 2023 (TURSTAT 2023a). However, price increases have remained high in Türkiye recently. Price increases intensified in 2018 and 2020 due to double-digit inflation that started in 2017, exchange rate volatility, macroeconomic instability, and the economic disruption brought about by COVID-19. In this process, both food inflation and the increase in the dollar exchange rate negatively affected real usable income, that is, the income remaining after paying taxes and social security premiums. Therefore, examining the impact of food inflation and the dollar exchange rate on disposable real income is important to guide the current situation and future of the Turkish economy.

An increasing body of literature examines the relationship between disposable real income, food inflation, and the dollar exchange rate. While defending the heterogeneity of food inflation on income, these studies focused on its effects on poverty and inequality (Hobijn and Lagakos 2005; Kaplan and Schulhofer-Wohl 2017; Gürer and Weichenrieder 2020). It is emphasized that, especially in the distribution of inflation rates, the distribution between demographic groups (age, household size, gender of the head of the household, etc.) and geographical regions is important and that cumulative differences lead to large inequalities in the medium and long term. Moreover, in some studies, low-income households generally suffer from food inflation. It has been determined that the burdens they undertake are higher (Akcelik 2016). According to Engel and Keynesian consumption models, food inflation increases household food expenses and reduces disposable income by increasing food prices (Aka 2020; Güngör and Erer 2022; Konak and Peçe 2023). increasing the share of food in the expenses of poor households reduces their welfare. Therefore, food inflation increases input costs for producers and living costs for consumers. Therefore, there is a preliminary argument that food inflation reduces the purchasing power of households by reducing disposable real income.

The dollar exchange rate shows the value of the Turkish lira against the US dollar. The dollar exchange rate affects export and import prices in terms of foreign trade and foreign capital inflows and outflows in terms of financial markets. The dollar exchange rate is also closely related to food inflation. Because there are some products that Türkiye depends on foreign sources for food production. Imports of these products are negatively affected by an increase in the dollar exchange rate. In addition, the increase in the dollar exchange rate increases oil prices and therefore the cost of inputs such as energy, fertilizer, and medicine used in food production. The increase in the dollar exchange rate increases the purchasing power of the foreign individual and vice versa for the Turkish citizen. This increases inflation and the cost of living. Therefore, if there is an increase in the income of an individual whose income is in dollars at the expense of an individual whose income is in local currency, the purchasing power of the individual whose income is in local currency gradually decreases. Therefore, the increase in the dollar exchange rate is expected to increase food inflation while also reducing disposable real income. The impact of these external shocks is felt more in developing countries (Iyer 2015; De Ferra et al. 2020; Zhou 2022; Guo et al. 2023). However, the negative impact of both food inflation and the dollar exchange rate on disposable real income may vary depending on households' income sources, consumption habits, savings and investment preferences, and technological advances. In households where food products constitute a significant part of the income source, an increase in food prices may have a positive impact on income. A similar situation applies to households with foreign currency income. Households with foreign currency income may be positively affected by an increase in the dollar exchange rate. Because an increase in the dollar exchange rate increases the value of foreign currency income in the Turkish lira. This increases the purchasing power of households with foreign currency income. Disposable real income, food inflation, and USD exchange rate trends in Türkiye between 2006 and 2022 are shown in Fig. 1.

Available evidence shows that low-income households are more likely to bear the burden of food inflation and dollar exchange rates, thereby reducing real income (Kim 1998; Dornbusch 2019; Artuc et al. 2022). However, there are different views in the literature regarding the relationships between macroeconomic variables. Some researchers argue that an increase in the dollar exchange rate increases inflation by making imports expensive and therefore reduces disposable real income (Cooper 2019; Edwards 2019). While some researchers claim that an increase in the dollar exchange rate increases economic growth and income levels by increasing exports and therefore increases disposable real income (Gabriel et al. 2020), on the other hand, a change in the dollar exchange rate does not have a significant effect on disposable real income or its effect is very low. There are studies suggesting that it is small (Thuy and Thuy 2019). A similar situation is valid for food inflation, and some studies show that when the share of poor households in the production of inflationary foods is high, rapidly increasing food prices may have a welfare-enhancing effect (Vu and Glewwe 2011). For this reason, countries need to investigate their own dynamism.

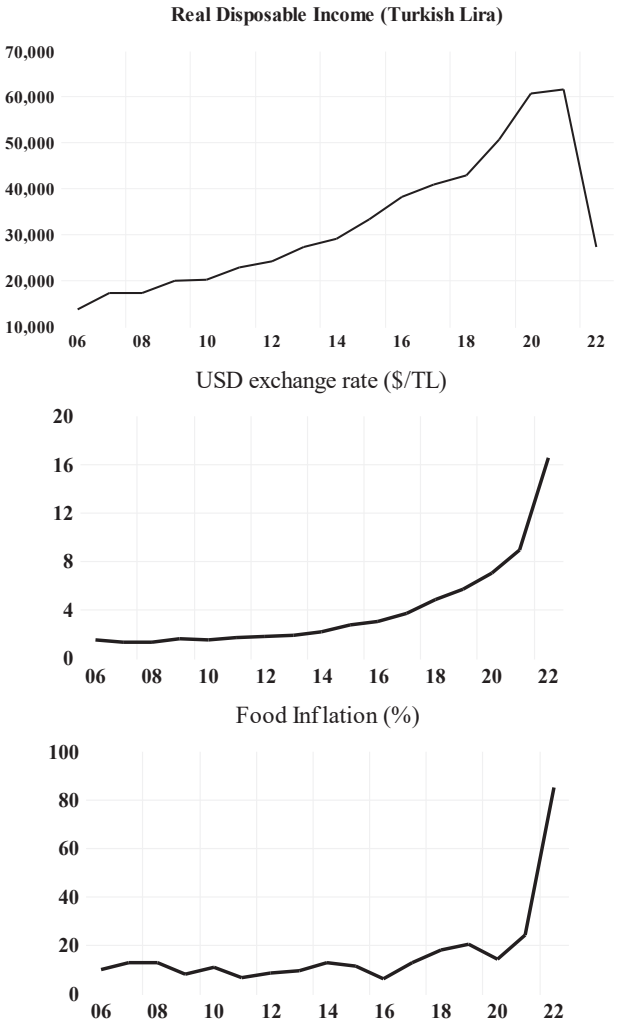

Figure 1. Disposable Real Income, USD Exchange Rate, and Food Inflation Trend in Türkiye between 2006–2022.

Demographic preferences, trade relations, energy prices, natural disasters, and technological advances, especially climate change and political uncertainties that vary by country, affect the dynamism of countries' macroeconomic indicators. These indicators provide a comprehensive analytical framework to achieve important goals such as assessing the overall performance of the economic system, policy formulation, and ensuring social welfare, while also constituting a basic set of tools to guide policymakers and other relevant stakeholders in assessing and managing the economic situation. Therefore, economists and policy makers use various models to analyze changes in macroeconomic indicators around the world and predict future trends, taking these factors into account. According to these models, the reasons for changes in the macroeconomic indicators of countries differ. While technological advances are at the forefront in developed countries, demographic and environmental factors are at the forefront in developing countries. In addition, macroeconomic indicators vary from country to country because the market conditions of the countries are not the same. Studies that focus more on the general inflation rate and economic growth do not specifically address the impact of food inflation. As a result, this article aims to measure the response of real income of households in the Turkish economy to food inflation and exchange rate shocks, and the dynamics of these three indicators are compared. For this purpose, using Türkiye's 2006–2022 period data, the relationship between these three variables was revealed by time series analysis. Revealing these factors that affect the welfare level of households living in a developing and rising economy such as Türkiye can serve as a guide for macroeconomic policy makers and countries with similar dynamics.

Methods

In this study, the course and relationship of food inflation, the dollar exchange rate, and disposable personal income in Türkiye between 2006 and 2022 were analyzed using statistical methods. For this purpose, monthly data on food inflation, the dollar exchange rate, and disposable personal income were obtained from the sources of the Turkish Statistical Institute (TUIK) and the Central Bank of the Republic of Türkiye (CBRT). Symbols and units for the data are given in Table 1.

Table 1. Variables, symbols, and data sources used in the study.

Variable	Symbol	Unit	Data Resource
Disposable real income	DRI	TL	TURKSTAT
Food inflation	FI	%	TURKSTAT
Dollar exchange rate	DEX	TL	TURKSTAT, CBTR*

*Central Bank of Türkiye Republic.

Time series covering the relevant years were created for the variables under investigation. After the dataset was created, the functional relationship was defined in full logarithmic form so that it could be proportionally interpreted. The hypothetically created functional relationship for the variables is as follows:

$$\ln \mathrm{DRI} = f(\ln \mathrm{FI}, \ln \mathrm{DEX}) \quad (1)$$

Based on the functional equation created, the following analyses were carried out to reveal the effect of food inflation and the dollar exchange rate on real disposable income.

- Unit root test (ADF)
- Johansen Co-integration Analysis
- Full Modified Ordinary Least Square (FMOLS)
- Dynamic Ordinary Least Square (DOLS)

Unit root test

Stationarity is investigated to prevent biased results that may arise because of the series being affected by their past values in the long term. The stationarity of the series is

investigated using the unit root test. There are many suggestions in the literature to investigate the unit root test (Dickey and Fuller 1979, 1981; Phillips 1987; Phillips and Perron 1988; Maddala and Wu 1999; Hadri 2000; Choi 2001; Kao and Chiang 2001). These tests are based on the ADF (Augmented Dickey Fuller) test. In this study, the ADF test statistic was used for the unit root test. The ADF unit root test can be expressed as in Equation 2:

$$\Delta X_t = \beta_0 + \beta_1 t + \beta_i X_{t-1} + \sum_{j=1}^{n} \theta_i \Delta X_{t-j} + e_t \quad (2)$$

ADF test statistic results were tested with the Mac-Kinnon critical value (MacKinnon 1996).

Johansen co-integration analysis

Johansen (1998) and Johansen-Juselius (1990) proposed two tests to test the significance of co-integration vectors of series that are stationary at the same level. These are the trace and maximum eigenvalue statistics:

$$\text{İz } Statistic = -T \sum_{i+1}^{P} \ln(1 - \lambda_i) \quad (3)$$

$$\text{Max. Eigenvalue} = -\text{T} \ln(1 - \lambda_{r+1}) \quad (4)$$

T = number of observations, r = number of co-integrated vectors.

The trace statistic tests the hypothesis that there are at most r cointegareations against the hypothesis that there are more than r cointegareations. The calculated maximum eigenvalue statistic tests the hypothesis that the number of co-integrating vectors is r against the hypothesis that there are r+1 co-integrated vectors (Yılmaz and Tezcan 2007; Topallı 2015).

Full Modified Ordinary Least Square (FMOLS) and Dynamic Ordinary Least Square (DOLS)

The FMOLS test developed by Pedroni (2001) and Pedroni (2004) reveals long-term relationships. It is preferred to prevent diagnostic problems and avoid spurious regression problems. While the process is being carried out, it considers the possible interaction between the constant term, error term, and the differences of the independent variables (Gülmez and Yardımcıoğlu 2012). This method regulates the LCM by considering correlation effects and tests the internal correlation (Kalim and Shahbaz 2009). The results obtained are consistent and effective. Under the assumption that the distribution is nominal, notations regarding the FMOLS equation can be made using Equation 5, 6:

$$\text{DRI}^{*}_{NT} = \text{N}^{-1} \sum_{i=1}^{N} \left[\sum_{t=1}^{T} \left(\text{FI}_t - \overline{F_l} \right)^2 \right]^{-1} \left[\sum_{t=1}^{T} \left(\text{FI}_t - \overline{\text{FI}_l} \right) \text{DRI}^{*}_{t} - T\hat{\tau}_i \right] \quad (5)$$

$$\text{DRI}^{*}_{NT} = \text{N}^{-1} \sum_{i=1}^{N} \left[\sum_{t=1}^{T} \left(\text{DEX}_t - \overline{\text{DEX}_l} \right)^2 \right]^{-1} \left[\sum_{t=1}^{T} \left(\text{DEX}_t - \overline{\text{DEX}_i} \right) \text{DRI}^{*}_{\text{t}} - T\hat{\tau}_i \right] \quad (6)$$

The power of the FMOLS method in small samples was investigated, and the performance of the t statistic in small samples was calculated to be good using Monte Carlo simulations (Kök and Şimşek 2006).

Another method used in this research is the DOLS model, which was proposed by Stock and Watson (1993). It also corrects for possible collinearity bias between regressors, especially in small samples. DOLS provides better results than FMOLS and eliminates the correlation between regressors (Kao and Chiang 2001; Mark and Sul 2003). From this perspective, FMOLS also allows the verification of test results. The notation for the DOLS model is given in Equation 7:

$$\text{DRI}_t = \text{a}_0 + \beta_{1t} FI_t + \beta_{2t} \text{DEX}_t + \sum_{k=-ki}^{k} c_t \Delta FI_{t-j} + \sum_{k=-ki}^{k} r_t \Delta DEX_{t-j} + u_t \quad (7)$$

Results

The ADF test statistics results for the stationarity tests of the variables examined are given in Table 2.

Table 2. Unit root test results for the variables.

Variables	ADF			
	Intercept		Trend and Intercept	
	Level	Δ	Level	Δ
DRI	-0.4583	-3.0417**	-2.3798	0.4506
FI	-0.0150	-3.1574**	-0.9877	-4.3717**
DEX	4.5370	-0.9567	0.5056	-3.3180***

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

When Table 2 is examined, real disposable income is determined to be stationary at the I(1) level in the fixed model. Additionally, it was observed that the model with trend and constant was not stationary at both the I(0) and I(1) levels. When the stationarity test for food inflation is examined, it can be said that it contains a unit root at the I(0) level in the constant model and is stationary at the I(1) level. Similarly, in the model with trend and constant, it can be stated that it contains a unit root at the I(0) level and is stationary at the I(1) level. In the stationarity test of the dollar exchange rate, it was determined that it contained unit roots at both I(0) level and I(1) level in the model with constant, while it contained unit root at I(0) level and was stationary at I(1) level in the model with trend and constant.

In this study, the Johansen Co-integration Test was conducted to investigate the existence of a long-term relationship between the variables examined. The Johansen Co-integration Test results for the variables examined in the study are given in Table 3.

Table 3. Johansen Co-integration Testi Sonuçları.

Rank	Johensen Co-integration Test Indicators	
	Trace Stat	Maximum Eigenvalue
r = 0	50.99*	30.32*
r ≤ 1	20.66*	13.69
r ≤ 2	6.97*	6.97*

* indicates significance at the 1% level.

According to the Johansen Co-integration Test results, the trace statistics, and the maximum eigenvalue statistics, the (r = 0) hypothesis is rejected at the 1% significance level. According to both test statistics, it is possible to discuss the existence of long-term vectors and co-integration between the variables.

The FMOLS and DOLS test results for the variables examined are given in Table 4.

Table 4. FMOLS and DOLS Test Sonuçları.

Variables	Dependent Variable: DRI					
	FMOLS			DOLS		
	Coff.	Std dev.	t-stat	Coff.	Std dev.	t-stat
DEX	0.8813	0.1045	8.4273*	0.8807	0.1334	6.6022*
FI	-0.6787	0.1263	-5.3733*	-0.4406	0.1395	-3.1578*
Diagtostic Cofficient						
R^2	0.79			0.99		
Ad. R^2	0.76			0.97		
Jarq. Bera	0.39			0.84		

* indicates 1% significant level.

When the FMOLS test results were examined, the dollar exchange rate, which was assumed to be effective on real disposable income, was found to be statistically significant. The coefficient sign is determined to be positive. A 1% increase in the dollar exchange rate increases real disposable income by 0.88%. There is a presupposition that both producer and market prices of many goods are directly explained by input costs, and in countries such as Türkiye where imports of intermediate goods and inputs are dominant, the rise in $-₺ prices increases prices, and this increase increases the ratio of expenditure items in disposable income. However, the volatility in foreign exchange prices in Türkiye in the last few years has led to households turning to the dollar as a savings instrument, resulting in an increase in income from the dollar held. Therefore, the negative expected sign becoming positive indicates the effect of $ in terms of the savings instrument in Türkiye. The other variable, food inflation, was also found to be statistically significant. The sign is negative. A 1% increase in food inflation reduces disposable real income by 0.67%. Inflation can be expressed as an increase in the general level of prices. Food inflation can be explained as an increase in the price level of food items, which have a significant share in CPI. Food inflation in Türkiye has been above the CPI in the last few years. While the rise in food prices has a negative impact on the CPI, it can also create social and economic trauma in the social structure. Considering the continuity of nutritional needs, increasing costs negatively affect households. Considering that food constitutes a significant share of the income of low-income households, the severe effects of the process come to the fore. At the macro level, this situation is both a decrease in demand and can lead to a negative divergence in the trend toward demand for other goods and services (Eştürk and Albayrak 2018). When the DOLS model is examined, it can be said that the coefficients are similar to those of the FMOLS test. A 1% increase in the dollar exchange rate increases real disposable income by 0.88%.

Discussion

It can be stated that in developing countries such as Türkiye, the tendency to save is very low. This can be attributed to the fact that interest rates remained low until a certain period, including the period in which this research is discussed, the relatively high youth unemployment rate, and the change in consumption-related growth models and consumption patterns after the 2000s (Narinç and Küçükönder 2020)). However, factors such as household size, education level, and working hours are at the forefront as determinants of savings in households. Considering the course of the Turkish economy in the last 20 years, advances in employment, education investments, and expenditures can also be considered as driving factors in savings. The increasing trend in the dollar exchange rate and the depreciation of TL may increase household foreign exchange demands. This situation, which can be explained as dollarization, indicates that the functions of money in a country, which can be defined as value, investment, exchange, and savings, can be determined as foreign currency. While dollarization in Türkiye was around 35% in 2012, it reached around 65% in 2021 (Künç and Tutgun 2023). This situation, which is synchronized with exchange rate movements, always carries the risk of creating a spiral by bringing inflation with it. Another variable in the DOLS model is annual food inflation. A 1% increase in food inflation reduces disposable real income by 0.44%. This situation can be considered a loss of welfare. As stated in the FMOLS test results, in a developing country like Türkiye, where the imbalance in income distribution is high, inflation, especially food inflation, is a major handicap. The high share of low-income households' incomes allocated to food items makes the living conditions of households more difficult with the increasing trend in food prices. In the early 2000s, there were significant increases in food prices worldwide. The increasing trends until 2009 started to decline after 2009. It can be thought that climate events and productivity factors come to the fore, and therefore increases in food supply are effective in this regard. In the ongoing period, the stability/decrease trend continued until the COVID-19 period. In this sense, Türkiye differed negatively from the world average. Food prices have gradually

increased in Türkiye. Because the high ratio of input prices in agricultural products and foreign dependency on energy is reflected in production costs, the continuous increase in the dollar exchange rate has led to an increase in the general level of food prices. Considering that 40% of the population with the lowest income receives only 16.4% of the total income in the resulting table (TURKSTAT 2023b), the importance of food inflation can be emphasized again. Inflation is one of the biggest factors that create income inequality. This situation can be explained in two ways. While the increase in welfare losses of low-income households due to high inflation may cause serious problems, the relatively higher savings rates of high-income households may lead to a relatively high-income increase. This may cause a positive separation of high-income groups from low-income groups in terms of real returns (Ünal and Doğan 2021). There are three important dynamics of country economies. These are interest, inflation, and the exchange rate. In particular, in developing countries, these dynamics are the determinants of the economic course. These dynamics, which are generally managed through monetary policy measures, directly affect the welfare level of households. Türkiye's monetary policy can be examined in two periods starting from the early 2000s. The first is the inflation targeting strategy in the period until 2010. Second, after 2010, it adopted not only price stability but also a financial stability strategy. However, it was measured as an increase in inflation in the periods following the expansion of monetary policy to ensure financial stability. The consequences of the increase in inflation in Türkiye are the negative effects of medium- and long-term uncertainty on planning strategies, disruptions in investments, an increase in unemployment rates, a decrease in long-term credit opportunities, and an increase in the tendency toward assets with nominal value. This situation coincides with the theory (Friedman 1977; Mishkin 1998; Apergis et al. 2021). In particular, low-income households are greatly affected by the rising trends of these economic phenomena. The effect of food inflation, a component of inflation, can lead to a contraction in the welfare areas of low-income households. This is because the high share of food items income makes the outcome inevitable. On the other hand, while foreign exchange volatility creates a negative impact on households with the costs arising from the pressure on input prices, it is dimensioned as an increase in income due to relatively large savings opportunities in high-income households. The results of this research confirm this approach, which can be considered as neoclassical economic theory.

Conclusion

According to the research results, it is possible to say that food inflation has a negative effect on disposable real income, which can be considered as an indicator of welfare, while the exchange rate has a positive effect on disposable real income. Inflationary processes are far from sustainable for the welfare of households in developing countries such as Türkiye. When income distribution statistics are examined, the impact of food inflation in terms of welfare loss can be emphasized, considering that 20% of the population with the highest income receives 48.00% of the total income or 40% of the population with the lowest income receives 16.4% of the income. Considering that the direction and size of the impact changes depending on the imbalances in income distribution, prioritizing political measures for low-income households in the fight against inflation may make the process relatively easier. In the construction of political measures, the focus should be on the market equilibrium price mechanism, considering the fight against demand inflation that may develop depending on the sustainability of demand and the cost inflation resulting from cost increases due to exchange rate volatility. Considering that the most important input in the agriculture-food sector, as in all sectors, is energy, that Türkiye's foreign dependency rate in energy is 92.8%, energy costs directly affect the food sector, and 46.2% of the total income is taken by fixed wage earners. Permanent measures to combat food inflation remain a necessity. This will contribute to the economic welfare of households and to the economic growth process based on effective demand.

Author contributions

HGD performed and interpreted the analyses, KA wrote the introduction and conclusion, SC wrote the discussion, ZB wrote the material and method, and designed the research.

Data collection and analysis

he datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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