The Influence of Changes in Oil Prices at the Inflation Levels: A Correlation-Regression Analysis

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Abstract. In the age of the global pandemic and during the war in Eastern Europe, inflation is increasing daily, affecting not only the socio-economic situation of developed but also developing and small open economy countries. Among the factors causing inflation are often indicated rising prices for petroleum products. Therefore, the aim of the paper is to make a correlation-regression analysis of the impact of changes in oil prices at the level of inflation. The majority of the empirical data covers the years 2000 to 2021. Quantitative data was analyzed in line with the objectives, resulting in the identification of particular issue tendencies. The paper examines the methodology of world prices for oil products and current factors. The characteristics of price formation in the global market and the indicators of the relationship between oil prices and the level of inflation are studied. The analysis of the impact of the dynamics of oil prices on inflation is established. The applicable conclusion was produced based on the examination of the information acquired through the characteristic and quantitative research methodologies.

Keywords: Inflation · Price · Oil market · Oil price shocks · SOE

1 Introduction

Over the last century, the significance of oil as an energy resource for the world economy has greatly increased. It originally had a fuel-energy function; later its role became much more important when mass-production and the use of automobiles were launched. Since then, oil has become a raw material of strategic significance and also plays a crucial role in the economic and political life of countries. The price of several products or services depends on the oil price, as it is involved in the production process of all fields. Despite technological advances, the transport sector is incredible without oil products, and it remains a major fuel-energy resource. Oil possession allows countries to determine the economic or political climate of the world. There has been a trend of frequent price changes in the oil market in recent years, it has increased dramatically and decreased at various intervals. Price manipulation has led to numerous crises all around the world.

OPEC still has a significant impact on the volume of oil supplies and price levels. However, its influence has been weakening recently and it is anticipated that this influence

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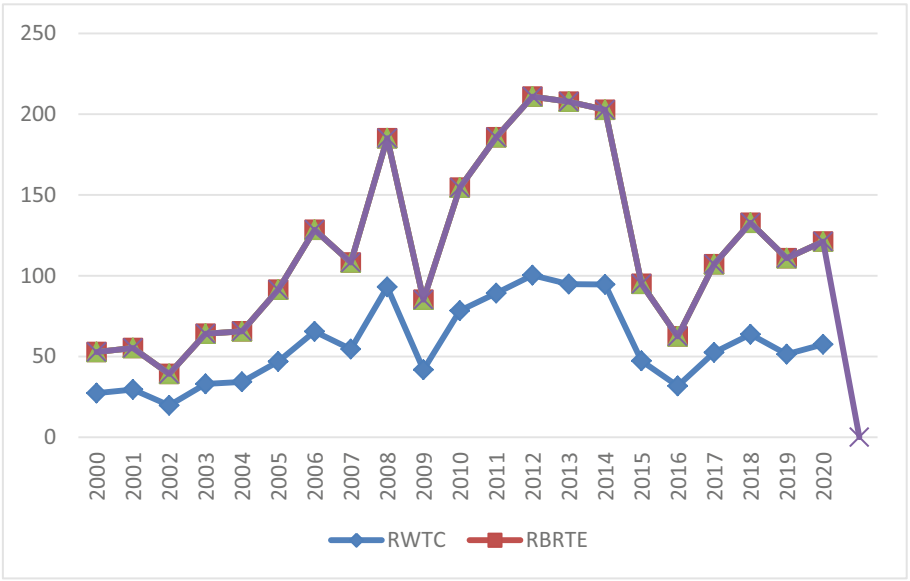


Fig. 1. Oil prices in 2000–2021. Source: Compiled by the author based on the [1, 2].

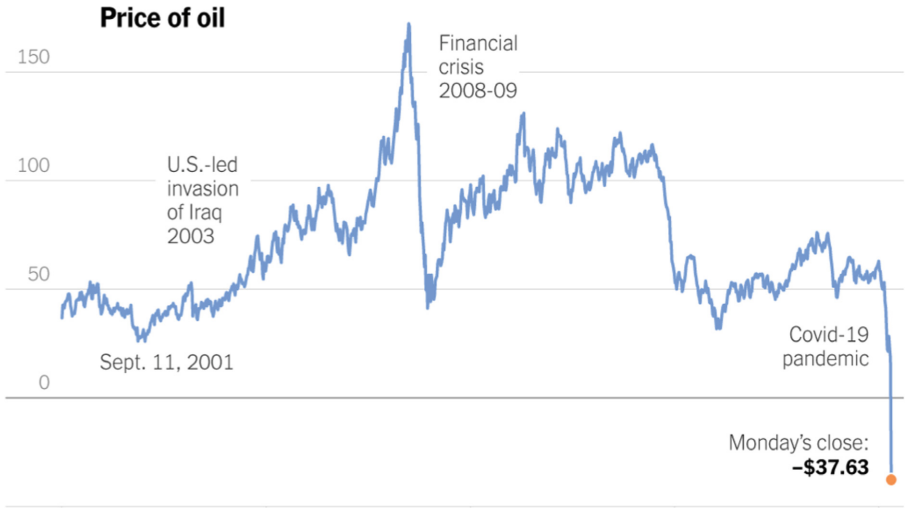


Fig. 2. Oil price change and global crises. Source: Compiled by the author based on the [3–7].

tends to disappear in the future. The fact is that today oil is a strategic resource and it has a great impact on the economies of both exporter and importer countries.

The aim of the research is to build an econometric model through selected factors and correlation-regression analysis of the obtained data. Based on the objectives of the research, we formulated H_0 and its anti-H_1 hypotheses:

H_0: The change in the price of oil on the world market affects the inflation rate of the oil - importing country;
H_1: The change in the price of oil on the world market does not affect the inflation rate of the importing country.

2 Methodology for Studying World Prices for Oil Products

Oil is one of the most important commodities whose price changes have a special impact on the world economy and macroeconomic factors such as inflation, GDP, recession, interest rates, exchange rates, among others. Consequently, the study of its price and price changes in general is still a topic of discussion for many economists and energy researchers. Numerous methods are used to predict accurately the prices of petroleum products and the events affecting the cost of crude oil. Econometric methods are especially popular among them, as well as recently widely used computational methods such as ANN and fuzzy expert systems, which are actively applied to financial markets as they are more flexible and accurate than other traditional methods. However, so far there is no agreement on which method is the most reliable.

Methodologies for studying the prices of petroleum products in the world literature are mainly divided into two categories: quantitative and qualitative methods. The quantitative method is divided into groups: econometric models including time, financial and structural models; non-standard models such as artificial neural networks (ANN) and Support Vector Machines (SVM). The qualitative method also includes various models, namely: Delphi method, Belief Networks, Fuzzy Logic, and Expert Systems, Web Text Mining method (WTM).

Quantitative methods are based on the past data and mathematical models and the main task are to predict short-term and medium-term prices.

One of the methods of studying prices is different variants of GARCH belonging to the econometric method. Morana (2001) applied a semi-parametric method to determine the price of a barrel which was based on the calculation of GARCH oil price fluctuations [8]. As a result, it was identified that this approach can be applied to determine forward prices as well as to calculate the price self-regulation interval. Moosa and Al-Loughani (1994) applied the GARCH-M model to prove that the future price is neither fair nor effective in the determination of the spot price [9]. Sadorsky (1999) using vector regression proved that changes in oil prices affect economic activity, but current changes in the economy have little effect on oil prices [10]. Sadorsky (2006) applied several one-sided and varied statistical models such as GARCH, TGARCH, AR, BIGARCH to calculate the daily change in profits from oil futures capital [11]. Postali and Picchetti (2006) applied the simple geometric Brownian method and asserted that their model was quite reliable for studying oil prices [8–13].

Peters (1994) opposes the application of similar models [14]. Most financial markets have fraudulent peaks, the Hens model, which is based on the normal assumption, excludes the aforementioned fraud. Moreover, the results of the Peters study suggest long-term memory. Dees *et al*. (2007) proposed a world oil market model to predict oil supply-demand and real prices to analyze the risks of each [15]. The model simulates, in particular, the determination of oil demand using behavioral equations, where demand is related to domestic government economic activity and real oil prices.

Adrangi *et al*. (2001) [16] investigated that oil prices are quite non-linear, while the results of a study by Panas and Nini (2000) point to the chaos of oil prices [17]. Gori *et al*. (2007) studied changes in the ratio of oil prices to consumption over the past decade and considered three possible scenarios for oil prices: parabolic, linear, and chaotic behaviors that predicted changes in oil prices and consumption [18]. Rehrl and Friedrich (2006) applied the LOPEX model to create a long-term scenario for the future delivery of world oil through 2010 [19]. However, the explanation of the facts is limited to idealized assumptions only.

ANN is inspired by the human brain biological system allowing it to study and analyze prices in the oil market. It is also widely used in business, science, or industry. Kaboudan (2001) presented a short-term monthly forecast of oil prices and proved that genetic programming (GP) gives more accurate results than the theory of randomness when ANN proved the discrepancy [20]. The following variables were studied: Monthly World Oil Production, Organization for Economic Co-operation and Development Consumption, World Crude Oil Shares, Monthly Change in Prominent US Securities, and Delayed FOB Crude Oil Price in US Imports. All variables except lagging prices did not prove to be useful. He also used GP and ANN to predict the cost of purchasing refineries at the price of petroleum products. Wang et al. (2004) applied the WTM and econometric method with intelligent forecasting techniques [21]. Based on the results, we can affirm the given model bearing the name TEI@I can predict better than the ANN and ARIMA models.

Fernandez (2007) predicted crude oil and natural gas prices using ANN, SVM, and ARIMA models and applied daily prices for 1995–2005 [22]. The results revealed that in the short run the ARIMA model is more reliable than the ANN and SVM, while in the long run, conversely, the ANN and SVM data are more accurate. Therefore, the length of the period is an important element of accurate price forecasting when applying this or that model.

As we can see the list of scientists applying different methods to study the prices of petroleum products is wide and it is clear that there is a substantial difference between the methods and models and different factors affect the accuracy of their price forecasting. However, as already mentioned, econometric methods are most often applied to predict oil price volatility. The second place is occupied by financial methods, followed by structural and non-standard models, and the last place is taken by qualitative methods.

3 Results and Discussion

Current developments in the world economy are closely interlinked and the market for strategic goods such as petroleum products has the potential to have a significant impact on the economies of countries [23–27]. A large share of public budget revenues is generated by revenues from oil exports because it is the most important source of tax revenue accumulation for importing countries and has a special fiscal effect [28, 29]. However, the relationship between oil prices and inflation levels is a topical issue for the study of world economists.

A study by Pederson (2011) in 46 countries confirmed the limited impact of oil price changes on core inflation [30]. However, 2010 study by S. Clerides entitled “Fuel

Retail Response to Oil Price Shocks in EU Countries" changes in oil prices directly affect the price of gasoline, although this will take some time [24]. In the long run, a single unit change in the price of oil in the international market will change the price of gasoline in the local market by the same amount. However, in the short term, gasoline prices for most EU countries account for only half of the change in international oil prices. It takes about 3 months for a full transfer of oil price change to gasoline prices in Europe. Price transfer is asymmetric. When oil prices rise, it is followed by a directly proportional increase in the price of gasoline, but the same does not happen in case of oil prices fall [24]. It is interesting that Georgia, unlike EU countries, is not characterized by the asymmetric transfer of prices. Both rising and falling Brent Crude Oil prices are symmetrically reflected in local gasoline prices.

For example, we can summarize how, on other equal terms, the increase in international oil prices by 10 US cents per liter is reflected (US $ 16 per barrel) in the overall inflation rate in Georgia and Europe (see Fig. 3).

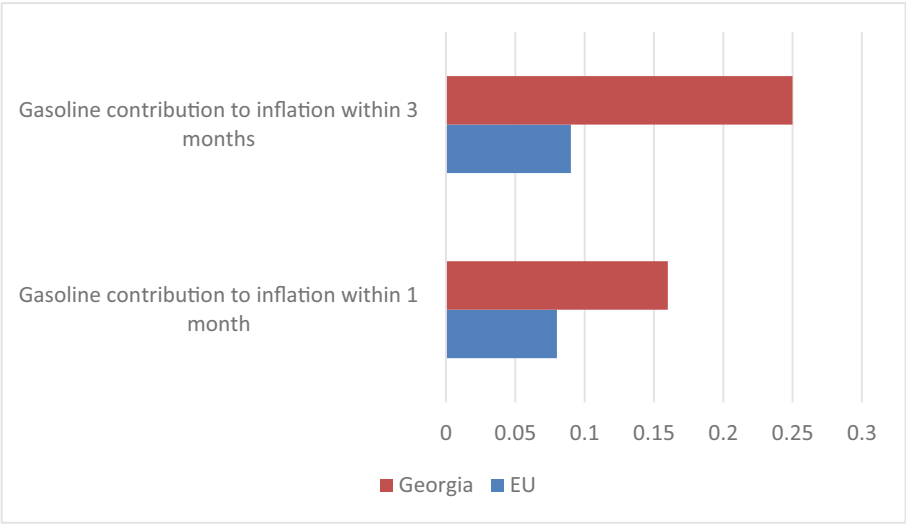


Fig. 3. Impact of oil prices on inflation rates in Georgia and Europe

If the price of "black gold" in the world market decreases, the economy of the exporting country begins to lose (decrease) the most important revenues from the sale of oil products. Accordingly, the issue of devaluation of the local currency is on the agenda. Mikhailov *et al*. (2019), Mukhtarov *et al*. (2019) [31, 32] applied modern mathematical models such as the VAR, the Granger method, the Dickey-Fuller test to determine the impact of oil prices on the Russian economy, and revealed that a 1% increase in GDP leads to local 1.47% strengthening of the currency, this fact is explained by the growth of the country's economy in general. And a 1% increase in oil prices leads to a strengthening of the ruble by 1.66%. Accordingly, we can affirm that the Russian economy depends on world oil prices. An increase of 1% in exports will also strengthen the ruble, as a foreign currency will flow in, which will ultimately increase supply in the interbank market.

To determine the impact of the oil price change on the inflation rate of importing countries, we conducted a correlation-regression analysis. Correlation-regression analysis shows the effect of the independent variable (in our case world oil prices) on the dependent variable (in our case the country's inflation and the price of gasoline in Georgia) and measures its magnitude. We took several countries as research objects: 1) South Korea, which is the largest importer of oil in the world. It ranks fourth in oil consumption and imports. For the analysis we took the world oil prices and the inflation rate in South Korea in 1990–2019; 2) China, which ranks first in terms of oil imports and consumption. For the analysis we took the world oil prices and the inflation rate in China in 1990–2019 [33–37]; 3) The US, which in addition to extracting oil, is also its importer. The US ranks second in the world in oil consumption and imports. For the analysis, we took the world oil prices and the inflation rate in the USA in 1990–2020 and 4) Georgia, which belongs to the importing country and is significantly dependent on the oil price (see Table 1).

Table 1. Impact of the oil price change on the inflation rate of importing countries

Years	World oil prices	Inflation rate in China	Inflation rate in the US	Inflation rate in Korea	Inflation rate in Georgia
1990	22.26	3.05	5.4	8.57	–
1991	18.62	3.55	4.2	9.33	–
1992	18.44	6.35	3	6.21	–
1993	16.33	14.61	3	4.8	–
1994	15.53	24.25	2.6	6.26	–
1995	16.86	16.79	2.8	4.48	162.71
1996	20.29	8.31	2.9	4.92	39.35
1997	18.86	2.78	2.3	4.43	7.08
1998	12.28	−0.77	1.6	7.51	3.56
1999	17.44	−1.4	2.2	0.81	19.19
2000	27.6	0.34	3.4	2.25	4.06
2001	23.12	0.71	2.8	4.06	4.64
2002	24.36	−0.73	1.6	2.76	5.58
2003	28.1	1.12	2.3	3.51	0.83
2004	36.05	3.82	2.7	3.59	5.65
2005	50.59	1.77	3.4	2.75	8.24
2006	61	1.64	3.2	2.24	9.16
2007	69.04	4.81	2.9	2.53	9.24
2008	94.1	5.92	3.8	4.67	9.99
2009	60.86	−0.72	−0.4	2.75	1.72

(*continued*)

Table 1. (*continued*)

Years	World oil prices	Inflation rate in China	Inflation rate in the US	Inflation rate in Korea	Inflation rate in Georgia
2010	77.38	3.17	1.6	2.93	7.11
2011	107.46	5.55	3.2	4.02	8.54
2012	109.45	2.62	2.1	2.87	−0.94
2013	105.87	2.62	1.5	1.3	−0.51
2014	96.29	1.92	1.6	1.27	3.06
2015	49.49	1.43	0.1	0.7	4
2016	40.76	2	1.3	0.97	2.13
2017	52.51	1.59	2.1	1.94	6.03
2018	69.78	2.07	2.4	1.47	2.61
2019	64.04	2.89	1.8	0.38	4.85
2020	49.99	2.39	1.25	0.54	5.22
2021	70.68	0.85	7.00	2.19	9.27
2022	117.25	2.08	8.5	1.65	12.8

Correlation-regression analysis of Chinese data gave us the following result: the coefficient of determination R^2 represents the part of the scatter explained by regression in the total scatter of the resulting variable and it is equal to 0.012. The closer this value gets to 0, the smaller the relationship between the dependent and independent variables is. There is no linear relationship between the variables and the selected model is unsuitable.

Statistical significance F (Significance F) is the probability that the null hypothesis (H_0) in our regression model cannot be rejected. Significance F = 0.25 - in our model, the null hypothesis is rejected or the H_1 hypothesis is true.

We provide a model with the obtained results:

$$Y = 5.86 - 0.037x$$

where Y is the inflation rate in Korea;

X - Change in world oil prices.

As we can see, there is an inverse relationship between the variables. An increase of one unit in oil prices reduces the inflation rate in China by 0.0037 points.

Correlation-regression analysis of US data gave the following results:

The coefficient of determination R^2 is equal to 0.008, ie the change in oil prices does not affect US inflation.

Significance F = 0.27 - The null hypothesis is rejected.

According to the data, we have the following model:

$$Y = 2.79 - 0.007x$$

The model shows that an increase in oil prices by one unit reduces the inflation rate in the US by 0.007 units.

The correlation-regression analysis of the South Korean data gave us the following result:

The coefficient of determination R^2 is equal to 0.19. That means that there is not any relationship between the variables i.e., the change in the dependent variable is entirely determined by random factors that are not included in the model. Significance F = 0.009 - Like other countries, we rejected the null hypothesis for Korea.

According to the results, the model is insignificant and the change in world oil prices has almost no effect on the inflation level of the importing country. Based on the data, we created a model: Y = 70.376 – 6.459x which shows that rising oil prices are reducing South Korea's inflation rate.

Indeed, Georgia is not even in the top ten in terms of oil consumption and import in the world, but it is still interesting whether oil prices have an impact on the inflation rate of our country. Table 1 shows the dynamics of changes in oil prices in 1995–2020 and the level of inflation in Georgia by years.

Correlation-regression analysis of these data gave the same results: Oil prices have almost no effect on the country's inflation rate ($R^2 = 0.054$), we reject the null hypothesis (Significance F = 0.13) and we have an inverse relationship between these two indicators (Y = 56.7 – 0.29x).

As discussed above, the gasoline prices in the country are directly proportional to the price of world oil. For the analysis, we took the dynamics of world oil prices and gasoline prices in Georgia by months from 2013 to 2020 (see Table 2).

Table 2. Price of World Oil and gasoline prices in Georgia [38, 39]

Year/Month	Gasoline price in Georgia	Oil price in the world market	Year/Month	Gasoline price in Georgia	Oil price in the world market
2020/12	2.21	49.34	2016/12	1.79	58.93
2020/11	2.17	46.16	2016/11	1.69	54.24
2020/10	2.2	36.4	2016/10	1.66	51.36
2020/9	2.3	40.94	2016/9	1.59	52.92
2020/8	1.98	53.42	2016/8	1.59	49.17
2020/7	1.85	41.16	2016/7	1.58	45.8
2020/6	1.82	40.33	2016/6	1.55	53.11
2020/5	1.93	36.66	2016/5	1.53	54.16
2020/4	2.17	19.46	2016/4	1.47	50.83
2020/3	2.39	21.01	2016/3	1.47	42.63
2020/2	2.44	45.83	2016/2	1.49	37.7
2020/1	2.49	52.95	2016/1	1.53	37.59

(*continued*)

Table 2. (*continued*)

Year/Month	Gasoline price in Georgia	Oil price in the world market	Year/Month	Gasoline price in Georgia	Oil price in the world market
2019/12	2.52	42.95	2015/12	1.67	41.48
2019/11	2.53	56.83	2015/11	1.82	46.48
2019/10	2.53	55.75	2015/10	1.85	51.9
2019/9	2.54	55.8	2015/9	1.89	50.19
2019/8	2.52	56.86	2015/8	1.94	54.66
2019/7	2.51	60.45	2015/7	1.99	52.3
2019/6	2.43	60.46	2015/6	1.99	66.01
2019/5	2.37	55.32	2015/5	1.89	67.17
2019/4	2.29	66.27	2015/4	1.76	66.79
2019/3	2.24	62.67	2015/3	1.68	53.41
2019/2	2.27	59.96	2015/2	1.64	56.13
2019/1	2.31	56.59	2015/1	1.71	54.66
2018/12	2.36	47.86	2014/12	1.9	60.09
2018/11	2.38	53.53	2014/11	2.01	74.22
2018/10	2.41	68.38	2014/10	2.05	89.88
2018/9	2.39	76.84	2014/9	2.11	101.46
2018/8	2.37	73.29	2014/8	2.12	106.9
2018/7	2.37	72.27	2014/7	2.13	109.17
2018/6	2.31	77.93	2014/6	2.1	117.07
2018/5	2.23	70.59	2014/5	2.07	114.32
2018/4	2.15	72.48	2014/4	2.03	111.41
2018/3	2.17	68.9	2014/3	2.02	113.87
2018/2	2.21	65.58	2014/2	2.02	115.72
2018/1	2.25	69.26	2014/1	2.02	110.36
2017/12	2.27	64.89	2013/12	2.02	111.9
2017/11	2.18	61.65	2013/11	1.99	105.33
2017/10	2.12	58.40	2013/10	1.99	109.29
2017/9	2.05	55.44	2013/9	2.01	115.74
2017/8	2	50.96	2013/8	2	121.97
2017/7	1.97	54.28	2013/7	1.96	119.1
2017/6	2.05	49.77	2013/6	1.95	109.5
2017/5	2.05	52.28	2013/5	1.97	104.57

(*continued*)

Table 2. (*continued*)

Year/Month	Gasoline price in Georgia	Oil price in the world market	Year/Month	Gasoline price in Georgia	Oil price in the world market
2017/4	2.05	53.42	2013/4	2.05	106.45
2017/3	2.1	54.35	2013/3	2.1	110.66
2017/2	2.15	51.71	2013/2	2.06	105.03
2017/1	1.97	57.62	2013/1	2.03	112.11

In this case, the dependent variable is the gasoline price in Georgia, and the independent variable is the same - oil price in the world market.

We will have the following hypotheses:

H_0: The change in the oil price in the world market affects the gasoline price in Georgia;
H_1: The change in the oil price in the world market does not affect the gasoline price in Georgia;

Correlation-regression analysis gave us radically different results from the study discussed above. The coefficient of determination R^2 is equal to 0.004, i.e. the oil price in Georgia is influenced by factors that are not considered in our model. The null hypothesis presented by us has not been confirmed - Significance $F = 0.5$.

$Y = 2 + 0.0007x$ - The model shows that an increase in oil prices by 0.0007 units increases gasoline price in Georgia.

4 Conclusions

Inflation is an important economic indicator, as high inflation or deflation can damage a country's long-term economic growth potential [40]. Therefore, the goal of economic policy is to keep inflation at a level where long-term real economic growth is maximal (i.e., corresponds to its potential level).

Based on the results of the study, we rejected the H_0 hypothesis and confirmed the H_1 hypothesis that the change in oil prices on the world market does not affect the inflation rate of the oil-importing country and it does not affect the gasoline price in Georgia. However, in reality, this is not the case. The result of the correlation-regression analysis can be easily explained: depending on the variable - inflation is affected by many factors that are not considered in our model. For example, the economic and political situation in the country. The change in world oil prices indeed affects the inflation rate of the importing country, but its impact is very small and therefore was not revealed during the regression analysis in the model. As for the second model - we took the market price of gasoline in Georgia, which includes the costs of oil transportation, taxes, and several other factors that determine the fuel price in Georgia. Against the background of existing factors, the impact of changes in world oil prices on gasoline prices in Georgia has been

greatly reduced in the model. Moreover, the reflection of oil prices on the gasoline price in the country takes some time, and this factor must be taken into account.

When oil prices rise in the world (sectorial inflation - rising prices in one sector increases prices in another sector) and as a result, fuel prices rise in Georgia and eventually the consumer price index, tightening monetary policy at such times will certainly not affect international oil prices, and it will only restrict the local economy, thereby causing slowing down the economy and rising unemployment. Consequently, central banks usually should not have to respond to these types of supply shocks (except when an increase in the consumer price index leads to an increase in inflation expectations in the country, which is necessary to tighten monetary policy), instead, the Ministry of Finance should respond through fiscal policy. In terms of productivity, in the current situation, we assume that orthodox and heterodox monetary methods should cohabit. At this time monetary and fiscal methods are converging and the gap between them is narrowing, which is the beginning of a new global economic paradigm in the history of world finance.

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