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Analysis and Measurement of the Causal Relationship between the Exchange Rate and Agricultural Growth in Iraq for the Period 2000-2022

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Abstract: This study aims to verify the existence and direction of the relationship between the exchange rate and agricultural growth in Iraq for the period 2000-2022 using the causality developed by Toda – Yamamoto. The research found a causal relationship in one direction from agricultural growth to the exchange rate, as the value of Chi-sq was about 7.4 in the event that the exchange rate is a dependent variable, which is significant at the level of 5%, and this means that there is a one-way causal relationship between agricultural growth and the exchange rate in Iraq, and this means that the lack of agricultural production in Iraq affected the exchange rate local currency. Because the country suffers from a shortage of agricultural production, it is forced to import more agricultural products. The study recommended diversifying foreign exchange sources by promoting trade with other countries, encouraging foreign investments in the country, promoting economic growth, and improving the investment climate.

Keywords: Toda-Yamamoto Causality, VAR Model, Roots of Characteristic Polynomial.

1. INTRODUCTION

The exchange rate is one of the most important factors of the economy in the modern world, as it greatly affects financial markets, international trade, foreign investments, and the monetary and economic policy of countries. Its importance in the economy comes in terms of its impact on international trade, as it affects the value of the national currency and thus affects the costs of imports and exports, as for foreign investments, it determines the value of the national currency and thus the returns that can be achieved from investment in the country. In general, it can be said that the exchange rate affects growth governments and central banks can take appropriate policies to control the exchange rate and stimulate sustainable economic growth. Monetary policymakers must understand the effects of the exchange rate on economic growth and take appropriate decisions accordingly, and here it is necessary to coordinate monetary, financial and trade policies to achieve economic balance and economic growth. Despite it is simple to define the exchange rate, which means "the process of exchanging one currency for another", but it leaves significant effects, whether negative or positive on the economy when it changes up or down without planning and

guidance. The difficulty lies in the extent to which the strength of the economy is achieved to influence the outside world and not vice versa, as the weak economy will be controlled by outside world through the exchange rate gate, because the non-solid economy will need to deal with the outside world to meet its needs. The importance of the research comes from the importance of studying the role of the exchange rate as a tool linking the prices of commodities in the local economy and their prices in the global market. The exchange rate is one of the tools pursued by the monetary authority in order to achieve stability in the real prices and maintain purchasing power by influencing the prices of exported and imported goods in which calls for standing on the most important merits of the subject, The problem of high local prices of commodities, especially agricultural and food, led to fluctuations in the volume of agricultural trade and the agricultural trade balance in Iraq, which encouraged the import of various types of agricultural products as well as the requirements of agricultural production itself, which necessitated a study of the impact of the exchange rate on growth in the agricultural sector, the research has assumed a causal relationship between the exchange rate and agricultural growth during the period studied, and also aims to identify the reality of Iraq on the one hand Developments in the exchange rate and agricultural growth and highlighting the most important joints of these variables during the period studied, as well as analyzing and studying the causal relationship between the exchange rate and agricultural growth and determining which one affects the other by applying the Toda-Yamamoto causality. In 2013, Kabadani and Kassem examined the impact of exchange rate systems on the economic growth of the MENA group of countries using the cross-sectional time series data approach (Panel Data) and the autoregressive vector model (VAR), namely countries (Egypt, Saudi Arabia, Kuwait, Algeria, Tunisia, Morocco and Libya), and the research concluded that the nature of the exchange rate regime followed did not affect the growth rates in this group (Kabadani and Qasim, 2013).

As for the researcher Touitou, he dealt with the relationship between exchange rate systems and economic growth in developing countries/ an econometric study for the period 1980-2018 , and the researcher used econometrics in the study using panel data for a sample of 21 countries The researcher found positive the relationship between exchange systems and economic growth, and it also supports the idea that developing countries with fixed exchange rate arrangements will achieve higher growth than if they follow flexible or intermediate exchange rate arrangements (Touitou, 2019). Ali also measured the impact of the exchange rate and interest rate on the economic growth of Algeria for the period 1990-2017, intending to identify the impact of the exchange rate and interest rate on the growth of GDP in Algeria using the joint integration approach of Johansen and lying Building multiple linear models of the study variables, and the research found that there is a long-term equilibrium relationship between the research variables of the degree, but the study recommended the need to achieve a balance between exchange rates and interest rates to achieve domestic monetary stability, and to encourage individuals to save by raising interest rates to increase banks' liquidity and ability to lend to investors (Ali, 2020). In 2021, Awad and Mahdi studied the interactive role of the interest rate on the relationship between the exchange rate and economic growth when mediating the volume of exports in the Egyptian economy, and the AMOS method and the Process v3.3 method were used to clarify the interactive relationship among these variables, and the research found that there is a significant correlation between the study variables and the negative impact of the exchange rate on the total. The study recommended that the Central Bank take into account the degree to which macro variables are affected by monetary

variables when developing its monetary policy so that there is no conflict between macro policies, especially those aimed at promoting economic growth (Awad and Mahdi, 2021).

2. MATERIALS AND METHODS

The agricultural output in Iraq for the period 2000-2022

The Iraqi agricultural sector faces several problems and challenges whose impact has increased with the succession of drought years, rain fluctuations and various environmental, political and demographic changes, and this is the reason for the decline in the role of the agricultural sector in the national economy and the challenges it faces in light of the liberalization of agricultural commodity trade, and therefore the urgent need to develop new and effective strategies and policies for the development of the agricultural sector The average agricultural output in Iraq during the period studied 4918.5 million dollars approximately, and it is noted that the time series fluctuates significantly during the study period. It ranged from a minimum of 2842.7 million dollars in 2018 to a high of about 6860.7 million dollars in 2020, and the years 2015-2018 witnessed their lowest levels due to the security and political conditions of the country. Figure 1 shows the gradual increase in the value of agricultural output in Iraq due to dependence on the agricultural sector to meet the domestic demand for food commodities until 2013, as it reached its highest value of 6.63 billion dollars approximately, but the security conditions that affected the country after that led to a decrease in the value of agricultural output to 3.07 billion dollars approximately in 2015 and the following years, with a negative annual change rate of -50.3%. after that, it reached its lowest value in 2018 and was 28 billion dollars, as a result of the country's dependence on the oil sector as a main source of income, and then agricultural production recovered from 2019 to reach its peak in 2020 with a value of 6.8 billion dollars and an annual growth rate of 27.54.

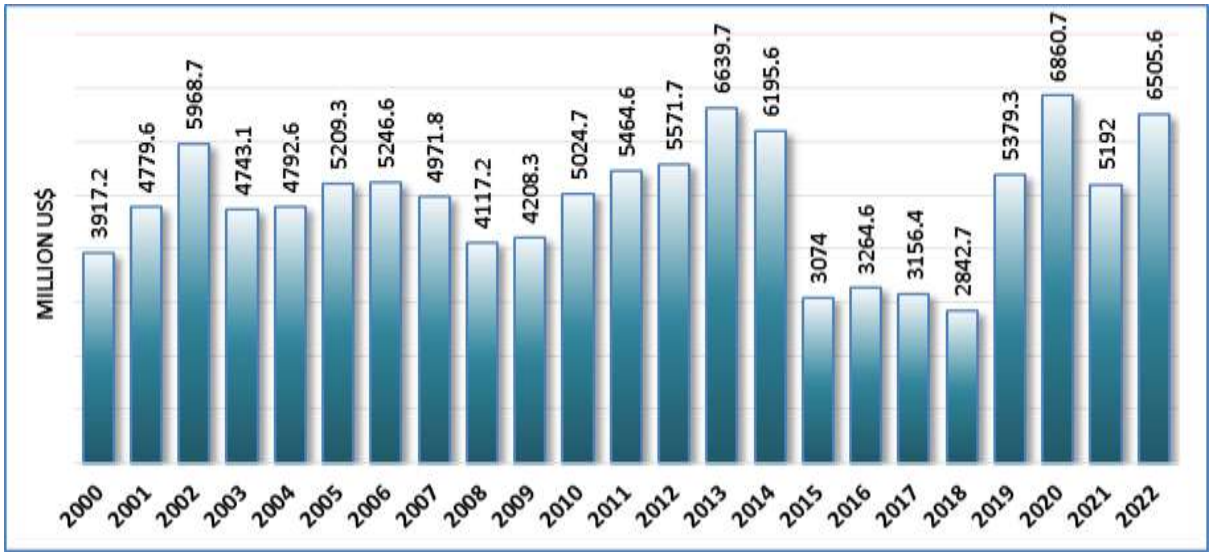

Figure 1. Agricultural output at constant prices in Iraq (2016=100) (million USD)
Resource: FAO web data.

Exchange rate in Iraq for the period 2000 - 2022

The depth of the impact of the Iraqi fiscal policy on macroeconomic variables, and its ability to move these variables in the desired direction in light of the continuous measures of fiscal

policy, but the expansionary trend taken by this policy during the study period has left several negative effects that weighed on the national economy. The monetary policy represented by the Central Bank after 2003 and through the mechanism of daily auctions for the sale and purchase of foreign currencies (US dollars), has worked to unify the exchange rates of the Iraqi dinar and achieve homogeneity in the exchange market mechanism for the dinar throughout the country, by meeting the market's need for foreign currency and the needs of the private sector to finance all its imports within balanced or real exchange rates (Al-Attabi, 2022). During the period from 2000 to 2022, exchange rates in Iraq witnessed some significant changes and extreme fluctuations as a result of the political and economic events that the country witnessed during that period, and the following are some of the main characteristics of exchange rates in Iraq during this period, at the beginning of the new millennium period, the exchange rate of the US dollar ranged around 2000 Iraqi dinars per dollar, in 2004 the exchange rate of the US dollar began to decline gradually with the improvement of the security situation in the country, It fell to about 1453 Iraqi dinars per dollar, and decreased even more during the years 2007-2009, reaching 1009 dinars, to settle in 2010 at an average of 1170 until 2010. In the last two years, currency exchange rates in Iraq have fluctuated, with some slight increases, and the value of the Iraqi dinar depreciating slightly during the global COVID-19 pandemic.

Figure 2. Exchange rate of the US dollar in Iraq.
Resource: Prepared by researchers based on data from the Central Bank of Iraq, Baghdad.

Toda & Yamamoto Causality Test

Toda-Yamamoto is used instead of Granger Causality when data need to analyze causal relationships between two non-independent time series, and the true causal assumptions required in the causality analysis using Granger's septic cannot be achieved in this case. Toda-Yamamoto captivity is particularly used in the analysis of causal relationships in nonlinear dynamic systems, where causal relationships in this case can be unclear or complex. The problem of instability restricts Granger's causality model, and the difficult part of this test when applied to several variables is the uncertainty of the relationship of cointegration, and how to estimate the VAR model accurately when the system is integrated by itself (Mohamed, 2014), that the Toda-Yamamoto causal technique overcomes the

problem of the invalidity of the critical values approach when applying the causality test in the presence of unstable data or even involving cointegration, and that one of the expected benefits of this methodology is It makes Granger's causality easier, so researchers don't have to test cointegration or convert the autoregressive vector model VAR to the error correction vector model VECM.

The test is applied by the following steps (Alattabi, et al, 2019):

1. We determine the degrees of integration and deceleration between variables according to the autoregression formula for each variable and use the Schwarz Information criterion to determine the deceleration of variables, so we get the deceleration k and the upper limit of integration (stability) d_{max}.
2. Estimating the VAR model and see if it passes the important tests which include roots of the characteristic polynomial and residual serial correlation (Salisu 2015).
3. The relationship between the variables is estimated by deceleration (k + d_{max}) and this means that k ≥ d_{max} and we adopt the Wald statistic that follows the distribution of $\chi 2$ with a degree of freedom equal to the number of observations and the model is expressed for two variables as follows:

$$AP_t = b_1 + \sum_{i=1}^{k} \beta_i AP_{t-i} + \sum_{i=k+1}^{k+d_{max}} \beta_i AP_{t-i} + \sum_{i=1}^{k} \rho_i EX_{t-i} + \sum_{i=k+1}^{k+d_{max}} \rho_i EX_{t-i} + \mu_t$$

$$EX_t = b_2 + \sum_{i=1}^{k} \varphi_i AP_{t-i} + \sum_{i=k+1}^{k+d_{max}} \varphi_i AP_{t-i} + \sum_{i=1}^{k} \varpi_i EX_{t-i} + \sum_{i=k+1}^{k+d_{max}} \varpi_i EX_{t-i} + \upsilon_t$$

Where:

- b_1, b_2, β, ρ, φ and ϖ Model Estimators
- μ and υ Error limits with a sum and a zero arithmetic mean each.

This method tests the null hypothesis that there is no causal relationship from EX to AP, which can be formulated as follows:

$$H_0 : \rho_i = 0 , i = 1, 2, \dots, k$$

The main objective of the test is to verify the nature of the relationship between agricultural imports and agricultural output and determine the direction of any possible relationship between them, to apply this we need to apply a modified model of Granger's causality test as previously explained, which requires the identification of information lag length (k) and upper limit of integration (d_{max}) of the two variables, and the reason for this is to avoid any possibility of spurious causality (Clark, 2006). The final step is the process of estimating the direction of causality according to the Toda-Yamamoto method between exchange rate (EX) and agricultural production (AP). This test is subject to a chi-square distribution. The adoption of the Toda-Yamamoto version of Granger's non-causality test for two autoregressive vectors (d_{max} = 1 and k = 1) follows the following system of equations:

$$\begin{bmatrix} EX_t \\ AP_t \end{bmatrix} = \begin{bmatrix} b_1 \\ b_2 \end{bmatrix} + \sum_{i=1}^{2} \begin{bmatrix} EX_{t-i} \\ AP_{t-i} \end{bmatrix} \begin{bmatrix} \beta_{1i} & \rho_{1i} \\ \beta_{2i} & \rho_{2i} \end{bmatrix} + \begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \end{bmatrix}$$

Where:

$$E_T(\epsilon_t) = \begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \end{bmatrix} = 0 \quad E(\epsilon_t, \epsilon_t') = \Sigma$$

To test that the exchange rate does not cause agricultural growth, a model was estimated with two autoregression vectors, testing that agricultural growth does not include an exchange rate, and this means that the exchange rate does not appear in the equation of agricultural growth, so the hypothesis of nothingness is:

$H0: \rho_{11} = \rho_{12} = 0$
$H_1: AP_t$ does Granger cause EX_t, if $\sum_{j=1}^{l} \beta_1 \neq 0$
The same case in the exchange rate equation, that is, the null hypothesis is as follows:
$H_0: \beta_{12} = \beta_{21} = 0$
$H_1: EX_t$ does Granger-cause AP_t, if $\sum_{j=1}^{l} \rho_2 \neq 0$
The existence of causality between the exchange rate and agricultural growth is based on the rejection of the above null hypothesis, and this requires the existence of a statistic (Chi-sq) for the time slowdown contained in the equation as an independent variable, and it is expected that four possibilities will appear for the relationship between the two variables:

1. First: the existence of a causal relationship Uni-directional from the exchange rate to agricultural growth.
2. Second: the existence of a causal relationship Uni-directional from agricultural growth to the exchange rate.
3. Third: the existence of a Bi-directional causal relationship between the exchange rate and agricultural growth.
4. Fourth: The absence of a causal relationship between the two variables.

3. RESULTS AND DISCUSSION

Time series stationary
A test was conducted for the stability of the time series and Table 3 shows the test results of the studied economic variables, to verify the level at which the data stabilizes and through which the value of dmax can be determined, and the Phillips – Perron (PP) test for stationary as adopted and is more accurate for the results of the data in small samples (Kozhan, 2009), and the test results were as follows:

Table 1. Unit root test using Philips-Perron (PP)

		I(0)		Δ	
		AP	EX	d(AP)	d(EX)
With Constant	**t-Statistic**	-2.7060	-2.1516	-5.2246	-5.2246
	Prob.	**0.0889**	**0.2281**	**0.0004**	**0.0004**
		*	No	***	***
With Constant & Trend	**t-Statistic**	-2.6420	-1.5252	-11.7886	-11.7886
	Prob.	**0.2671**	**0.7890**	**0.0000**	**0.0000**
		No	No	***	***
Without Constant & Trend	**t-Statistic**	0.4375	-1.7477	-5.0280	-5.0280
	Prob.	**0.8000**	**0.0764**	**0.0000**	**0.0000**
		No	*	***	***

***: Significant at 1%, ** Significant at 5% and No: No-significant.
Resource: Outputs of the statistical program Eviews 12.

We note the stability of the data for the two variables when taking the first difference and at the level of significance 1%, so the value of d_{max} is 1.

Determine the optimal lag length

In light of Table 2, we note that the optimal lang length is 1 based on some criteria applied to it, including the SC standard, which is reliable in such a test because it is the most sensitive to lag periods, and therefore the value of the lag period, which is denoted by the symbol k previously, is 1.

Table 2. Optimal lag length selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-302.7372	NA	5.88e+10	30.47372	30.57329	30.49315
1	-289.6296	22.28284*	2.38e+10	29.56296	29.86168*	29.62128
2	-284.7417	7.331950	2.21e+10*	29.47417*	29.97203	29.57135*
3	-284.3148	0.554910	3.29e+10	29.83148	30.52849	29.96754

* Represents standard choices for optimal lag.
Resource: Outputs of the statistical program Eviews 12.

Where:

- FPE: Final Prediction Error.
- AIC: Akaike Information Criterion = $\ln|\sum \varepsilon| + \frac{2K^2L}{N}$
- SC: Schwarz Information Criterion = $\ln|\sum \varepsilon| + \frac{2logn}{N}K^2L$
- HQ: Hannan-Quinn information criterion = $\ln|\sum \varepsilon| + \frac{K^2Lln(N)}{N}$

And that: K: number of variables, N: number of observations, L the number of time lag, Σε: variance matrix and the covariance of the residuals.

Estimation of the VAR model

The VAR model for the variable exchange rate and agricultural production was estimated and the results were as shown in Table 3, after determining the optimal lag length period by 1, as follows:

Table 3. Estimated VAR Model

Vector Autoregression Estimates Sample (adjusted): 2002 2022 Included observations: 21 after adjustments Standard errors in ( ) & t-statistics in [ ]		
	AP	EX
AP(-1)	0.589881 (0.25041) [2.35568]	0.058348 (0.02659) [2.19461]
AP(-2)	-0.304703 (0.24607) [-1.23830]	-0.062780 (0.02613) [-2.40296]
EX(-1)	1.309808 (2.01186) [0.65104]	0.513321 (0.21361) [2.40309]
EX(-2)	-0.960913	0.223418

	(1.80591) [-0.53209]	(0.19174) [1.16520]
C	3112.948 (1641.48) [1.89642]	330.4670 (174.284) [1.89614]
R-squared	0.288599	0.808162
Adj. R-squared	0.110749	0.760203
Sum sq. resids	19839878	223656.7
S.E. equation	1113.549	118.2309
F-statistic	1.622707	16.85094
Log likelihood	-174.2639	-127.1678
Akaike AIC	17.07275	12.58741
Schwarz SC	17.32145	12.83611
Mean dependent	4972.819	1304.952
S.D. dependent	1180.857	241.4397

Resource: Outputs of the statistical program Eviews 12.

Roots of Characteristic Polynomial

Table 4 shows that the model does not include roots up to one integer value, and that all roots are located in the circle of unity as in Figure 3 thus the model has met the condition of stability.

Table 4. Test for characteristic polynomial roots

Roots of Characteristic Polynomial Endogenous variables: EX AP Exogenous variables: C EX (-2) AP (-2) Lag specification: 1 1	
Root	Modulus
0.830720	0.830720
0.272618	0.272618
No root lies outside the unit circle. VAR satisfies the stability condition.	

Resource: Outputs of the statistical program Eviews 12.

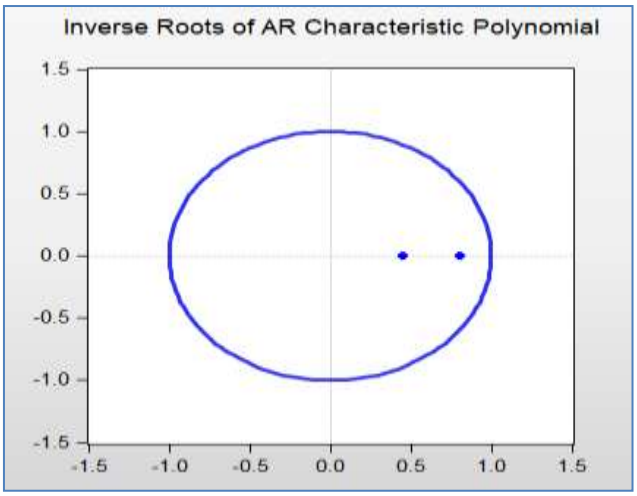

Figure 3. Test the inverse roots of the characteristic polynomial.
Resource: Eviews 12 program output.

Test of Serial Correlation LM

The most relevant post-estimation test for Multivariate Models is the Serial Correlation test (using the LM test). The outcome denotes that the null hypothesis for the test is that there is no serial correlation. The result presented in Table 5 suggests that there is no serial correlation.

Table 5. VAR Residual Serial Correlation LM test

Null hypothesis: No serial correlation at lag h						
Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	2.620871	4	0.6231	0.662589	(4, 26.0)	0.6236
2	10.46469	8	0.2339	1.429487	(8, 22.0)	0.2394
3	14.85453	12	0.2495	1.361409	(12, 18.0)	0.2690

Resource: Outputs of the statistical program Eviews 12.

Causality test according to Toda – Yamamoto

It is noted from the test results that the statistical value (Chi-sq) reached 4.8 at a significant level of 5%, and therefore we accept the alternative hypothesis that there is a one-way causal relationship (Uni-directional) from agricultural output to the exchange rate. The test also showed the absence of a causal relationship in the case of agricultural output (dependent variable) and exchange rate (independent variable), as the statistical probability (Chi-sq) was about 0.43, and therefore we also accept the hypothesis of the absence of the causal relationship between the dependent variable and the independent variable, as in Table 6.

Table 6. Causality Test Results for Toda-Yamamoto

VAR Granger Causality/Block Exogeneity Wald Tests Sample: 2000 2022 Included observations: 21			
Dependent variable: AP			
Excluded	Chi-sq	df	Prob.
EX	0.434394	2	0.8048
Dependent variable: EX			
Excluded	Chi-sq	df	Prob.
AP	7.407142	2	0.0246

Resource: Outputs of the statistical program Eviews 12.

In general, it can be said that agricultural growth affects the exchange rate by affecting the supply and demand for foreign currency, the monetary reserves of the country, and trade relations between Iraq and the countries of trade exchange, and it is important that agricultural output is well managed to achieve macroeconomic balance and avoid fluctuations in the exchange rate that can affect the economic stability of the state. The lack of agricultural production in Iraq affected the exchange rate of the local currency, because the country suffers from a shortage of agricultural production, it is forced to import more agricultural products, and thus the demand for foreign currency increased. Thus, the demand for foreign currencies in the market can increase, leading to a rise in the exchange rate of these currencies against the local currency of Iraq. Thus, this increase in the foreign exchange rate can lead to a depreciation of Iraq's local currency, as it can buy more foreign currency per unit of its currency. Thus, this decline in the exchange rate of the local currency could increase the cost of imported agricultural products, as Iraq must pay more to buy more

foreign currency needed to import agricultural products. Thus, this can lead to an increase in the cost of living and inflation. Therefore, the study recommends following some measures to improve the economic situation and relieve pressure on the exchange rate, including:

1. Encouraging local agricultural production, as the government policy can encourage farmers to increase local agricultural production by providing financial, technical and training support, and paying attention to the import of modern agricultural technologies by the country because of its positive impact on agricultural output and raising awareness of farmers in this aspect through seminars and media bulletins.
2. Diversify sources of foreign currency by promoting trade with other countries and encouraging foreign investments in the country.
3. Improve macroeconomic management by improving government spending, improving public debt management, promoting economic growth, and improving the investment climate.
4. Local industries can also be developed to replace imported agricultural products, thereby reducing the need for foreign exchange.
5. Implement cash reserve policies to provide an adequate supply of foreign currency that can be used to cover more agricultural imports.
6. Reconsider the structure of customs tariffs for the import of agricultural commodities and try to reduce and raise them for investment goods for consumer goods in support of domestic production.

In general, reducing the impact of agricultural production shortages on the exchange rate requires the implementation of a variety of integrated and balanced economic and agricultural policies, including encouraging domestic production, diversifying foreign exchange sources, and improving macroeconomic management.

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