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ANALYZING LONG-TERM RELATIONSHIP BETWEEN THE AVERAGE WAGES AND INFLATION

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Abstract

This study examines the long-run relationship between average wages and inflation using a vector error correction model. The model includes exogenous variables such as GDP, labor, and exchange rates, and examines and summarizes the short-term effects on average wages using relevant statistical indicators.

Keywords: Average salary, Vector error correction model

INTRODUCTION

In our economy, inflation, exchange rate, GDP, labor force and macroeconomic indicators affect wage growth. In addition to these macro-factors, inflation is most affected by purchasing power, or average wages. In other words, wages and inflation are two-pointed needles that interact with each other. The increase in the salaries of civil servants is empirically confirmed as being highly dependent on the growth of salaries in other sectors. There are also a number of cases of inflation caused by higher public sector salaries. For example, according to the Government Resolution of September 27, 2007 "On Re-establishing the Salary Chain and Minimum Standards for Civil Servants", inflation in October was 14.7% compared to the same period of the previous year and reached 34.2% in August.

1. RESEARCH METHODOLOGY

Many researchers have studied the relationship between wages and inflation, for instance, Aron [3], Garcha [6], Bauer [4] and Zanetti [5]. On the example of Mongolia, D.Gan-Ochir conducted a research in 2005 [2] on "The relationship between wages and income inflation".

Our study differs in that it incorporates the number of employees into the model to study the relationship between inflation and wages.

This section provides a brief overview of the unit root test used in the study, the Granger causality test, and the Vector error correction model.

Extended Dickey-Fuller test (ADF)

Time 's series analysis is necessary to determine whether the data stationary. [1] This is because the vector autoregressive model we are considering requires variables to be stationary. Most economic data tends to increase (decrease) over time or has a stochastic trend. Therefore, the most widely used unit root test to verify that data is stationary is the ADF test.

Vector autoregressive model (VAR)

Consider the p-order VAR (p) model:

$$Y_t = \propto + \sum_{i=1}^{p} \Phi_{\mathrm{i}}\, Y_{t-i} + \varepsilon_t \qquad (1)$$

Here: $Y_t = \begin{pmatrix} y_{1t} \\ \vdots \\ y_{mt} \end{pmatrix}$, $\alpha = \begin{pmatrix} \alpha_1 \\ \vdots \\ \alpha_m \end{pmatrix}$, $\Phi_{\mathrm{i}} \sim (\mathrm{m} \times \mathrm{m})$, $\mathrm{i} = 1, \dots, \mathrm{p}$ dimensional matrix

$\varepsilon_t = \begin{pmatrix} \varepsilon_{1t} \\ \vdots \\ \varepsilon_{mt} \end{pmatrix}$ − white noise and $\varepsilon_t \sim \mathrm{IID}(0, \Omega)$[1]

$$\Phi(L) Y_t = \alpha + \varepsilon_t \qquad (2)$$

Here, $\Phi(L) = I - \Phi_1 L - \cdots - \Phi_p L^p$ $\quad LY_t = Y_{t-1} -$ *the* VAR model is written in the form (2), which is equivalent to the form (1).

In Equation (1), each component of the variable has a simple minimum squared and a maximum true percentage estimates under normal conditions with normal asymptotic properties. Therefore, the significance of the coefficients can be tested with conventional t and F tests, and the order of the VAR model can be used with the Akaika and Schwartz data indicators.

If the y_t, x_t variables are not stationary and the first-order difference is stationary, the co-integration relationship needs to be checked. If a number β is found that makes a linear combination stationary $y_t + \beta x_t$, these are called co-integration processes. This result can be extended to m variables.

As mentioned above, the analysis of the VAR model is based on stationary assumptions for all m variables. Because many economic variables have a stochastic trend, the VAR model can be used after a sufficient difference between the variables and their stabilization. This is actually only possible if the variables are independent of co-integration.

The VAR (p) model is written in the following format as the VECM model.

$$\Delta Y_t = \gamma + \Pi Y_{t-1} + \Gamma_1 \Delta Y_{t-1} + \cdots + \Gamma_{\mathrm{p}-1} \Delta Y_{t-p+1} + \varepsilon_t \qquad (3)$$

Here: $\quad \Pi = -\Phi(1)$

Depending on the rank of the matrix, the number of stochastic trends and co-integration correlations can be found. The rank of the matrix is determined in three cases.

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[1] IID- have the same distribution regardless

If all variables are stationary it states $rank(\Pi) = m$. In this case, there is no stochastic trend.

If rank (Π) = 0 is an unit root of m and is a VAR (p-1) dependent on the -variable.

If the $rank(\Pi) = r, \quad 1 \le r \le m-1$, m-r variable of the m variable is a stochastic trend and the r variable is a co-integration relationship.

When the number of co-integration dependencies is known, the VECM model can be evaluated with the maximum true percentage.

$H_0: rank(\Pi) = r,\ H_1: rank(\Pi) \ge r+1$ Johansen's trace test to test hypotheses is defined by the following formula.

$$\lambda_{trace}(r) = -(n-p)\sum_{j=r+1}^{m} \ln\left(1-\hat{\lambda}_j\right) \qquad (4)$$

Here $\hat{\lambda}_j$ are the Π individual values of the matrix, n is the number of data (4) and the test has a simple χ^2 distribution.

Consider the most commonly used test equations:

Test equations with deterministic trends in data constant and co-integration:

$$\Delta Y_t = \gamma_1 + A(B^T Y_{t-1} - \gamma_2 - \delta t) + \sum_{i=1}^{p+1} \Gamma_\text{i}\, \Delta Y_{t-i} + \varepsilon_t$$

In this case, the long-term equilibrium is reached $B^T Y_{t-1} - \gamma_2 - \delta t = 0$

Fixed and non-trend checking equations for data:

$$\Delta Y_t = \gamma_1 + A(B^T Y_{t-1} - \gamma_2) + \sum_{i=1}^{p+1} \Gamma_\text{i}\, \Delta Y_{t-i} + \varepsilon_t$$

In this case, the long-run equilibrium is $B^T Y_{t-1} - \gamma_2 = 0$.

Trendless verification equations for data and co-integration:

$$\Delta Y_t = A(B^T Y_{t-1} - \gamma_2) + \sum_{i=1}^{p+1} \Gamma_\text{i}\, \Delta Y_{t-i} + \varepsilon_t$$

In this case, the long-run equilibrium is $B^T Y_{t-1} - \gamma_2 = 0$.

In the VECM model, the variables are in a single-order integral, which is the case for the co-integration-dependent VAR model. This model has the advantage over the VAR model in that it allows for both long-term and short-term equilibrium.

2. RESEARCH SECTION

2.1 Current Situation

As of the third quarter of 2019, there were 1,155,945 employees in the labor market, of which 588,990 were in the service sector, 296,410 in the agricultural sector and 270,627 in the manufacturing sector. The unemployment rate is 9.9% and the national average salary is MNT 1166,400, the average salary for men is MNT 1287,600 and for women it is MNT 1040'200.

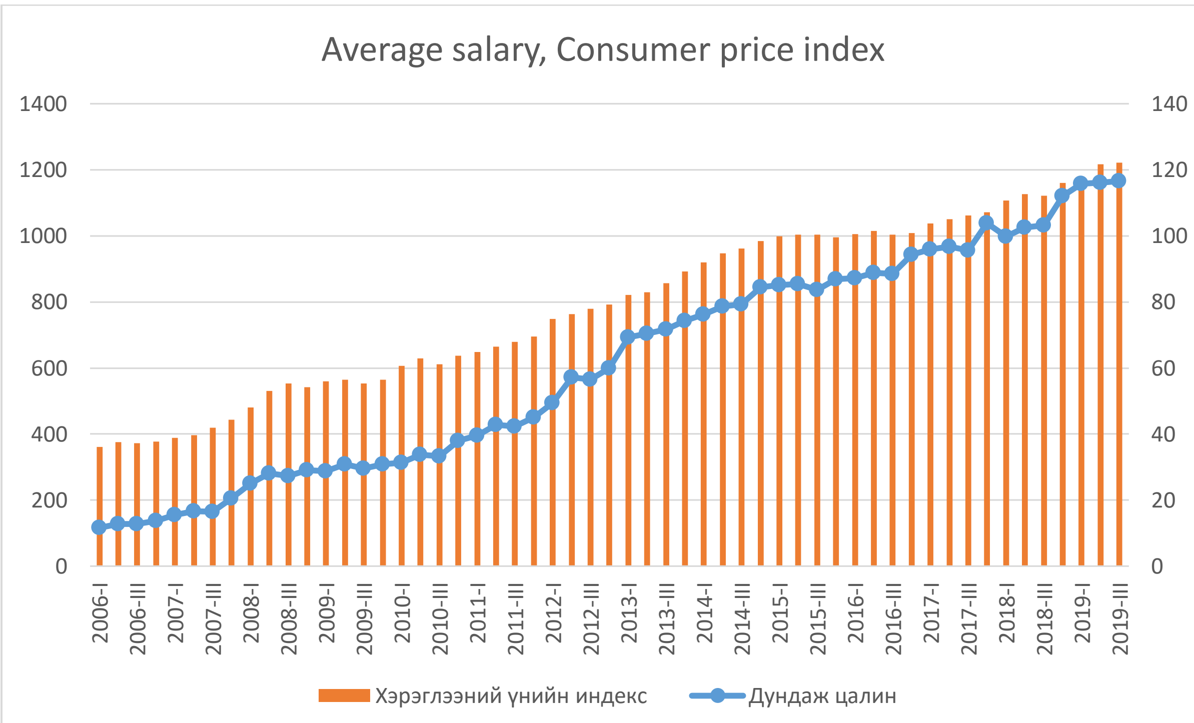

Figure 1. Average wage, Consumer price index (National Statistics Office)

Let's look at the relationship between the average wage and the consumer price index in the graph. As shown in Figure 1, the average wage and the consumer price index are directly proportional.

2.2 Empiric Research

The table uses data on average wages, consumer price indices, GDP, number of employees, and exchange rates, and the sources of these variables are shown in the table below.

Variables	Source	Note
Average salary (wage)	National Statistics Office www.1212.mn	Average MONTHLY SALARY OF EMPLOYEES OF BUSINESS ENTITIES AND ORGANIZATIONS, by region, aimag, capital city, sex, quarter, year, thousand MNT
Consumer price index (CPI)	National Statistics Office www.1212.mn	NATIONAL CONSUMER PRICE INDEX, 2015 = 100, by group, by month, by percentage
Gross domestic products (GDP)	National Statistics Office www.1212.mn	TOTAL DOMESTIC PRODUCT, by production method, quarterly, by sector, million MNT (2005 and 2010 at comparable prices)
Number of employees (labor)	National Statistics Office www.1212.mn	NUMBER OF EMPLOYEES AGED 15 AND AGE, by sex, region, aimag, capital city, quarter, year, person
Exchange rate (USD)	Bank of Mongolia www.mongolbank.mn	Monthly exchange rate announced by the Bank of Mongolia

Table 1 shows the statistical values of the stability test for the above variables with the extended Dickey-Fuller test.

Table 1. Results of the ADF test for unit roots of variables (Source: Researcher estimates)

Variables	On the level		The first difference was obtained	
	t-stat	Prob	t-stat	t-stat
wage	0.2781	0.9750	-8.7369	0.0000***
cpi	-0.0940	0.9446	-6.0782	0.0000***
gr_gdp	-6.8813	0.0000***	-	-
gr_lab	-9.6377	0.0000***	-	-
gr_usd	-7.5060	0.0000***		

The average wage and consumer price index is an endogenous variable in the model, and a graph of the variables is shown in Figure 2.

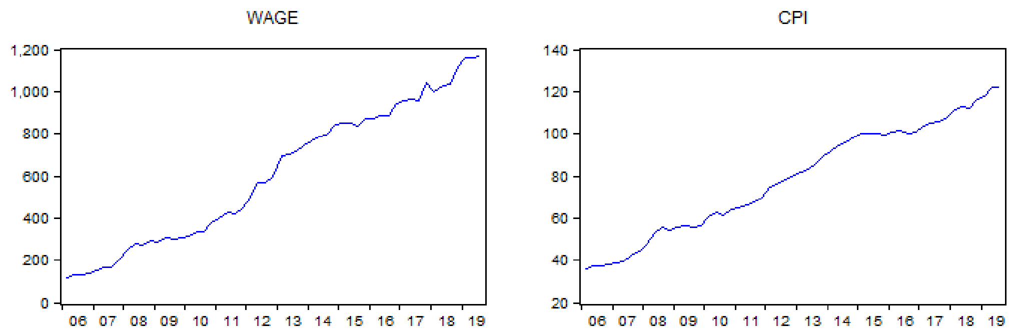

Figure 2. Graph of endogenous variables (Source: National Statistics Office)

Figure 2 shows that from an endogenous variable and stability on makeup done level of consumer price index, the average salary in Table 1 in the ADF see the results of the test for first-order difference is fairly stable through. Therefore, these variables may be subject to long-term co-integration, so the Johansen test should be tested.

Figure 3 shows that the exogenous GDP, labor force, and exchange rate variables in the model are not stable at the unaltered level, and that the GDP and labor force variables are seasonal.

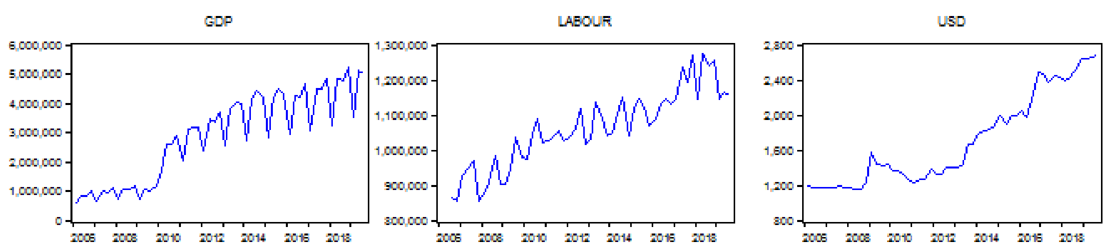

Figure 3. Graph of exogenous variables (Source: National Statistics Office)

Therefore, the seasonal effects of GDP and labor force variables were adjusted using the Census X-13 method and shown in Figure 4. Since seasonally adjusted variables are also unstable, it is appropriate to model the growth of these variables by creating variables by level. Table 1 shows the results of the ADF test for variability, denoted by gr_gdp and gr_lab, as variables for GDP and labor growth rates. There is no seasonal effect on the exchange rate, but it is also volatile, so create a growth rate variable called gr_usd and insert it exogenously into the model.

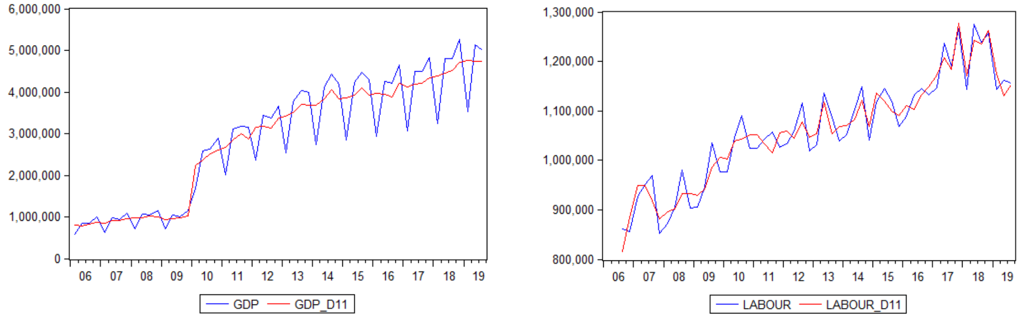

Figure 4. Seasonal adjustment of CENSUS X-13 for GDP and labor force variables (Source: Researcher estimates)

Figure 5 shows the stability of the exogenous GDP, labor force, and exchange rate growth variables in the model.

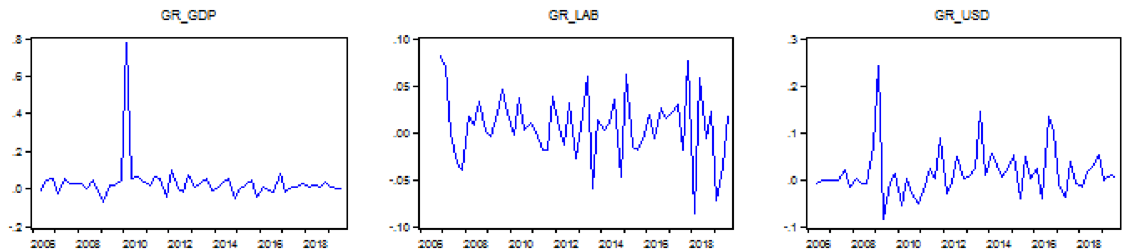

Figure 5. GDP, labor force, exchange rate growth rate, exogenous variables (Source: Researcher estimates)

Since the endogenous variables of the model, such as the average wage and consumer price index, are co-integrated, Johansen's trajectory and the maximum percentage value assume a zero assumption of co-integration (test results are attached in Appendix 1). The correction model is suitable for evaluation.

The endogenous variables of the vector error correction model include average wage and consumer price index variables, exogenous variables include GDP, labor, and exchange rate growth, and endogenous and exogenous variables lag based on Akaika and Schwartz data, and statistics. Detailed design results are attached in Appendix 2. Considering the general form of the model equation:

$$\begin{cases} \Delta wage_t = 0.1036(wage_{t-1} - 29.06cpi_{t-1} + 25.81t + 970.88) + \sum_{i=1}^{4} \alpha_i \Delta wage_{t-i} + \sum_{i=1}^{4} \beta_i \Delta cpi_{t-i} + A \\ \Delta cpi_t = 0.0118(wage_{t-1} - 29.06cpi_{t-1} + 25.81t + 970.88) + \sum_{i=1}^{4} \gamma_i \Delta wage_{t-i} + \sum_{i=1}^{4} \rho_i \Delta cpi_{t-i} + B \end{cases}$$

Here: $A = \sum_{i=0}^{4}(a_i gr\_gdp_{t-i} + b_i gr\_lab_{t-i} + c_i gr\_usd_{t-i})$

$$B = \sum_{i=0}^{4}(d_i gr\_gdp_{t-i} + e_i gr\_lab_{t-i} + f_i gr\_usd_{t-i})$$

i	α_i	β_i	γ_i	ρ_i	a_i	b_i	c_i	d_i	e_i	f_i
0	-	-	-	-	-27.14	-92.12	-54.27	4.10	-12.91	-0.51
1	-0.27	3.98	0.01	0.23	23.38	-110.9	83.41	4.24	-12.30	8.54
2	-0.26	1.11	-0.005	0.14	-13.31	21.49	-88.17	-1.66	-7.81	-2.02
3	-0.12	-0.75	-0.003	0.04	43.89	-258.4	2.89	3.04	-24.33	5.97
4	0.46	2.12	0.01	0.25	12.52	-98.21	30.22	0.51	3.64	3.20

From the model, we can distinguish the co-integration relationship of endogenous variables or the long-run equilibrium relationship:

$$wage + 25.81t + 970.88 = 29.06cpi$$

From the above equation, the long-run equilibrium ratio can be inferred: the average wage and consumer price index are positively correlated, and the average wage tends to increase by an average of MNT 25,000 per year over time. In other words, these variables tend to grow interdependently as long as the average wage and other macro factors affecting the consumer price index remain stable.

CONCLUSION

In order to analyze whether there is a long-term relationship between average wages and inflation in the study, the macro-5 factors such as average wage, consumer price index, GDP, labor force, and exchange rate were measured quarterly from Q1 2006 to Q3 2019.

Evaluate the vector error correction model based on the time series data with the sample. Vector error with 4-quarter lag and linear trend in co-integration, taking into account the statistical significance of the relevant statistics and indicators by modeling the variables of the average wage and consumer price index endogenously, and the variables expressed exogenously by GDP, labor force and exchange rate growth. The choice of correction model was the most optimal. As a result of the empirical model, the average wage is highly correlated with changes in the previous period, changes in the consumer price index in the past, or changes in inflation lags and other exogenous variables.

In the long run, for a sample of 13 years, the average wage and consumer price index are positively correlated. In other words, it is empirically proven that an increase in wages causes an increase in the consumer price index, and an increase in the consumer price index causes an increase in wages. It has also been observed that in the long run, the average wage increases over time.

Therefore, the government's policy measures to increase salaries and pensions do not increase real wages but open the door to raising the general price level. Government decrees to increase the salaries of civil servants over the last 13 years are usually issued in the year before the election, leading to higher prices and higher private sector salaries. If the government pursues a policy of increasing real wages, it would be appropriate to pursue a double macroeconomic policy to keep inflation in general.

APPENDIX

Appendix 1

Date: 01/30/20 Time: 12:49
Sample (adjusted): 2006Q3 2019Q3
Included observations: 53 after adjustments
Trend assumption: No deterministic trend (restricted constant)
Series: WAGE CPI
Lags interval (in first differences): 1 to 1
Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.299480	26.06687	20.26184	0.0070
At most 1	0.127065	7.202420	9.164546	0.1161

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.299480	18.86445	15.89210	0.0166
At most 1	0.127065	7.202420	9.164546	0.1161

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

WAGE	CPI	C
0.001039	-0.012182	1.861881
-0.028883	0.377859	-12.29125

Unrestricted Adjustment Coefficients (alpha):

D(WAGE)	13.97709	5.218764
D(CPI)	0.793975	-0.292860

1 Cointegrating Equation(s): Log likelihood -339.3544

Normalized cointegrating coefficients (standard error in parentheses)

WAGE	CPI	C
1.000000	-11.72071	1791.401
	(8.36068)	(709.850)

Adjustment coefficients (standard error in parentheses)

D(WAGE)	0.014527
	(0.00381)
D(CPI)	0.000825
	(0.00022)

Appendix 2

Vector Error Correction Estimates
Date: 01/30/20 Time: 13:09
Sample (adjusted): 2007Q4 2019Q3

Included observations: 48 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
WAGE(-1)	1.000000
CPI(-1)	-29.06361
	(6.50120)
	[-4.47050]
@TREND(06Q1)	25.81856
	(10.4963)
	[2.45978]
C	970.8848

Error Correction:	D(WAGE)	D(CPI)
CointEq1	0.103665	0.011839
	(0.09318)	(0.00375)
	[1.11258]	[3.16087]
D(WAGE(-1))	-0.267121	0.011087
	(0.21821)	(0.00877)
	[-1.22416]	[1.26402]
D(WAGE(-2))	-0.261775	-0.005369
	(0.21863)	(0.00879)
	[-1.19732]	[-0.61094]
D(WAGE(-3))	-0.122906	-0.003291
	(0.23687)	(0.00952)
	[-0.51887]	[-0.34563]
D(WAGE(-4))	0.462184	0.011814
	(0.22301)	(0.00896)
	[2.07251]	[1.31789]
D(CPI(-1))	3.983045	0.238201
	(4.50288)	(0.18100)
	[0.88455]	[1.31600]
D(CPI(-2))	1.110831	0.145848
	(4.67347)	(0.18786)
	[0.23769]	[0.77636]
D(CPI(-3))	-0.754152	0.048395
	(4.26098)	(0.17128)
	[-0.17699]	[0.28255]
D(CPI(-4))	2.124298	0.259858
	(4.38482)	(0.17626)
	[0.48447]	[1.47431]

C	17.52438	-0.051390
	(14.7320)	(0.59219)
	[1.18954]	[-0.08678]
GR_GDP	-27.14963	4.104012
	(60.5572)	(2.43423)
	[-0.44833]	[1.68596]
GR_LAB	-92.13277	-12.91229
	(181.516)	(7.29644)
	[-0.50757]	[-1.76967]
GR_USD	-54.27204	-0.513802
	(106.145)	(4.26672)
	[-0.51130]	[-0.12042]
GR_GDP(-1)	23.38827	4.245767
	(53.3321)	(2.14380)
	[0.43854]	[1.98049]
GR_LAB(-1)	-110.9171	-12.30773
	(204.233)	(8.20959)
	[-0.54309]	[-1.49919]
GR_USD(-1)	83.41312	8.549182
	(106.446)	(4.27883)
	[0.78362]	[1.99802]
GR_GDP(-2)	-13.31040	-1.665884
	(51.2744)	(2.06108)
	[-0.25959]	[-0.80826]
GR_LAB(-2)	21.49201	-7.811709
	(208.299)	(8.37303)
	[0.10318]	[-0.93296]
GR_USD(-2)	-88.17814	-2.028746
	(109.055)	(4.38370)
	[-0.80857]	[-0.46279]
GR_GDP(-3)	43.89983	3.045504
	(50.6961)	(2.03784)
	[0.86594]	[1.49448]
GR_LAB(-3)	-258.4477	-24.33470

	(207.426)	(8.33794)
	[-1.24597]	[-2.91855]
GR_USD(-3)	2.892677	5.970669
	(101.092)	(4.06362)
	[0.02861]	[1.46930]
GR_GDP(-4)	12.52728	0.512853
	(52.5840)	(2.11373)
	[0.23823]	[0.24263]
GR_LAB(-4)	-98.21853	3.645492
	(197.634)	(7.94433)
	[-0.49697]	[0.45888]
GR_USD(-4)	30.22468	3.209946
	(128.994)	(5.18521)
	[0.23431]	[0.61906]
R-squared	0.447082	0.724440
Adj. R-squared	-0.129876	0.436899
Sum sq. resids	19962.47	32.25563
S.E. equation	29.46071	1.184238
F-statistic	0.774895	2.519432
Log likelihood	-212.8388	-58.56884
Akaike AIC	9.909952	3.482035
Schwarz SC	10.88454	4.456619
Mean dependent	20.86042	1.672917
S.D. dependent	27.71582	1.578141
Determinant resid covariance (dof adj.)		1215.384
Determinant resid covariance		279.0530
Log likelihood		-271.3717
Akaike information criterion		13.51549
Schwarz criterion		15.58161

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