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FORECASTING OF IMPORTS AND EXPORTS IN PAKISTAN: A COMPARISON OF SOME TIME SERIES METHODOLOGY

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ABSTRACT

The main objective of this study is to estimate a significant model to forecast Pakistan's yearly economic variables of imports and exports. The data have been collected from the World Bank website ranging from 1962 to 2020. Imports and Exports of Pakistan are observed and analyzed by using time series analysis techniques by utilizing the Box-Jenkins methodology and Vector autoregressive model through Eviews-10 software. These methods were used for analysis, estimation, and forecasting purposes. The empirical analysis involved using the ADF (Augmented Dickey-Fuller) unit root test to check the stationary of the data. We used multivariate and univariate time series models. Before forecasting we check the correlation among the variables and apply the VAR model. it checks the forecasting accuracy by using RMSE, and MAE. We conclude that VAR model is the best technique for the forecasting of imports and exports.

Key Words: *Imports, Exports, Pakistan, Time Series Analysis, VAR, MAPE, MAE*

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1. BACKGROUND OF THE STUDY

Forecasting is the technique of relevant events of the future, based on the analysis of their previous and current behavior. Development is the main goal of any economy. The fundamental of economic development is economic growth. Economic variables such as imports and exports, of Pakistan. Exports and imports play an important part in the economic growth and progress of any nation. Balance of payments surplus means that the value of the country's exports is higher than the imports. Export and import together play an integral role in determining the trade balance of a country. By increasing exports, we increase trade, which results in a faster GDP growth rate. Generally, exports enhance communication between two countries, so people who do business on a smaller scale can expand their business by exporting at a global scale. Export competition forces manufacturers in countries to create high-quality items at as low a cost as possible.

Correlation is a common problem to be present among economic variables. The present study is an effort to forecast the economic variables (imports and exports) of Pakistan by using time series analysis through Box Jenkins methodology, VAR model. We will se which forecasting model will do better when we have high correlation among the variables.

2. LITERATURE REVIEW

Din (2004) examined the export-led growth hypothesis for the five largest economies of the South Asian region using a multivariate time series analysis. Export promotion is a key part of their growth strategies and outward orientation. Imports were explicitly incorporated in the analysis to control for their role in the export economic growth relationship, which made the study unique the results indicate that exports and output growth causality correlated in Bangladesh India, and Sri Lanka evidence of a long-run relationship among the relevant variables is found.

Ince and Trafalis (2005) has forecasted exchange rate using different forecasting models such as ARIMA, VAR, SVR, and ANN. They found SVR models performed better as compared to other models.

Ghafoor and Hanif (2005) examined the pattern of trade in Pakistan for the period 1971-to 2003 and forecast the level of imports and exports by the year 2010. The study has used ARIMA modeling for forecasting and a log-linear model for estimating growth trends.

Mehmood et al. (2012) studied to forecast Pakistan's exports to SAARC for upcoming years. Box and Jenkins's methodology of the univariate ARIMA model was used. Based on this study ARIMA (1,1,4) was found to be the best model to forecast Pakistan's exports to SAARC. Javed et al. (2012) proved that export has a positive and significant impact on the economy of Pakistan and the results showed that international trade is an important factor for the Pakistani economy.

Farooqi (2014) studied the Forecasting of imports and exports of Pakistan during the period 1947 to 2013. The Box-Jenkins Methodology (ARIMA) model was selected. Used the Statistical Software R. Selecting the values using both (AIC and SBC) showed that ARIMA (2,2,2) and ARIMA (1,2,2) models had the best forecasting performance of the imports and exports of Pakistan.

Ahmad et al. (2017) had been studied examined the impact of exports on the economic growth of Pakistan. The study obtained annual time series data from 1972 to 2014. The relationship regressed through Gross Domestic Product as a dependent variable while Exports, Imports, Consumer Price Index, and Terms of Trade as independent variables. GDP, imports, and consumer price index whereas stationary the level, and exports and terms of trade were stationary at first difference.

Khan and Ullah (2019) studied the impact of exports on the economic growth of Pakistan and India for the time-series data from 1990 to 2016. Unit root test especially the augmented Dickey-Fuller (ADF) test was used to identify stationarity in the data.

Ghauri et al. (2020) has compared the performance of autoregressive with seasonal dummies and Box-Jenkins Approach for the fiscal year of 2020. They have used data from 2002 to 2019. In their findings autoregressive approach is performing better as compare to other forecasting model.

Khan and Khan (2020) compared the forecasting performance of different economic variables of Bangladesh using VAR and Box-Jenkins methodology. They compare the performance of forecasting using different techniques such as ME, RMSE, MAE, MPE, MAPE, and MASE. The results of their study showed that for highly correlated variables VAR techniques performed better then Box-Jenkins methodology. Both methods almost performed same for the variables having low correlations.

3. DATA AND METHODOLOGY

The data of economic variables in Pakistan have been forecast using Box-Jenkins methodology and VAR model using EViews. Imports and Exports are selected as economic variables because of their relationship. The data have been collected from the World Bank website ranging from 1962 to 2020.

Box Jenkins Methodology

It is used for forecasting. Box-Jenkins refers to a systematic method of identifying, fitting, checking, and using integrated auto-regressive, moving average (ARIMA) time series models. It has the following steps:

- Stationary checking
- Model identification
- Parameter estimation
- Diagnostic checking
- Forecasting

Vector Autoregressive model

The vector autoregression (VAR) model is widely used in multivariate time series analysis. It is an extension of the univariate autoregressive model to dynamic multivariate time series. Using the VAR model for multivariate analysis, it has been shown to be particularly useful for analyzing economic and financial time series dynamically and predicting future outcomes.

Forecasting Errors

Error is an essential part of forecasting, therefore to the maximum accuracy of error RMSE, MAE, and MAPE are used to compare the performance of the forecasting models. The formulas for calculating this errors are as follows

Root means square error: $\mathrm{RMSE} = \sqrt{\frac{1}{T} e^2_{t+h,t}}$ (01)

Mean absolute error: $MAE = \frac{1}{T}\sum_{t=1}^{T}\left|e_{t+h,t}\right|$ (02)

Mean absolute percent error: $MAPE = \frac{1}{T}\left|\sum_{t=1}^{T} p^2_{t+h,t}\right|$ (03)

4. FINDINGS OF THE STUDY

In this section, results of the study are concluded. First, we will calculate the correlation among exports and imports and the results are showed in table 4.1. The result identifies a high correlation between imports and exports. Now, we will apply Box-Jenkins and vector autoregressive techniques to see which of them will perform better in presence of such high correlation.

Table 4.1: Correlation matrix

	Imports	**Exports**
Imports	1	0.985643
Exports	0.985643	1

4.1. Box Jenkins Methodology

For Box-Jenkins methodology first we will check the stationarity of the data for this we will apply ADF will null hypothesis that data is not stationary. Data was stationary at first difference and the results of the test are as follows

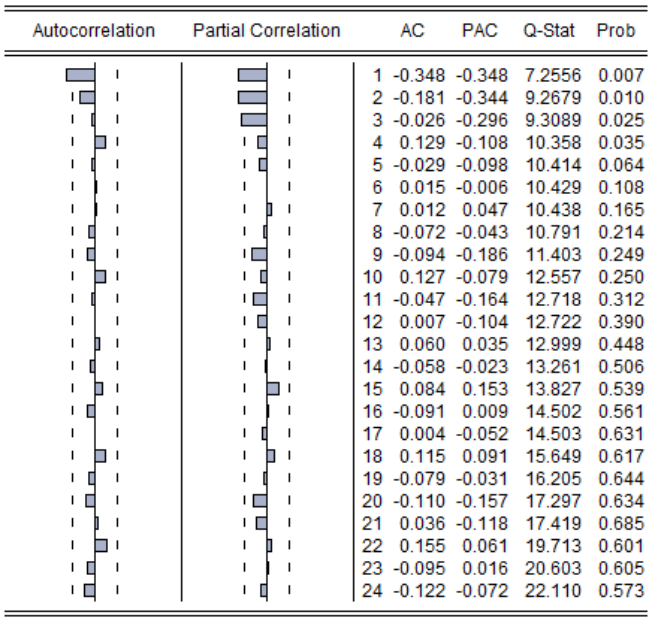
Table 4.2: Unit root test for Imports

		t-Statistic	Prob*
Augmented Dickey-Fuller test statistic		-6.858241	0.0000
Test critical values:	1% level	-3.552666	
	5% level	-2.914517	
	10% level	-2.595033	

From the provided evidence p-value for ADF test is 0.00000 which is less than 0.05 so we have strong evidence against Ho and conclude that the data of imports is stationary at a different level of significance.

Now, as our dataset is staionary at first difference, our next step will be to identify the model. For this we will plot correlogram of the data and will see possible orders of p and q. the correlogram of imports at first difference is hown in figure 4.1.

Figure 4.1: Correlogram for Imports



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.348	-0.348	7.2556	0.007
		2	-0.181	-0.344	9.2679	0.010
		3	-0.026	-0.296	9.3089	0.025
		4	0.129	-0.108	10.358	0.035
		5	-0.029	-0.098	10.414	0.064
		6	0.015	-0.006	10.429	0.108
		7	0.012	0.047	10.438	0.165
		8	-0.072	-0.043	10.791	0.214
		9	-0.094	-0.186	11.403	0.249
		10	0.127	-0.079	12.557	0.250
		11	-0.047	-0.164	12.718	0.312
		12	0.007	-0.104	12.722	0.390
		13	0.060	0.035	12.999	0.448
		14	-0.058	-0.023	13.261	0.506
		15	0.084	0.153	13.827	0.539
		16	-0.091	0.009	14.502	0.561
		17	0.004	-0.052	14.503	0.631
		18	0.115	0.091	15.649	0.617
		19	-0.079	-0.031	16.205	0.644
		20	-0.110	-0.157	17.297	0.634
		21	0.036	-0.118	17.419	0.685
		22	0.155	0.061	19.713	0.601
		23	-0.095	0.016	20.603	0.605
		24	-0.122	-0.072	22.110	0.573

The ACF plots and PACF plots of the difference series can be used to identify the order of autoregressive terms and moving average terms. To define the best model, parameters need to be estimated. From the possible values of p and q, ARIMA (1,1,1), ARIMA (0,1,2) ARIMA (0,1,3) has been identified as possible models.

4.2. Model selection for Imports

Table 4.3: AIC and SBC of Different ARIMA Models

Models	AIC	SBC
ARIMA(1,1,1)	-2.418854	-2.276754
ARIMA(0,1,2)	-2.431888	-2.325313
ARIMA(0,1,4)	-2.431888	-2.325313

Constructing different ARIMA models with Akaike information criterion (AIC), and Schwarz Bayesian criterion (SBC). From the constructed ARIMA model we draw the inference that ARIMA (1,1,1) has the lowest value of AIC, SBC So, we select this model as the best for forecasting

4.3. Exports of Pakistan

We have applied ADF test to determine the stationary of the data. Data was stationary at first difference and the results of the test are as follows with the null hypothesis of data is not stationary.

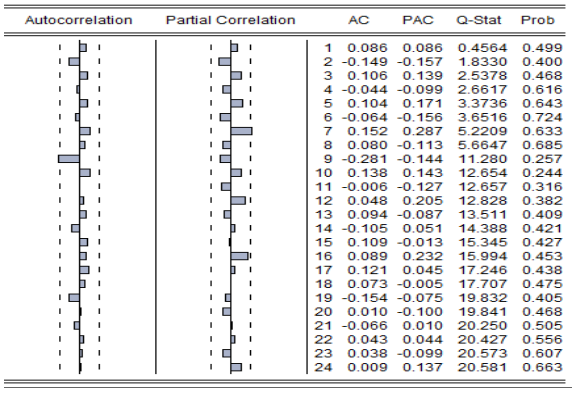
Table 4.4: Unit root test for Exports

		t-Statistic	Prob*
Augmented Dickey-Fuller test statistic		-6.858241	0.0000
Test critical values:	1% level	-3.552666	
	5% level	-2.914517	
	10% level	-2.595033	

From the provided evidence p-value for ADF test is 0.00000 which is less than 0.05 so we have strong evidence against Ho and conclude that the data of exports is stationary at a different level of significance.

4.4. Model-identification for Exports

Figure 4.2: Correlogram for Exports



	AC	PAC	Q-Stat	Prob
1	0.086	0.086	0.4564	0.499
2	-0.149	-0.157	1.8330	0.400
3	0.106	0.139	2.5378	0.468
4	-0.044	-0.099	2.6617	0.616
5	0.104	0.171	3.3736	0.643
6	-0.064	-0.156	3.6516	0.724
7	0.152	0.287	5.2209	0.633
8	0.080	-0.113	5.6647	0.685
9	-0.281	-0.144	11.280	0.257
10	0.138	0.143	12.654	0.244
11	-0.006	-0.127	12.657	0.316
12	0.048	0.205	12.828	0.382
13	0.094	-0.087	13.511	0.409
14	-0.105	0.051	14.388	0.421
15	0.109	-0.013	15.345	0.427
16	0.089	0.232	15.994	0.453
17	0.121	0.045	17.246	0.438
18	0.073	-0.005	17.707	0.475
19	-0.154	-0.075	19.832	0.405
20	0.010	-0.100	19.841	0.468
21	-0.066	0.010	20.250	0.505
22	0.043	0.044	20.427	0.556
23	0.038	-0.099	20.573	0.607
24	0.009	0.137	20.581	0.663

The ACF plots and PACF plots of the differenced series can be used to identify the order of autoregressive terms and moving average terms. To define the best model, parameters need to be estimated. From the possible values of p and q, two ARIMA models that is, Since the ACF and PACF spike at the lag 7,9 So, we estimate the ARIMA (0,1,7) and ARIMA (9,1,0) have been proposed.

4.5. Model Selection for Exports

Table 4.5: AIC and SBC of Different ARIMA models

ARIMA Model	AIC	SBC
ARIMA (0,1,7)	-3.096962	-2.990387
ARIMA (9,1,0)	-3.159778	-3.053204

Construct different ARIMA models with Akaike information criterion (AIC), and Schwarz Bayesian criterion (SBC). From the constructed ARIMA model we draw the inference that ARIMA (0,1,7) has the lowest value of AIC and SBC So, we select this model as the best for forecasting.

4.6. Vector Autoregressive Model

The VAR model with a different order for multivariate time series analysis. Here we discussed prediction based on VAR for the multivariate time series model and considered point and interval forecasts.

Table 4.6: VAR analysis of Imports and Exports

	EXPORTS	IMPORTS
EXPORTS (-1)	1.064863	0.571538
	(0.15623)	(0.20550)
	[6.81620]	[2.78117]
EXPORTS (-2)	-0.042620	-0.384522
	(0.16118)	(0.21202)
	[-0.26442]	[-1.81360]
IMPORTS (-1)	-0.099857	0.861688
	(0.11486)	(0.15108)
	[-0.86941]	[5.70337]
IMPORTS (-2)	0.053245	-0.061488
	(0.11440)	(0.15048)
	[0.46545]	[-0.40861]
C	0.277355	0.175401
	(0.11836)	(0.15569)
	[2.34336]	[1.12660]

Our selected model using VAR is

Imports = 0.861688*Imports (-1) - -0.061488* Imports (-2) + 0.571538*Exports (-1) + 0. -0.384522*Exports (-2) + 0.175401

Exports = -0.099857*Imports (-1) +0.053245*Imports (-2) + 1.064863*Exports (-1) -.042620*Exports (-2) + 0.277355

Table 4.7: AIC and SBC for VAR model of imports and exports

VAR Model	AIC	SBC	R square	Adjusted R^2
Imports	-2.5804	-2.4012	0.9888	0.9879
Exports	-3.1284	-2.9495	0.9938	0.9933

Now, we will compare the performance of both models using forecasting error. To see which forecasting model perform better, the model has least forecasting error will be preferred.

4.7. Comparison of ARIMA and VAR model

Table 4.8: Imports and exports

Model	Variables	MAE	RMSE	MAPE
VAR	Imports	0.4866	0.0610	0.4976
	Exports	0.0365	0.0463	0.3802
ARIMA	Imports	0.0531	0.0689	196.3124
	Exports	0.0396	0.0496	241.4128

Compared to VAR and ARIMA models, the VAR model has the lowest RMSE, MAE and MAPE values, so we concluded the VAR model would the best model for forecasting imports and exports in comparison to ARIMA models. Therefore, when we have high correlation among the variables, then we can use VAR models for forecasting.

5. CONCLUSION AND POLICY OPTIONS

The aim of this study is to forecast imports and exports in Pakistan. Based on the data collected from the World Bank's website ranging from 1962 to 2020 and applied the Box-Jenkins methodology and Vector autoregressive model. We observed that the data was not stationary. The difference is the best way to transform the non-stationary series is stationary. We calculated the differences and construct correlogram to determine the order of the model. For imports ARIMA (1,1,1) and for exports ARIMA (0,1,7) has been selected and then we apply the VAR model. Then, we checked the forecasting accuracy by using RMSE, MAE and MAPE. On comparing all forecasting accuracies, we have concluded that in presence of high correlated variables VAR rather then ARIMA would give better results as their forecasting accuracies are better. Our recommendations are as

we have used only two economic variables others can use other economic variables that are correlated with each other. For government and policy makers, they should keep in mind the presence of correlation. When there is chance of correlation between variables, they can use VAR model to provide better results.

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