Exploring Channels of Economic Linkages of Pakistan's Economy to the Globe

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ABSTRACT

The globalization of international economies have important implications for policy makers, short and long term investors and businesses leaders. Globalization implies that the power of local policy makers in controlling and manipulating the economy is limited since the economic managers have to keep an eye not only on the local economic conditions but also to the shocks originating outside their economy. An economy encompasses several aspects e.g. financial, monetary, real sectors and foreign trade, therefore a multidimensional set of variables is required for measuring progress of an economy over time. In this paper we propose and apply the multivariate statistical technique of canonical correlation analysis to the study of linkages of Pakistani economy to the globe. The multivariate statistical technique of canonical correlation analysis is used to investigate the extent to which Pakistani economy is affected by global economic development in particular the G-7 countries and China. This is achieved by representing the Pakistani economy as a linear composites of macroeconomic and financial variables. Similar linear composites are determined for each of the G-7 countries and China. The

coefficients of a linear composite are selected so as to maximize the correlation between the two sets. The paper also investigates the channels of transmission of economic and financial development in these economies to Pakistani by investigating which Pakistani economic and financial variables are linked to the macroeconomic developments in these global economies. To this end, correlation between the individual observable macro and financial variables and the associated linear composite are estimated. It is found that there are several different types of channels of economic linkages with the G-7 countries and China with Pakistan. However inflation, exchange rate and stock price and to a lesser extent trade are found as important channels of international transmission of external shocks from these global economies to Pakistan.

1. Introduction

World economies have witnessed an increasing trend of integration. The globalization of economies has been facilitated by several important factors including the liberalization of financial and macroeconomic policies by sovereign governments, innovations in communication technology and increasing role of multinational corporations in global business. The level of integration has important implications for economists, policy makers, governments and investors. Lower levels of international integration provides opportunities of diversifying portfolio investment risks, which results in increasing investment in capital markets and providing a stimulus for growth in productive capacity building. As integrated economies move together, the shocks originating in one economy are transmitted to other economies. Due to their relatively higher informational efficiency and frequent data dissemination, the financial markets transmit the shocks

quite rapidly. The real sector follows the shocks with a lag as adjustment to productive sector takes time. In addition to these implications for global business, integration also implies that the power of local policy makers in controlling and manipulating the economic variables gets reduced since the economic managers have to be alert to the shocks originating outside their economy in addition to keeping an eye on the local economic conditions. The emergence of trading blocks and economic unions can also be seen as attempts to facilitate better economic control and macroeconomic stability. Globalization refers to the expansion and depth of trade, ethnological advancement and greater level of international flow of capital within an integrated world. The evolution of international laws and institutions have reduced barriers to trade of goods and services and movement of capital and technology across borders which has accelerated the pace of world integration. Global integration has brought significant benefits to world economies such as increase in world output; better standard of living; improved quality of goods and services and advancement of information technology. But globalization has not been without problems. According to its opponents, it has resulted in loss of jobs; widening divergence between rich and poor; increased vulnerability against external shocks; loss of sovereignty of developing nations; exploitation of weak nations by powerful ones and dominance of developed nations in world affairs. But no one can deny that it has produced winners even among developing nations.

This paper attempts to explore important channels of economic linkages of Pakistan's economy to large economies which dominate the global economic and business horizon. These are the G-7 countries i.e. Canada, France, Germany, Italy, Japan, the United

Kingdom and the United States. We also include China as this is the second biggest economy in the world having strong trade and diplomatic relationship with Pakistan.

Pakistan is world's 6th largest country with respect to population with an estimated population of 191.7 million in 2015. By PPP based GDP comparison, Pakistan ranks world number 24 in 2015 with the GDP of 952.5 billion international dollars. According to International Trade Centre data in 2015 Pakistan's exports to the G7 countries and China are estimated to be 44% of her total exports. The import from the eight countries comprise 40% of the total imports to Pakistan.

2. Theoretical Framework and Empirical Strategy

2.1 Theoretical Economic Framework

As world economies are increasingly integrated, small open economies e.g. Pakistan are highly exposed to global developments in their major trading partners. Chowla et al. (2014) proposed two possible ways in which the world can have an impact on an economy. Firstly, events occurring outside of an economy may have an impact on the domestic nation through cross-border linkages. Secondly, world shocks common to most nations of the world can affect a nation's economy. Conceptually both are different but in practice they are jointly referred as external shocks. Chowla et.al (2014) also divided different sources of external shocks into three broad groups-world demand shocks, world supply/price shocks and world financial shocks. World demand shocks are connected with an increase or decrease in spending and confidence in the global economy. Changes in the fiscal policy of major countries or regions, change in the level of confidence of firms and households and their economic decision making are also part of it.

World supply or price shocks are produced in the production sector globally and affect world supply and prices of goods and services e.g. an oil price shock. World financial shocks occur in the global financial system, such as high stress in the international banking system or financial markets. They might relate, along with other factors, to changes in risk premium driven by investors' decisions to reconsider their perception on a certain asset, including holdings of foreign exchange.

Among the channels through which external shocks are transmitted to a country, trade channel has been considered the most important. The impact of external shock is felt in the domestic economy through changes in the quantities and prices of domestic nation's exports and imports. These price shocks are generally reflected in domestic consumer prices. A positive demand shock abroad will boost demand for domestic exports, escalating the price and quantity of domestic goods and services. This increases the output of domestic economy relative to her trading partners. The positive demand shock may also cause an appreciation in the domestic currency. A world supply or price shock that leads to a fall in the production of oil and an increase in oil prices would have an impact through increased domestic import prices, which would subsequently result in an increase in firms' costs and a decrease of households' income allocations for other purchases. A foreign financial shock, such as a failure of a financial institution abroad, results in a fall of demand for domestic exports. Indirect effects trade may also have a significant effect on domestic economy which is not significantly linked with the origin of shock. It can happen by transmission of the shock through other economies which are major trading partners of the domestic economy. Financial or monetary channels work simultaneously with trade channel. Financial channels are divided into credit channel,

funding channel and non-banking channel. The credit channel works through banking sector of the domestic economy. A domestic bank's overseas exposure may affects lending to the households and business sector in domestic economy. Low demand conditions in a foreign economy leads to an increase in non-performing loans. This might add to losses of the domestic bank's operating abroad resulting in a reduction of its capital base. In response, the bank may opt to reduce supply of new loans to domestic economy by raising interest rates on new loans in a bid to rebuild its capital ratio (Farag et al., 2013).

The funding channel involves reliance of financial institutions of a country on foreign funding. This channel is very important in case of small developing economies. If a foreign bank is short of liquidity, it may withdraw funding to domestic economy. If domestic banks cannot replace this, they may reduce lending thus making it difficult to achieve credit targets. The world shocks can promulgate to the domestic economy through non-banking financial channels. They may occur via 'wealth effect' whereby domestic residents and firms cut down their spending if a shock abroad results in losses on their foreign financial investments. This could be exacerbated if the fall in the value of their assets also restricts their ability to borrow. These traditional channels of external shock transmission are also influenced by people's expectations and uncertainty.

It is important to note that the above mentioned channels of external shock transmission are not mutually exclusive i.e. they do not work in isolation. Instead they are interrelated. Thus it is possible that one channel may increase the extent of impact of another channel.

2.2 Empirical Strategy

Empirical studies on financial markets have employed time series techniques of vector auto regression and co-integration to study dynamic linkages of financial and economic variables. There is now an enormous amount of literature on these techniques which are well known to researchers in financial market linkages.

This paper proposes and employs the multivariate statistical technique of canonical correlation analysis (CCA) to the study of integration of a small open economy of Pakistan to the world economies. Proposed by Hotelling (1936), canonical correlation analysis is a multivariate statistical method that facilitates the study of interrelationships among sets of multiple dependent variables and multiple independent variables. Canonical correlation analysis determines correlation between the linear combination of vector of variables $x' = (x_1, x_2, ..., x_q)$ and a vector of variables $y' = (y_1, y_2, ..., y_p)$. Specifically, the first canonical correlation determines coefficient vectors *'a'* and *'b'* so that Pearsonain correlation between the linear combination $a'x$ and $b'y$ is maximized. Then a second pair of canonical variate is obtained subject to the condition that they are uncorrelated with the first pair. The procedure is continued up to min (p, q) times. Subsequent analysis can reveal which individual observable variable or variables play a role in driving the correlation between each of linear composites. Canonical correlation appears to be a potentially important alternative tool to the study of economic integration. Yet this technique has not been employed in integration studies. However as Meyer (2003) points out that a connection between co-integration and canonical correlation exists and the multivariate co-integration approach of Johansen (1988) exploits this link. As most

time series economic and financial variable are non-stationary, the covariances and correlations between them are time dependent. Thus the application of CCA needs to be made on first differences of the variables so that correlation between composite variables is not affected by spurious canonical correlation. However in this case the CCA will uncover short term linkages. Level variables can be employed if non stationary time series variables in each set are co-integrated.

There are certain advantages of canonical correlation analysis as compared to the dynamic time series techniques. Firstly, whereas in integration and linkages studies dynamic time series techniques of VAR and co-integration employ a single country index returns or exchange rate series to represent that economy, the canonical correlation analysis accommodates a broader set of interlinked financial and macroeconomic variables. This is an important advantage since VAR and co-integration may not fully utilize the information provided by several interrelated variables related to the economy in linkages studies. Thus CCA may provide a potentially stronger measure of linkage. This canonical correlation based composite indicator of a country can also be used to rank countries with respect to their extent of global integration. The composite variables are essentially latent variables and so are not directly interpreted. The interpretation is facilitated by finding the correlation of observable macroeconomic and financial variables with the linear composite found.

Like all multivariate analysis techniques, the canonical correlation analysis is potentially an important technique for the analysis of large data sets since a total of $p \times q$ correlations in the two data sets are reduced to minimum of (p, q) canonical correlations representing several dimensions of the relationship. The actual number of correlations to analyze is even smaller since only a few large canonical correlations are found significant in most studies. Thus the

CCA can help facilitate the analysis of big data sets. In addition if there are a large number of variables in each data set, the CCA can be applied to principal components extracted from these data sets. According to Hair et al., (2005) canonical correlation can address a wide range of objectives.

Rencher and Christensen (2012) discuss the mathematical formulation of canonical correlation. The CCA analysis starts with computation of the overall partitioned covariance or correlation matrix. If variables differ in scale and variability the analysis needs to be performed using partitioned correlation matrix given by:

$$R = \begin{bmatrix} R_{yy} & R_{yx} \\ R_{xy} & R_{xx} \end{bmatrix}$$

Where R_{yy} is the $p \times p$ sample correlation matrix of the 'p' y variables and R_{yx} is the $p \times q$ matrix of the sample correlations between y variables and x variables. The following two characteristic equations are solved to yield 's' eigenvalues r_1^2, $r_2^2, \ldots r_s^2$

$$\left| R_{yy}^{-1} R_{yx} R_{xx}^{-1} R_{xy} - r^2 I \right| = 0 \qquad (1)$$

$$\left| R_{xx}^{-1} R_{xy} R_{yy}^{-1} R_{yx} - r^2 I \right| = 0 \qquad (2)$$

The positive square root of these eigenvalues provide the 's' canonical correlations $r_1, r_2, ..., r_s$ where $s = \min(p, q)$. The eigenvectors corresponding to the eigenvalues of (1) and (2) provide the weights in the 's' pairs of canonical variates $u_i = c_i' y$ and $v_i' = d_i' x$. These canonical variates $u_1, u_2, ..., u_s$ are uncorrelated. Similarly $v_1, v_2, ..., v_s$ are uncorrelated with each other and with u_i. The contribution of each eigenvalues is obtained by the relative size $r_i^2 \Big/ \sum_{j=1}^{s} r_j^2$. The importance of individual y and x variable in the

canonical correlation is provided by the standardized coefficients '*c*' and '*d*' of these variables. The first canonical correlation is the maximum correlation obtained from the linear composites that is:

$$r_1 = \underbrace{\max}_{c,d} corr(c'y, d'x)$$

The canonical functions are usually interpreted by examining the sign and magnitude of canonical coefficients of the standardized variable. The interpretation is similar to the beta coefficients of multiple regression. Variables with higher absolute weights contribute more to the corresponding canonical variate. For interpretation of CCA results researchers also use canonical loading, also called canonical structural correlation, which is the correlation between an original observed variable in the dependent or independent set and the set's canonical variate.

3. Literature Review

Investigating the global economic linkages to domestic economy possess the challenge of handling a large number of variables which requires estimating many parameters. Several econometric models are employed in the literature to handle the curse of dimensionality. These include the factor augmented VAR model, the dynamic factor model and more recently the global VAR model. Kose et al. (2003) investigated whether world economies are driven by a common business cycle. They used a Bayesian latent factor model for output, consumption and investment for 63 countries. Their results supported evidence that in most countries economic aggregates are driven by common business cycle while region specific factors play a relatively minor role. They found that oil price changes played an important role in increasing business cycle co-movements. It was

found that there are strong unilateral spillover effects from North America to the Euro area that were caused by increasing globalization and resulting financial market linkages. A variance decomposition analysis showed that the world factor explains a noticeable fraction of aggregate volatility in countries in Latin America, developed Asia, and Oceania, although it was less important in North America and Europe.

After the pioneering development of the global VAR model by Pesaran et al. (2004), many papers have based their empirical analysis on their methodology. Dees et al. (2007) used quarterly data from 1973 to 2003 to estimate a global VAR model using 33 countries (25 separate countries and 8 Euro area countries treated as one region). Thy used trade weighted foreign variables. Their simulation analysis indicates that financial linkages are quite strong as the financial shocks from the US to Europe are transmitted quite rapidly. They found that equity and bond markets seem to be far more synchronous as compared to real output, inflation and short-term interest rates. While the impact of an oil price shock on inflation is statistically significant, the impact on output remains limited despite some deterioration in the financing conditions through a tightening monetary policy, an increase in long-term interest rates and a decrease in real equity prices. They found that the effect of a change in US monetary policy to the euro area were statistically insignificant.

Greenwood-Nimmo et al. (2008) used quarterly data from 1980q1 to 2006q4 and constructed a global VAR model by combing 26 country or region specific models. They investigated the impact of oil price shock, a US monetary policy shock, a US stock market shock and a Chines inflationary shock on the Korean economy. They found

theoretically consistent effect of these global variables on the Korean economy. They found that oil price shock is inflationary and positive US stock market shock boost is associated with increasing Korean output. They found that the Chinese inflation passes through Korean economy quite rapidly.

Sun et al. (2013) investigate the regional interdependencies and propagation of real and financial shocks within the European countries using quarterly data from 2000q2 to 2011q4 by estimating a modified global VAR model of Pesaran et. al. (2004). Their model include real GDP growth, inflation, real credit growth and long term interest rate. They found evidence of strong co-movements in output growth and interest rates but somewhat weaker co-movements in inflation and credit growth. It was found that shocks originating from long term interest rates from the UK have strong impact on the long term interest rates in the euro area and Nordic countries, but have weak impact on Central, Eastern and Southern European (CESEE) countries.

Are Low-Income Developing Countries (LIDCs) more or less exposed to the international business cycle than emerging markets? This question was investigated by Biljanovska and Meyer-Cirkel (2016) using quarterly data from 1990q1 to 2013q4. They tested the transmission of business cycle fluctuations and credit conditions from advanced and emerging market economies to LIDCs using a global VAR framework and related country specific error correction models. Their impulse response analyses show that business cycles in oil and commodity exporting as well as in frontier LIDCs are more synchronized with those in emerging market economies. The credit conditions in the US economy are found to have a significant impact on exports and real economic activity in

LIDCs, while these variables are basically unresponsive to credit availability in emerging markets or economies in other parts of the world.

This paper intends to contribute to literature by employing the canonical correlation approach from of the multivariate statistics to investigate the global linkages of Pakistan's economy.

4. Empirical Analysis

We investigate empirically whether and to what extent Pakistan's economy is linked with the global economy. The previous studies aimed at exploring linkages have focused on an individual variable e.g. country stock market index. However the linkages between economies are derived by a multidimensional set of variables comprising many aspects of economy e.g. monetary, financial and real variables. Accordingly, we analyze the linkages of Pakistan's economy to the global economy using set of variables related to an economy. The variable relating global and Pakistani economy employed in this study are some key macroeconomic variables which are backed by literature. These variables include inflation rate, changes in industrial production index, changes in a short term interest rate, growth in exchange rate between local currency and the US dollar and percentage change in the stock market index returns and changes in total trade i.e. sum of exports and imports.

We use monthly data from Jan 1970 to April 2016. However depending on the data availability, the effective sample range is reduced for some country pairs. For example, longer reliable historical data on China are not available in international databases so the Pakistan-China pair has considerably lower sample size of 303 months. The data are obtained from various issues of International Financial Statistics (IFS), and the OECD database. Except for the short term interest rate, the variables are expressed in first

difference of log variables to avoid non-stationarity and spurious canonical correlations. The paper employs monthly data so that the impact of some highly volatile financial variables e.g. stock market index and exchange rate are uncovered. Use of annual data may lead to aggregation issues and possible veiling of short run fluctuations. The impact of global development on the local economy may not be reflected instantaneously especially from the non-financial sector. It was therefore decided to include some lags of local and global variables in both sets of canonical variables in addition to contemporaneous terms. To assess the number of lags to be used in the analysis the vector auto regression model was estimated for each local variable with each county's economic and financial variables. Using information criteria. It was found that first and second lag was sufficient in most cases. We therefore employ first and second lag of each variable as well.

4.1 Descriptive Statistics

Table 1 presents the means and standard deviations of the variables employed in the study. It can be observed that generally the variables corresponding to Pakistan are quite volatile as seen from standard deviations which are comparably higher than the developed countries. Average monthly inflation is seen to be higher in Pakistan and China as compared to the G-7 countries. China is observed to have the highest average industrial production growth during the sample period considered. Consistent with the stylized facts, the stock returns in developing countries Pakistan and China have higher averages and higher volatilities than the G-7 countries. The variability of interest rate changes is higher in Pakistan as compared to other countries. As the level of variability of the variables is not similar, the canonical correlations will be calculated for the

standardized variables which correspond to the use of correlation matrix rather than the covariance matrix in the analysis.

Table 1: Descriptive Statistics (% change of variables)

	Inflation	**Exchange Rate**	**Industrial Production**	**Interest Rate**	**Stock Price**	**Trade**
Pakistan (n = 464)						
Mean	0.631	0.508	0.517	-1.232	0.792	0.681
St. Dev	0.867	1.525	5.855	2.208	7.294	13.723
China (n = 303)						
Mean	0.713	0.072	1.064	-0.011	1.032	1.324
St. Dev	1.666	2.367	2.154	0.536	12.409	9.521
Canada (n=553)						
Mean	0.333	0.046	0.162	-0.015	0.453	0.593
St. Dev	0.434	1.418	1.080	0.515	4.067	3.982
France (n = 549)						
Mean	0.344	0.008	0.063	-0.020	0.483	0.621
St. Dev	0.400	2.558	1.418	0.447	5.537	3.469
Germany (n = 553)						
Mean	0.221	-0.133	0.131	-0.017	0.367	0.664
St. Dev	0.334	2.633	1.676	0.362	4.544	3.666
Italy (n =553)						
Mean	0.521	0.181	0.070	-0.009	0.395	0.623
St. Dev	0.545	2.565	2.093	0.571	5.967	6.741
Japan (n = 355)						
Mean	0.042	-0.091	0.034	-0.013	-0.015	0.349
St.Dev	0.378	2.650	1.927	0.133	4.982	3.835
UK (n = 457)						

Mean	0.326	0.065	0.039	-0.012	0.565	0.428
St.Dev	0.538	2.479	1.182	0.442	3.873	3.718
US (n = 554)						
Mean	0.332	-	0.174	-0.015	0.530	0.682
St.Dev	0.377	-	0.736	0.590	3.776	3.616

This table reports the mean and standard deviation of percentage change in the variables except the interest rate where the number refers to change from previous month

4.2 Tests of significance of canonical correlations

The tests of statistical significance of canonical correlations are used to indicate whether canonical correlation between pairs of local Pakistani variables are statistically significant with the G-7 countries and China. The four commonly employed tests are the Wilks Lambda, Pillai, Lawle-Hotelling and the Roy's largest root test. Exact critical values of these tests are provided in multivariate texts e.g. Rencher and Christension (2012). Statistical softwares also provide approximate F-tests. The Wilks Λ is the most popular test in this regard. The Wilks Λ test statistic is given by:

$$\Lambda = \prod_{i=1}^{s} (1 - r_i^2) \tag{3}$$

Where r_i^2 are the eigenvalues of the matrices appearing in eq (1) and eq (2). Table 2 reports the canonical correlations between pairs of Pakistan variables with China and G-7 countries and the associated approximate F-test and p-values of the test based on Wilks Lambda.

Table 2: Wilks Lambda test of significance of canonical correlations

	Canonical Variates Number	Canonical Correlation	F-statistic	Prob>F-statistic
Pak-China	1	0.543	1.258	0.002
Pak-Canada	1	0.479	1.367	0.000
Pak-France	1	0.420	1.457	0.000
	2	0.382	1.326	0.000
	3	0.356	1.221	0.010
Pak-Germany	1	0.419	1.439	0.000
	2	0.385	1.309	0.000
	3	0.353	1.196	0.021
Pak-Italy	1	0.405	1.258	0.001
Pak-Japan	1	0.551	1.666	0.000
	2	0.491	1.666	0.000
	3	0.449	1.426	0.000
Pak-UK	1	0.503	1.690	0.000
	2	0.447	1.434	0.000
	3	0.362	1.227	0.009
Pak-US	1	0.476	1.603	0.000
	2	0.403	1.319	0.001

The canonical correlation measures the strength of correlation between the optimal linear composite of economic and financial variables from Pakistan and the paired country. For example for China this is reported as 0.543. This corresponds to 29.4% (0.543^2) common variance in set of Pakistani canonical variate being explained by the Chinese canonical variate. The canonical correlation of Pakistani linear composites exceeds 0.5 for China, Japan and the UK. The F-Statistic corresponds to the test of jointly zero canonical

correlation between canonical variates and higher order. For example the test corresponding to canonical variate 2 indicates the joint significance of 2 through all higher order canonical correlations. The table reports only the significant canonical correlations for each country pair. It is observed that with each of the three countries namely France, Germany and UK Pakistan's economy is linked with three independent dimensions. In case of China, and Canada only one canonical dimension is significant. Thus it is observed that the linear composite of the macro and financial variables representing Pakistan's economy is significantly related to the China and the G-7 countries. The significant linkages of Pakistan's economy with the major global economies implies that managing Pakistan's economy is a challenging task since the policy makers need to keep them abreast with the development taking place in these economies. Concluding his research Mackowiak (2007) supports the view that the central question for policy in emerging markets is how to stabilize the economy in response to external shocks. Concluding his studies of impacts of the US monetary shocks on Latin American countries, Canova (2005) comments "the results of the investigation have important policy implications: putting the house in order is far from being sufficient to avoid cyclical fluctuations in Latin American economies. Given that the majority of domestic fluctuations are of foreign origin, Latin American policymakers are required to carefully monitor international conditions and to disentangle the informational content of the US disturbances in order to properly react to external imbalances". Depending on the results of the above analysis the subsequent analysis will focus on the contribution of individual variable that results in significant canonical correlations for each country pair with Pakistan.

4.3 Contribution of Individual variables

Having determined the significance of canonical correlations, the next important question is which of the individual macro and financial variables are important drivers of the significant canonical correlation. We can use coefficients of the standardized variables (also known as canonical weights). The use of standardized variables ensures that importance of the variables is not affected by the differences in scaling and scatterness of the variables. While canonical weights are strongly advocated for interpretation of contribution of individual variables by Rencher and Christensen (2012), some authors e.g. Black et al. (1995) and Stevens (2009) suggest the use of the correlation between individual observable variables and the associated canonical variates for interpretation. This correlation is also known as structural correlation or canonical loading and is similar in character to the factor-variable correlation in Factor Analysis. It is often the case that with large number of variables as in the present case, the interpretation of structural correlation can be difficult since many variables may be associated with moderate size correlations. In such cases Finn (1978) suggested to use rotated structural correlations as these rotated structural correlations are large only for a small number of variables thus improving interpretation. Table 3 presents the rotated (Varimax) structural correlation for Pakistani and foreign variables for the cases where the rotated structural absolute correlation exceeds 0.3 which corresponds to a moderately large correlation. Table 3 reveals some interesting findings. It is found that Pakistani economy is linked with different countries through quite varied channels. Inflation in Pakistan is seen to be associated with the two largest economies i.e. the US and China. Pakistani economy is found to be linked with Chines economy mainly through the consumer price channel.

Current and past two months higher consumer prices in China are associated with higher consumer price inflation in Pakistan. Whereas Pakistani economy is seen to be connected with Chines economy through consumer price inflation channel, the US economy is found to have multiple sources of linkages with Pakistan. Past month's industrial production growth and exchange rate appreciation in Pakistan are also seen to be connected with the past month's US trade growth. Consumer price inflation in Pakistan is also seen to be associated with Canadian consumer prices inflation. Pakistan is also seen to have multiple channels of linkages with Japan as found from the three canonical correlations. These are industrial production, stock market and trade channels. While the variables loadings for first canonical correlation are not easier to interpret the variables loaded on second canonical variate indicates past month's stock prices in Pakistan are strongly linked with stock price in Japan. Past month's trade in Japan is also associated with higher same month trade in Pakistan but with lower trade growth in the next month. Pakistan's connection with German and French economies are mainly with exchange rate and trade channels. Higher Italian inflation in the past months are associate with higher trade in the Pakistan in the past month. Pakistan's linkages with the UK is found to have multiple dimensions. Firstly, higher short term interest rate in the UK is associated with higher short term interest rate and lower trade growth in Pakistan. A dip in the UK pound two months earlier is associated with a decrease in trade growth in the same month but increasing trade growth in the subsequent month in Pakistan. The results of second and third canonical correlation indicate that the UK and Pakistan's currency bear a similar trend against the US dollar as depreciating UK pound is associated with similar

deprecation of Pakistan's rupee. It is to be mentioned that like any correlation, the correlations reported in Table 3 do not necessarily imply causation.

Table 3: Rotated Structural Correlation of Canonical Variates and Observable Variables Related to Pakistan and Foreign Country

Paired Countries	Pakistani Variables		Foreign Variables	
Pakistan-China (First Canonical Correlation)	Inflation	0.894	Inflation	0.649
			Inflation Lag1	0.754
			Inflation Lag2	0.944
Pakistan-Canada (First Canonical Correlation)	Inflation	0.985	Inflation	0.335
			Inflation Lag1	0.616
			Inflation Lag2	0.658
Pakistan-France (First Canonical Correlation)	Exchange Rate Lag2	0.953	Trade Lag2	-0.589
			Exchange Rate Lag1	0.335
			Exchange Rate Lag2	0.814
Pakistan-France (Second Canonical Correlation)	Exchange Rate Lag1	0.968	Stock Price Lag2	0.357
			Trade Lag1	-0.489
			Exchange Rate	0.334
			Exchange Rate Lag1	0.797
Pakistan-France (Third Canonical Correlation)	Exchange Rate	0.967	Trade	-0.538
			Exchange Rate	0.835
Pakistan-Germany (First Canonical Correlation)	Stock Price Lag2	0.942	Stock Price Lag1	0.433
			Stock Price Lag2	0.874
			Exchange Rate Lag2	0.324
Pakistan-Germany (Second Canonical Correlation)	Exchange Rate Lag2	0.937	Trade Lag2	-0.636
			Exchange Rate Lag1	0.342
			Exchange Rate Lag2	0.810
Pakistan-Germany (Third Canonical Correlation)	Exchange Rate Lag1	0.958	Trade Lag1	-0.650
			Exchange Rate	0.369
			Exchange Rate Lag1	0.710
Pakistan-Italy (First Canonical Correlation)	Trade Lag1	0.465	Inflation	0.783
			Inflation Lag1	0.941
			Inflation Lag2	0.863
Pakistan-Japan (First Canonical Correlation)	Industrial Production Lag1	0.634	Interest Rate	0.927
	Industrial Production Lag2	-0.714		
Pakistan-Japan (Second Canonical Correlation)	Stock Price Lag1	0.914	Stock Price Lag1	0.418
			Exchange Rate Lag1	0.889

Pakistan-Japan (Third Canonical Correlation)	Trade	-0.807	Trade Lag1	0.896
	Trade Lag1	0.580		
Pakistan-UK (First Canonical Correlation)	Interest Rate	0.319	Interest Rate	0.912
	Trade	-0.513	Exchange Rate Lag2	0.788
	Trade Lag1	0.866		
	Trade Lag2	-0.319		
Pakistan-UK (Second Canonical Correlation)	Inflation Lag2	-0.319	Trade Lag2	-0.640
	Exchange Rate Lag2	0.788	Exchange Rate Lag2	0.959
Pakistan-UK (Third Canonical Correlation)	Interest Rate Lag1	0.439	Trade Lag1	-0.652
	Trade Lag2	-0.319	Exchange Rate Lag1	0.915
	Exchange Rate Lag1	0.634		
Pakistan-US (First Canonical Correlation)	Inflation	0.632	Inflation Lag1	0.707
	Inflation Lag1	0.827	Inflation Lag2	0.885
Pakistan-US (Second Canonical Correlation)	Industrial Production Lag1	-0.503	Trade Lag1	0.816
	Industrial Production Lag2	0.707		
	Trade Lag2	0.342		
	Exchange Rate Lag1	-0.353		

4.4 Importance of Global Linkages to Pakistan

The above analysis was performed separately for each of the G-7 country and China. It is of interest to investigate the extent of variation of observable Pakistani macroeconomic and financial variables that is explained by the macroeconomy of all the eight countries together. However, the resulting dimension of covariance matrix is too large since 18 variables are to be used as independent variables from each country except in the case of US which involves 15 variables. In such cases it is prudent to use scores obtained by principal component to reduce dimension of data. We therefore extract principal component scores using the data from eight countries for each of the economic variables. Thus for example we extract a principal component using the inflation rates and their lag1 and lag2 for each of the G-7 countries and China. This principal component score is intended to represent the essential variation in the original inflation variables. Only the first two principal components were extracted as these represent the highest extracted variance from the original 24 inflation variables. Similarly the first two principal

component scores are extracted for exchange rate, industrial production, interest rate, stock price and trade variables. To investigate the extent of variation of individual Pakistani variables we performed a multivariate seemingly unrelated regression of the current month's Pakistani variables as dependent variables and the first two principal components scores extracted from foreign variables as independent variables. We also included oil prices and their two lags in the regression as foreign variables. Including oil price variables to some extent compensates the exclusion of Middle East countries in our analysis. These oil dependent Middle East countries also have important trade links with Pakistan.

$$y_j = \beta_0 + \beta_1 PC1Inf + \beta_2 PC2Inf + \beta_3 PC1ExRate + \beta_4 PC2ExRate + \beta_5 PC1Ind\,\mathrm{Pr}od + \beta_6 PC2Ind\,\mathrm{Pr} + \beta_7 PC1IntRate + \beta_8 PC2IntRate + \beta_9 PC1Stock\,\mathrm{Pr}ice + \beta_{10} PC2Stock\,\mathrm{Pr}ice + \beta_{11} PC1Trade + \beta_{12} PC2Trade + \beta_{13} Oil\,\mathrm{Pr}ice + \beta_{14} Oil\,\mathrm{Pr}iceLag1 + \beta_{15} Oil\,\mathrm{Pr}iceLag2 + \varepsilon_j \quad (4)$$

Here y_j represents each of the observable Pakistani variable. Thus (4) is a multivariate system of equations with identical right hand side variables. As such, each equation of this system of seemingly unrelated equations can be estimated separately by OLS which yields estimates which are same as the system estimate. The results are reported in Table 4.

Table 4: Variation in Pakistani Variables Explained by Principal Components of Foreign Variables

Pakistani Variable	R-Square (%)	F-Statistic	P-Value
Inflation	14.38	3.179	0.000
Exchange rate	10.58	2.240	0.005
Industrial production	4.57	0.906	0.557
Interest rate	3.24	0.634	0.845
Stock price	9.81	2.058	0.012
Trade	7.67	1.572	0.080

Table 4 indicates that significant important receivers of global short term economic shocks in Pakistan are consumer price inflation, exchange rate, stock price and trade (at 10% level). It is observed that about 14.38% variation in current month inflation in Pakistan is associated with economic linkages with the G-7 and China. The significant explanation of Pakistani inflation from foreign variables and oil prices can be explained both by cross-border linkages and common world shocks as postulated by Chowla et al. (2014). For example higher Chinese and the US inflation means Pakistan's import from these countries brings some of their inflation in Pakistan in the form of higher prices of imported goods. Also the oil prices shocks being world common shocks translate into higher inflation in Pakistan. It is therefore a more challenging task to control inflation by monetary authorities in Pakistan as a small but significant part of it is imported which is a results of changes in price of imported goods and services. It is observed that 10.58% variation in exchange rate and 9.81% variation in stock prices are associated with global linkages from China and G-7 countries. Thus the Pakistani investors are vulnerable to external financial shocks. A diversified portfolio of financial investment is necessary to curtail some of the risk associated with external shocks. This research indicates that in Pakistan price variables (i.e. consumer price, currency price i.e. exchange rate and stock price) have significantly high linkages with global economy. The financial markets in Pakistan appear to be significantly integrated into world financial markets as seen by significance of these variables. However real economic variables e.g. the manufacturing production is not seen to be affected by global business and economic conditions at least in the short run. Dees et al. (2007) also found similar results for real output in their study.

Trade is also found to be an important source of linkage between Pakistan and global economy.

5. CONCLUSION

This paper explores the channels of transmission of short term economic development in global economy to Pakistan. The paper applies the canonical correlation analysis for assessing the linkages of Pakistan's economy to the globe. A canonical correlation analysis was conducted on pairs of macroeconomic and financial variables relating to Pakistan, the G7 countries and China using monthly time series data for Jan 1970 to April 2016. The data on the G-7 countries and China are employed to represent a proxy of the major global economy variables. The Wilks Lambda test indicates that the canonical correlation between pair of Pakistani and eight countries are statistically significant. Pakistani economy is found to be connected with different countries through quite varied channels. Pakistan's short term linkages with the US, Canada and China are mainly through the consumer price inflation channel. Current and past two months higher consumer prices in the US and China are associated with higher consumer price inflation in Pakistan. We found multiple sources of linkages of Pakistan with the US economy. Past month's industrial production growth and exchange rate appreciation in Pakistan are also seen to be linked with the past month's US trade growth. In addition to the US, the industrial production in Pakistan has some linkages with Japan as well. Linkages with Japan are also reflected through stock market and trade channels. Pakistan's linkages with the UK is found to have multiple dimensions including short term interest rate,

exchange rate and trade growth. Pakistan's connection with German and French economies are mainly with exchange rate and trade channels.

We then focus on explaining the extent of variation in individual Pakistani variables that is attributed to eight global economies together. To achieve this we extracted principal component scores for each of the inflation, exchange rate, industrial production, interest rate, stock price and trade variables by employing the corresponding variables data from the eight countries and using these principal component scores together with oil prices as independent variables in a multivariate regression to explain the variation of Pakistani variables attributed to the global economy. It is found that only the inflation, exchange rate and stock prices and to a lesser extent trade are significantly explained by the extracted principal components related to the global economies and oil prices. Inflation seems to be an important source of international linkages in Pakistan. Approximately 14% variation in inflation in Pakistan is explained by global linkages. Forex and stock markets are also important source of global linkages. Trade is also found to be an important source linking global economy to Pakistan.

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