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Structure-Conduct-Performance (SCP) Paradigm: A VAR and VECM-based Granger Causality Analysis

Asad Abbas[1,2], Muhammad Ramzan Sheikh[3]

Abstract
This study has focused on Pakistan's manufacturing sector through the lens of the structure, conduct and performance (SCP) model over the period of 2004-2018. Three types of analyses i.e., SCP paradigm in a VAR framework, SCP paradigm in a Granger causality analysis through VAR framework and SCP paradigm in a VECM framework have been conducted. The pairwise Granger causality shows that there is bi-directional causality between structure and performance, conduct and performance and conduct and structure. The block exogeneity Wald test suggests that one-way causality is in the SCP paradigm. Three-panel cointegration tests i.e., Kao residual cointegration test, Johansen Fisher Panel cointegration test and Pedroni Residual Cointegration test confirm the existence of the long run relationship. VECM-based Granger causality exhibits the long run and short run causality in the SCP approach. The study suggests that all the stakeholders of SCP must formulate their policies by recognizing their mutual interdependence.
***Keywords*:** Concentration, Price-cost margin, Conjectural Variations

1. Introduction

The industrial sector plays an essential role in the economic development of a country. Economic growth and development stem from the strength and growth of the industrial sector. The industrial sector not only fulfils the domestic production needs of a country, if it operates efficiently, rather it also contributes significantly to the exports and subsequently the flow of foreign currency in a country which in turn enhances foreign reserves and helps in improving the balance of payment needs of a country (Abbas et al., 2015; Jamil, 2017 and Parvan et al., 2019).

The industrial sector in Pakistan is the second-largest sector in terms of contribution to the economy of Pakistan. The share of the industrial sector in the GDP of Pakistan is almost 25 percent. Major industries which constitute the industrial sector include textile, sports, sugar, cement and fertilizer industries (Arif and Awwaliyah, 2019). The development of the industrial sector causes growth in employment, production and investment. With the advent and adoption of new technologies and smart machinery, the productivity of workers in the industrial sector and productive efficiency are also increasing which in turn causes an increase in per-capita income and quantity of product. Availability of sufficient quantity, quality and variety of products improves also contributes to improving living standards and economic stability. The number of products beyond the domestic needs is used for export purposes and earn foreign currency which in turn is employed in the payment of debt and improving the balance of payment. Hence industrialization also causes structural changes in international trade and turns the balance in the favour of a country. Hence increase in employment, diversification, extension in government revenue and market, economic stability and subsequently political stability are among the outcome of industrial growth.

The Pakistani industrial sector is also a key sector which may lead the entire economy toward progress and development. Though the industrial sector is playing its part in the growth of the economy however this sector is suffering due to multiple internal and external factors including structural and performance-related issues (Begum, 2018; Bhattacharya, 2002; Chandra and Weinberg, 2018).

Amjad (1977) explains despite its fundamental role in the country's GDP Pakistani industrial sector suffers from various issues and inefficiencies due to which its effectiveness and competitiveness in the international market are adversely affected. Due to such inefficiencies, this sector has been unable to contribute to a desirable extent.

Khan and Hanif (2019) point out the common problem to which the Pakistani industrial sector is exposed, includes lack of investment and slow growth, lack of diversification and efficiency (both allocative and X-efficiency) poor quality of the products and services and low productivity of factor of production. Lack of innovation and standardization, low-value addition, high cost of production, the poor skill level of the workforce, the non-friendly attitude of the government, legal and regulatory framework challenges, weak and inefficient financial and other government institutions and capital markets, which in turn cause governance problems, poor infrastructure and power supply shortage are among other

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[2] Lecturer in Economics, COMSATS University Islamabad, Vehari Campus and PhD Student, School of Economics, Bahauddin Zakariya University Multan, Pakistan, Email: asad@cuivehari.edu.pk
[3] Corresponding Author: Associate Professor, School of Economics, Bahauddin Zakariya University Multan, Pakistan, Email: ramzansheikh@bzu.edu.pk

challenges which the country's industrial sector has to face. Due to such serious problems and grave concerns, our industrial sector loses its competitiveness in the international market and subsequently our exports suffer which in turn deteriorates our balance of payments (Pattitoni et al., 2014; Yoon, 2004 and Talpur et al., 2016).

The majority of the above-mentioned problems are either related to the structure of the market or the market conduct or performance. Hence if the paradigm of structure, conduct and performance is studied it may encompass almost the entire industrial sector. Hence study may serve the purpose of highlighting key issues and suggesting solutions and efficiencies for the sake of improvement. It can provide important insights and solutions to researchers and the market. This study is an effort to resolve the modelling problem of the structure-conduct performance hypothesis. The following paragraphs highlight the details of this paradigm and the nature of the relationship that exists among these factors and suggest the research gap.

The SCP paradigm points out that industry is based on three fundamentally associated aspects. The causal link of SCP exhibits that firstly the structure indicators i.e., number of sellers and buyers, concentration, barriers to entry, diversification, minimum efficient scale and product differentiation 'causes' to influence the conduct (behavior) of the firms in a certain direction in the form of collusion, advertisement activities, strategic behavior and R&D and finally the conduct 'causes' to affect market performance which is measured by the price-cost margin, efficiency, profits, Tobin-q etc (Abbas & Sheikh., 2021)

It is an admitted fact that one-way causality is the best but incomplete view of the SCP paradigm. Based on feedback critique, a one-way causality among structure, conduct and performance is not a better explanation of the SCP approach as all the factors of SCP are interconnected. These three aspects may influence each other rather than saying that structure affects conduct and conduct influences the performance, conduct may affect the structure, and performance influences conduct and structure. The SCP approach and feedback critique are strongly linked with the 'five forces framework' that identifies that there are five interrelated forces i.e. entry of firms, input suppliers' power, buyers' power, industry rivalry, and substitutes and complements (Arif and Awwaliyah, 2019; Chin and Lin, 2015 and Bhayani, 2010).

The rest of the paper is organised as Section 2 specifies the model in three ways i.e. i) structure-conduct-performance paradigm in a VAR framework ii) structure-conduct-performance paradigm in a Granger causality analysis through VAR framework and iii) structure-conduct-performance paradigm in a VECM framework. Section 3 explains the sources and description of the data. Section 4 shows results and discussions while finally in section 5, we have presented the conclusion and policy implications.

2. Model Specification and Methodology

In economics, it is not uncommon to observe that many times the dependent variable of the model is explained by the set of explanatory variable(s). Further, it is quite possible that in some cases models where a few variables are not only explanatory variables for a particular dependent variable, but these are also determined by the dependent variable(s). In this scenario, we apply a system of simultaneous equations to identify the endogenous and exogenous variables of the models. It is noteworthy to mention here that such type of determination between the nature of variables is highly criticized by Sims (1980).

2.1 Structure-Conduct-Performance Paradigm: A VAR Framework

Sims (1980) thrashed out that all the variables should be treated as endogenous variables in case of simultaneity issue exists. So, each equation in its reduced form contains the same set of covariates which results in the evolution of the VAR models.

Sims (1980) also suggest that when the nature of the variable in terms of exogeneity is not vivid, we must consider each variable symmetrically. To investigate the one-way or two-way causality of SCP-related variables within a VAR framework, we have the simple tri-variate model in which each variable of SCP is influenced by its previous values along with current and previous values of other variables, given by:

$$PCM_{it} = \alpha_{10} + \lambda_{12}CONJ_{it} + \lambda_{13}HHI_{it} + \beta_{11}PCM_{it-1} + \beta_{12}CONJ_{it-1} + \beta_{13}HHI_{it-1} + \gamma_{11}PCM_{it-2} + \gamma_{12}CONJ_{it-2} + \gamma_{13}HHI_{it-2} + \theta_{11}PCM_{it-3} + \theta_{12}CONJ_{it-3} + \theta_{13}HHI_{it-3} + \mu_{PCM_{it}} \quad (1)$$

$$CONJ_{it} = \alpha_{20} + \lambda_{21}PCM_{it} + \lambda_{23}HHI_{it} + \beta_{21}PCM_{it-1} + \beta_{22}CONJ_{it-1} + \beta_{23}HHI_{it-1} + \gamma_{21}PCM_{it-2} + \gamma_{22}CONJ_{it-2} + \gamma_{23}HHI_{it-2} + \theta_{21}PCM_{it-3} + \theta_{22}CONJ_{it-3} + \theta_{23}HHI_{it-3} + \mu_{CONJ_{it}} \quad (2)$$

$$HHI_{it} = \alpha_{30} + \lambda_{31}PCM_{it} + \lambda_{32}CONJ_{it} + \beta_{31}PCM_{it-1} + \beta_{32}CONJ_{it-1} + \beta_{33}HHI_{it-1} + \gamma_{31}PCM_{it-2} + \gamma_{32}CONJ_{it-2} + \gamma_{33}HHI_{it-2} + \theta_{31}PCM_{it-3} + \theta_{32}CONJ_{it-3} + \theta_{33}HHI_{it-3} + \mu_{HHI_{it}} \quad (3)$$

Assuming that the variables related to SCP are stationary and their error terms follow the white noise process. The equations (1, 2 and 3) represent the third-order structural or primitive VAR model as the optimal lag length[4] is 3. Equation (1) shows the contemporaneous impact of conjecture variations (conduct) given by λ_{12} and concentration (structure) given by λ_{13} on price-cost margin (performance). Equation (2) indicates the contemporaneous impact of price-cost margin (performance) given by λ_{21} and concentration (structure) given by λ_{23} on conjecture variations (conduct). Similarly, equation (3) denotes the contemporaneous impact of price-cost margin (performance) given by λ_{31} and conjecture variations (conduct) given by λ_{32} on concentration (structure). After factoring out the contemporaneous effect, we have:

$$PCM_{it} - \lambda_{12}CONJ_{it} - \lambda_{13}HHI_{it} = \alpha_{10} + \beta_{11}PCM_{it-1} + \beta_{12}CONJ_{it-1} + \beta_{13}HHI_{it-1} + \gamma_{11}PCM_{it-2} + \gamma_{12}CONJ_{it-2} + \gamma_{13}HHI_{it-2} + \theta_{11}PCM_{it-3} + \theta_{12}CONJ_{it-3} + \theta_{13}HHI_{it-3} + \mu_{PCM_{it}} \quad (4)$$

$$-\lambda_{21}PCM_{it} + CONJ_{it} - \lambda_{23}HHI_{it} = \alpha_{20} + \beta_{21}PCM_{it-1} + \beta_{22}CONJ_{it-1} + \beta_{23}HHI_{it-1} + \gamma_{21}PCM_{it-2} + \gamma_{22}CONJ_{it-2} + \gamma_{23}HHI_{it-2} + \theta_{21}PCM_{it-3} + \theta_{22}CONJ_{it-3} + \theta_{23}HHI_{it-3} + \mu_{CONJ_{it}} \quad (5)$$

$$-\lambda_{31}PCM_{it} - \lambda_{32}CONJ_{it} + HHI_{it} = \alpha_{30} + \beta_{31}PCM_{it-1} + \beta_{32}CONJ_{it-1} + \beta_{33}HHI_{it-1} + \gamma_{31}PCM_{it-2} + \gamma_{32}CONJ_{it-2} + \gamma_{33}HHI_{it-2} + \theta_{31}PCM_{it-3} + \theta_{32}CONJ_{it-3} + \theta_{33}HHI_{it-3} + \mu_{HHI_{it}} \quad (6)$$

Rewriting the system of equations by using matrix algebra, we get:

$$\begin{bmatrix} 1 & -\lambda_{12} & -\lambda_{13} \\ -\lambda_{21} & 1 & -\lambda_{23} \\ -\lambda_{31} & -\lambda_{32} & 1 \end{bmatrix} \begin{bmatrix} PCM_{it} \\ CONJ_{it} \\ HHI_{it} \end{bmatrix} = \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \\ \alpha_{30} \end{bmatrix} + \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} \\ \beta_{21} & \beta_{22} & \beta_{23} \\ \beta_{31} & \beta_{32} & \beta_{33} \end{bmatrix} \begin{bmatrix} PCM_{it-1} \\ CONJ_{it-1} \\ HHI_{it-1} \end{bmatrix} + \begin{bmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} \\ \gamma_{21} & \gamma_{22} & \gamma_{23} \\ \gamma_{31} & \gamma_{32} & \gamma_{33} \end{bmatrix} \begin{bmatrix} PCM_{it-2} \\ CONJ_{it-2} \\ HHI_{it-2} \end{bmatrix} + \begin{bmatrix} \theta_{11} & \theta_{12} & \theta_{13} \\ \theta_{21} & \theta_{22} & \theta_{23} \\ \theta_{31} & \theta_{32} & \theta_{33} \end{bmatrix} \begin{bmatrix} PCM_{it-3} \\ CONJ_{it-3} \\ HHI_{it-3} \end{bmatrix} + \begin{bmatrix} \mu_{PCM_{it}} \\ \mu_{CONJ_{it}} \\ \mu_{HHI_{it}} \end{bmatrix} \quad (7)$$

$$LZ_{it} = A + BZ_{it-1} + GZ_{it-2} + TZ_{it-3} + \mu_{it} \quad (8)$$

$$Z_{it} = L^{-1}A + L^{-1}BZ_{it-1} + L^{-1}GZ_{it-2} + L^{-1}TZ_{it-3} + L^{-1}\mu_{it} \quad (9)$$

$$Z_{it} = D_0 + H_1Z_{it-1} + T_2Z_{it-2} + S_3Z_{it-3} + \varepsilon_{it} \quad (10)$$

We use equation (10) to rewrite system of equations in VAR in reduced form:

$$PCM_{it} = \delta_{10} + \eta_{11}PCM_{it-1} + \eta_{12}CONJ_{it-1} + \eta_{13}HHI_{it-1} + \tau_{11}PCM_{it-2} + \tau_{12}CONJ_{it-2} + \tau_{13}HHI_{it-2} + \sigma_{11}PCM_{it-3} + \sigma_{12}CONJ_{it-3} + \sigma_{13}HHI_{it-3} + \varepsilon_{PCM_{it}} \quad (11)$$

$$CONJ_{it} = \delta_{20} + \eta_{21}PCM_{it-1} + \eta_{22}CONJ_{it-1} + \eta_{23}HHI_{it-1} + \tau_{21}PCM_{it-2} + \tau_{22}CONJ_{it-2} + \tau_{23}HHI_{it-2} + \sigma_{21}PCM_{it-3} + \sigma_{22}CONJ_{it-3} + \sigma_{23}HHI_{it-3} + \varepsilon_{CONJ_{it}} \quad (12)$$

$$HHI_{it} = \delta_{30} + \eta_{31}PCM_{it-1} + \eta_{32}CONJ_{it-1} + \eta_{33}HHI_{it-1} + \tau_{31}PCM_{it-2} + \tau_{32}CONJ_{it-2} + \tau_{33}HHI_{it-2} + \sigma_{31}PCM_{it-3} + \sigma_{32}CONJ_{it-3} + \sigma_{33}HHI_{it-3} + \varepsilon_{HHI_{it}} \quad (13)$$

In other words, the vector of all the variables would appear in the level form on the left side of the VAR model, while the lag of the vector of these left-hand side variables would appear on the right-hand side of the VAR model along with the vector of constants and matrices of coefficients.

2.2 Structure-Conduct-Performance Paradigm: A Granger Causality Analysis in VAR Framework

Causality means the degree of capability of one variable to predict the other variable. Granger (1969) defined causality as: *"a variable Y_t is said to Granger-cause X_t, if X_t can be predicted with greater accuracy by using past values of the Y_t variable rather than not using such past values, all other terms remaining unchanged".*

Granger (1969) has suggested two types of causality i.e., pairwise causality and block exogeneity Wald test-based causality.

The Granger causality test for SCP stationary variables in the following reduced or standard form VAR model:

$$PCM_{it} = \alpha_1 + \sum_{i=1}^{p}\beta_i PCM_{it-i} + \sum_{j=1}^{q}\gamma_j HHI_{it-j} + \sum_{k=1}^{r}\theta_k CONJ_{it-k} + \mu_{PCM_{it}} \quad (14)$$

$$CONJ_{it} = \alpha_2 + \sum_{i=1}^{p}\eta_i PCM_{it-i} + \sum_{j=1}^{q}\xi_j HHI_{it-j} + \sum_{k=1}^{r}\psi_k CONJ_{it-k} + \mu_{CONJ_{it}} \quad (15)$$

$$HHI_{it} = \alpha_3 + \sum_{i=1}^{p}\delta_i PCM_{it-i} + \sum_{j=1}^{q}\lambda_j HHI_{it-j} + \sum_{k=1}^{r}\varphi_k CONJ_{it-k} + \mu_{HHI_{it}} \quad (16)$$

To check the Granger causality, the null and alternative hypotheses are:

[4] See Table 3 and 4 for the results of optimal lag length.

$$For\ PCM:\ H0:\sum_{j=1}^{q}\gamma_j=\sum_{k=1}^{r}\theta_k=0\ ,H1:\sum_{j=1}^{q}\gamma_j=\sum_{k=1}^{r}\theta_k\neq 0$$

$$For\,CONJ:H0:\sum_{i=1}^{p}\eta_i=\sum_{j=1}^{q}\xi_j=0\ ,\ H1:\sum_{i=1}^{p}\eta_i=\sum_{j=1}^{q}\xi_j\neq 0$$

$$For\,HHI:H0:\sum_{i=1}^{p}\delta_i=\sum_{k=1}^{r}\phi_k=0\ ,\ H1:\sum_{i=1}^{p}\delta_i=\sum_{k=1}^{r}\phi_k\neq 0$$

2.3 Structure-Conduct-Performance Paradigm: A VECM Framework

To find the short-run and long-run causality, it is worthwhile to reparametrize the conventional Granger causality model in the equivalent ECM form as follows:

$$\Delta PCM_{it}=\alpha_1+\sum_{i=1}^{p-1}\beta_i\Delta PCM_{it-i}+\sum_{j=0}^{q-1}\gamma_j\Delta HHI_{it-j}+\sum_{k=0}^{r-1}\theta_k\Delta CONJ_{it-k}+\pi\hat{\varepsilon}_{it-1}+\mu_{PCM_{it}} \quad (17)$$

$$\Delta CONJ_{it}=\alpha_2+\sum_{i=0}^{p-1}\eta_i\Delta PCM_{it-i}+\sum_{j=0}^{q-1}\xi_j\Delta HHI_{it-j}+\sum_{k=1}^{r-1}\psi_k\Delta CONJ_{it-k}+\pi\hat{\varepsilon}_{it-1}+\mu_{CONJ_{it}} \quad (18)$$

$$\Delta HHI_{it}=\alpha_3+\sum_{i=0}^{p-1}\delta_i\Delta PCM_{it-i}+\sum_{j=1}^{q-1}\lambda_j\Delta HHI_{it-j}+\sum_{k=0}^{r-1}\varphi_k\Delta CONJ_{it-k}+\pi\hat{\varepsilon}_{it-1}+\mu_{HHI_{it}} \quad (19)$$

Where: $\pi\hat{\varepsilon}_{it-1}$ are long-run causality parameters or error correction coefficients or adjustment coefficients and explains that in what frequency of time, the error would be corrected or speed of adjustment towards equilibrium while the other parameters starting with lag zero are short-run parameters in every equation.

3. Data: Sources and Description

In the current study, the data are collected from 'Balance Sheet Analysis of Joint Stock companies listed on Karachi Stock Exchange', The report is published by the State Bank of Pakistan (SBP). The data of 280 firms are collected from the fifteen (15) different industries which belong to non-financial sectors (i.e., the manufacturing sector) only. The data are gathered from these industries: Services Activities; Electrical Machinery & Apparatus; Paperboard & Products; Petroleum Products; Information, Communication & Transport; Fuel & Energy; Motor Vehicles, Trailers & Auto Parts; Cement; Mineral Products; Manufacturing; Chemicals & Pharmaceuticals; Sugar; Spinning& Weaving; Finishing; and Made-up &Other Textile. The criterion that is used in the current study for the selection of the firm are:

a. The data of each variable of each firm for the complete period have been taken i.e., balanced panel.
b. The description of the product or its substitutes products that comply with the theoretical definition of industry

The selection of firms varies from each sector as per the above criterion, a minimum of five (5) firms and a maximum of thirty-five (35) firms are finalized as the sample. If the selection of firms is followed by the classification defined by the State Bank of Pakistan (SBP), which becomes the reason for deviations from the theoretical definition of the industry. The firm belongs to different industries that are involved in production activities and may differ from other industries, so, the definition of homogeneous product is not applicable in this case.

The definition of each variable is explained along with the method of their calculation and the source of the collection of data is reported in Table 1.

Table 1: Description and Measurement of Variable

Variable	Abbreviation	Description and Measurement
Hirschinann-Herfindahl index	HHI	Sum of the square of market share of all the firms in the industry. It is measured in terms of ratio.
Price-Cost-Margin	PCM	Gross profit is arrived at by subtracting the cost of sales from sales revenue. By taking the ratio of Gross profit from its gross sales, we get the Price-Cost-Margin(PCM) of a particular Firm.
Conjectural Variation	CONJ	The conjectural variation is measured as the inverse of market share less one. $\lambda_i=\frac{Y}{y_i}-1$

Table 2: Results of Panel Unit Root Tests (on Level)

Variable	Structure of Equation	LLC Test	ADF-Fisher Test	PP-Fisher Test	IPS Test	Conclusion
PCM	Intercept	3.72968 (0.9999)	754.823 (0.0000)	1081.03 (0.0000)	-2.6448 (0.0041)	Stationary
HHI		-0.1281 (0.4490)	521.921 (0.8608)	794.137 (0.1945)	2.8882 (0.9981)	Stationary
CONJ		-6.3467 (0.5608)	723.040 (0.1267)	982.245 (0.3467)	-3.9283 (0.4316)	Stationary
PCM	Intercept and Trend	4.59964 (1.0000)	630.782 (0.0058)	1127.67 (0.4500)	0.56346 (0.7134)	Stationary
HHI		-12.160 (0.8942)	692.581 (0.4001)	957.032 (0.2001)	-2.8407 (0.1023)	Stationary
CONJ		-9.3124 (0.1269)	728.258 (0.9923)	10057.93 (0.4488)	-4.1711 (0.6587)	Stationary
PCM	None	-7.1467 (0.2301)	603.718 (0.2706)	841.206 (0.4901)	---	Stationary
HHI		8.23247 (0.0051)	227.032 0.0000)	273.560 (0.9912)	---	Stationary
CONJ		-6.9495 (0.2234)	648.524 (0.1047)	831.116 (0.1005)	---	Stationary

4. Results and Discussions

Now we explain the results of the Structure-Conduct-Performance (SCP) Paradigm which we have found after applying VAR and VECM-based Granger Causality tests.

4.1 Testing for Unit Root

Mostly, the extended DF and ADF unit-root tests are used in the panel unit-root tests by considering the degree of heterogeneity in panel regressions because all cross-sections in the panel may or may not have stationary or non-stationary series. The famous four-panel unit root tests i.e., LLC test, IPS test, ADF-Fisher test and PP-Fisher test are applied by considering three structures (intercept, intercept and trend, none) of a particular equation except IPS test in the 'none' equation. Table 2 exhibits the results of panel unit root tests.

All the tests in all the specifications show that the order of integration of the variables in level form is zero meaning that there is no unit root[5] or the series is stationary at a level so no need to take the difference between the series to make it stationary.

4.2 Optimal Lag Length Criteria

The next step is to check is optimal lag length criterion. Optimal lag length is vital to have a standard normal error or the Gaussian error term. If the optimal lag length is not chosen, it shows the omitted variable bias and resultantly the error term is not free from autocorrelation, non-normality, heteroskedasticity etc. So, to overcome the model specification bias, we have to be careful in choosing the optimal lag length. According to the two mostly used criteria AIC and SBC, the optimal lag length would be selected at the minimum or lowest value of AIC and SBC. Table 3 displays the results of VAR-based lag order selection criteria.

All the lag order selection criteria except the log-likelihood criterion suggest that the optimal lag is 3 for the causality and cointegration analysis of the Structure-Conduct-Performance (SCP) Paradigm. As five out of six criteria suggest that the optimal lag length is 3 but the log-likelihood criterion proposes that the optimal lag length is 4 so there is no consensus among the various criteria and log-likelihood criterion.

[5] In all the equations of panel unit root tests, we test the hypothesis that the root of the coefficient of lag variable of dependent variable is unit or not. The term 'unit root' indicates to the root of the polynomial in lag operator. If (1-L=0), L=1 so the name is unit root.

To authenticate the results of the VAR-based lag order selection criteria, we have also applied the VAR-based lag exclusion criterion. Table 4 shows the results of VAR based lag exclusion criterion which represents lag exclusion tests for each lag in the VAR, based on the chi-square Wald statistic for every equation individually and jointly.

Table 3: VAR-Based Lag Order Selection Criteria

Endogenous variables: PCM HHI CONJ, Exogenous variables: C						
Sample: 2004 2018, Observations: 4180						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-17549.4	NA	62.03	12.64	12.65	12.64
1	-12138.33	10806.56	1.27	8.75	8.78	8.76
2	-12044.38	187.42	1.19	8.69	8.73	8.71
3	-12004.13	80.21*	1.17*	8.67*	8.73*	8.69*
4	-11995.73*	16.73	1.17	8.67	8.75	8.70

Table 4: VAR-Based Lag Exclusion Criterion

VAR Lag Exclusion Wald Tests				
Endogenous variables: PCM HHI CONJ, Exogenous variables: C				
Sample: 2004 2018, Included observations: 4180				
	PCM	HHI	CONJ	Joint
Lag 1	140.07 (0.0000)	2331.39 (0.0000)	1595.33 (0.0000)	4038.79 (0.0000)
Lag 2	95.01 (0.0000)	4.83 (0.1846)	7.39 (0.0603)	102.44 (0.0000)
Lag 3	20.3301 (0.0001)	3.1960 (0.3624)	15.8477 (0.0012)	40.3956 (0.0000)
Lag 4	3.98 (0.2715)	1.63 (0.6508)	10.15 (0.0173)	16.76 (0.1525)

According to lags 1, 2 and 3, we may reject the null hypothesis of excluded lag structure for PCM, HHI, CONJ and for jointly three variables. At lag 4, we are unable to reject the null hypothesis of excluded lag structure for PCM, HHI, CONJ and for jointly three variables. So, we have again found that the optimal lag is 3.

4.3 VAR-based Granger Causality

We have computed the pairwise Granger causality as it assumes the pair of two endogenous variables and the Block Exogeneity Wald test Based on the VAR framework. Table 5 demonstrates the results of the pairwise Granger causality test for three Lag structures.

Table 5: Pairwise Granger Causality Test for different Lag Structures

H_0	Lag	F-Statistic	Prob	Decision	Outcome	Direction of Causality
HHI ⇏ PCM	1	0.4989	0.0480	Reject H_o	HHI → PCM	One Way
PCM ⇏HHI		0.5880	0.4432	Do Not Reject H_o	PCM ⇏HHI	
CONJ ⇏PCM		17.2228	0.0000	Reject H_o	CONJ →PCM	Two Way
PCM ⇏CONJ		14.1575	0.0002	Reject H_o	PCM → CONJ	
CONJ ⇏HHI		0.6987	0.0330	Reject H_o	CONJ → HHI	Two Way
HHI ⇏CONJ		0.1305	0.0179	Reject H_o	HHI →CONJ	
HHI ⇏ PCM	2	0.0641	0.0379	Reject H_o	HHI → PCM	One Way
PCM ⇏HHI		0.4963	0.6088	Do Not Reject H_o	PCM → HHI	
CONJ ⇏PCM		11.5038	0.0000	Reject H_o	CONJ →PCM	Two Way
PCM ⇏CONJ		7.6074	0.0005	Reject H_o	PCM → CONJ	
CONJ ⇏HHI		0.2364	0.0095	Reject H_o	CONJ → HHI	Two Way
HHI ⇏CONJ		0.7600	0.0677	Reject H_o	HHI →CONJ	
HHI ⇏ PCM	3	1.9557	0.0185	Reject H_o	HHI → PCM	Two Way
PCM ⇏HHI		0.3511	0.0883	Reject H_o	PCM → HHI	
CONJ ⇏PCM		8.7135	0.0000	Reject H_o	CONJ →PCM	Two Way
PCM ⇏CONJ		5.9873	0.0005	Reject H_o	PCM → CONJ	
CONJ ⇏HHI		0.2183	0.0038	Reject H_o	CONJ → HHI	Two Way

HHI $\nRightarrow$ CONJ		2.0113	0.0002	Reject H_o	HHI → CONJ	

The results show that for optimal lag which is 3, there is bi-variate causality between structure and performance (HHI↔PCM), conduct and performance (CONJ↔PCM) and conduct and structure (CONJ↔HHI).

Now we explain the results of the block exogeneity Wald test which excludes the lagged regressors one by one firstly and then all the lagged regressors in all for estimating each equation in the VAR model. Table 6 shows findings of block exogeneity Wald test based on VAR Granger causality.

Table 6: Block Exogeneity Wald test Based on VAR Granger Causality

VAR Based Block	Excluded	χ^2 Statistic	Prob	Decision	Outcome	Direction of Causality
PCM	HHI	4.7720	0.0731	Included	HHI_{it-i} → PCM	One Way
	CONJ	25.0183	0.0000	Included	$CONJ_{it-j}$ → PCM	One Way
	ALL	30.9275	0.0000	Included	HHI_{it-i} & $CONJ_{it-j}$ → PCM	One Way
HHI	PCM	1.5399	0.1093	Included	PCM_{it-i} → HHI	One Way
	CONJ	3.8501	0.0781	Included	$CONJ_{it-k}$ → HHI	One Way
	ALL	4.9037	0.0562	Included	PCM_{it-i} & $CONJ_{it-k}$ → HHI	One Way
CONJ	PCM	17.7155	0.0005	Included	PCM_{it-i} → CONJ	One Way
	HHI	6.1327	0.1053	Included	HHI_{it-j} → CONJ	One Way
	ALL	24.1129	0.0005	Included	PCM_{it-i} & HHI_{it-j} → CONJ	One Way

In Table 6, the first block of the VAR model is about the performance in which PCM is the dependent variable while conjectural variations, concentration and both conjectural variations, concentration are independent variables. The null hypothesis of the block exogeneity Wald test is that a particular independent is excluded from the equation. The results indicate that both the independent variables are included separately and jointly in the equation of the performance block, so a univariate causality exists. In the second block, HHI is the dependent variable and price-cost margin, conjectural variations and both price-cost margin and conjectural variations are independent variables. The findings suggest that there is no exclusion of variables. The third block is about conjectural variations along with price-cost margin and concentration. The results again confirm the univariate causality. Our results are in line with the studies see, for example, Talpur et al., 2016; Mohamed et al., 2015 and Ullah et al., 2020; Ali, 2022.

4.4 Testing for Cointegration

Cointegration testing is necessary to avoid spurious regression which is an issue of non-stationarity. Almost all the panel cointegration tests have roots in the relationship given by Engle and Granger (1987) which explain that if the variables have cointegration, an error-correcting formulation always exists in the dynamic model and the reverse is true. We have applied three-panel cointegration tests i) Kao residual cointegration tests ii) Johansen Fisher Panel cointegration test and iii) Pedroni Residual Cointegration test to test the cointegration relationship[6]. Table 7 indicates the results of Kao residual and Johansen Fisher panel cointegration tests for the SCP model.

Table 7: Kao Residual and Johansen Fisher Panel Cointegration Tests for SCP Model

Kao Residual Cointegration Test				
Augmented Dickey-Fuller Test Equation, Included Series: PCM HHI CONJ				
Sample: 2004 2018, Included observations: 4185				
Trend assumption: No deterministic trend				
Null Hypothesis		ADF τ – Statistic		Prob.
No Cointegration		5.4643		0.0000
Johansen Fisher Panel Cointegration Test				
Hypothesized No. of CE(s)	λ - trace test	Prob.	λ - max-Eigen test	Prob.
None	2756	0.0000	2355	0.0000
At most 1	1064	0.0000	928.2	0.0000

6 Kao (1999) test is DF and ADF residual-based test and presumes the homogeneity between individuals in cointegration vectors. It also assumes the long-run covariance remains the same across individuals. Pedroni (1999, 2004) test is also residual-based and allows individual heterogeneous fixed effects and trend terms. Johansen Fisher Panel Cointegration test is on the other hand is maximum likelihood method and based on λ - trace test and λ - max-Eigen test. We have applied these three tests for robustness of the results.

At most 2	814.1	0.0000	814.1	0.0000

Table 8: Pedroni Residual Cointegration Test for SCP Model

Null Hypothesis: No Cointegration, Series: PCM HHI CONJ					
Sample: 2004 2018, Cross-sections included: 277 (2 dropped), Included observations: 4185					
Trend Assumption	Test Statistic	Calculated Value	Prob.	Weighted Statistic	Prob.
	Alternative hypothesis: common AR coefs. (within-dimension)				
No deterministic trend	Panel v-Statistic	20.5706	0.0000	-3.5827	0.9998
	Panel rho-Statistic	-10.6726	0.0000	-1.9122	0.0279
	Panel PP-Statistic	-27.4298	0.0000	-15.7266	0.0000
	Panel ADF-Statistic	-4.5245	0.0000	-10.0415	0.0000
	Alternative hypothesis: individual AR coefs. (between-dimension)				
	Group rho-Statistic	4.7697	1.0000		
	Group PP-Statistic	-19.2086	0.0000		
	Group ADF-Statistic	-7.2234	0.0000		
Deterministic intercept and trend	Alternative hypothesis: common AR coefs. (within-dimension)				
	Panel v-Statistic	8.0038	0.0000	-12.0398	1.0000
	Panel rho-Statistic	-4.7196	0.0000	5.7167	1.0000
	Panel PP-Statistic	-26.9252	0.0000	-19.0487	0.0000
	Panel ADF-Statistic	2.5353	0.9944	-12.1786	0.0000
	Alternative hypothesis: individual AR coefs. (between-dimension)				
	Group rho-Statistic	11.5999	1.0000		
	Group PP-Statistic	-23.8516	0.0000		
	Group ADF-Statistic	-7.9491	0.0000		
No deterministic intercept or trend	Alternative hypothesis: common AR coefs. (within-dimension)				
	Panel v-Statistic	31.9721	0.0000	-3.5470	0.9998
	Panel rho-Statistic	-13.7725	0.0000	-5.1538	0.0000
	Panel PP-Statistic	-22.6269	0.0000	-12.2089	0.0000
	Panel ADF-Statistic	-16.6649	0.0000	-5.7868	0.0000
	Alternative hypothesis: individual AR coefs. (between-dimension)				
	Group rho-Statistic	-0.0798	0.4682		
	Group PP-Statistic	-18.8600	0.0000		
	Group ADF-Statistic	-7.7752	0.0000		

The results of the Kao Residual cointegration test indicate that cointegration exists in PCM HHI and CONJ. Johansen Fisher's panel cointegration test also supports cointegration.

Table 8 exhibits the results of the Pedroni Residual cointegration test. The results of the Pedroni residual cointegration test under ‘no deterministic trend’ exhibit the existence of cointegration in 9 out of 11 test statistics. In the ‘deterministic intercept and trend’ assumption, 8 out of 11 test statistics support the cointegration relationship while in the ‘no deterministic intercept or trend’ assumption, 9 out of 11 test statistics validate the existence of cointegration. So, we may conclude that Pedroni residual cointegration test in its three assumptions shows the existence of cointegration in most of the test statistics.

Table 9: Long-run Causality for SCP Model in VECM Framework

Coefficient	Variable	Coefficient	Std. Error	t-Stat.	Prob.
VECM of SCP Model, DV=D(PCM)					
C(1)	ECT	-0.2551	0.0403	-6.3242	0.0000
C(2)	D(PCM(-1))	-0.4448	0.0456	-9.7562	0.0000
C(3)	D(PCM(-2))	-0.1323	0.0483	-2.7403	0.0062
C(4)	D(PCM(-3))	0.0952	0.0572	1.6633	0.0963
C(5)	D(HHI(-1))	0.2044	0.3608	0.5664	0.5711
C(6)	D(HHI(-2))	0.8523	0.3638	2.3431	0.0191
C(7)	D(HHI(-3))	0.0541	0.3541	0.1527	0.8786
C(8)	D(CONJ(-1))	0.0015	0.0004	4.1295	0.0000
C(9)	D(CONJ(-2))	0.0009	0.0004	2.3957	0.0166
C(10)	D(CONJ(-3))	0.0003	0.0004	0.8563	0.3918
C(11)	C	0.0342	0.0137	2.4904	0.0128
Diagnostic Statistics					
R^2	0.41	Adj-R^2	0.4	D.W	1.89
VECM of SCP Model, DV=D(HHI)					
C(12)	ECT	-0.0740	0.0190	-3.9025	0.0001
C(13)	D(PCM(-1))	0.0026	0.0022	1.1745	0.2402
C(14)	D(PCM(-2))	0.1649	0.0320	5.1617	0.0000
C(15)	D(PCM(-3))	0.0013	0.0002	7.6514	0.0000
C(16)	D(HHI(-1))	0.0015	0.0008	1.8752	0.0609
C(17)	D(HHI(-2))	0.8289	0.0194	42.7656	0.0000
C(18)	D(HHI(-3))	0.0008	0.0008	0.9752	0.3295
C(19)	D(CONJ(-1))	0.9423	0.0170	55.5769	0.0000
C(20)	D(CONJ(-2))	0.0870	0.0171	5.0974	0.0000
C(21)	D(CONJ(-3))	0.9885	0.0030	334.5230	0.0000
C(22)	C(22)	0.0024	0.0007	3.3752	0.0007
Diagnostic Statistics					
R^2	0.42	Adj-R^2	0.4	D.W	2.01
VECM of SCP Model, DV=D(CONJ)					
C(23)	ECT	-0.2941	0.0206	-14.2537	0.0000
C(24)	D(PCM(-1))	-4.0065	2.5121	-1.5949	0.1108
C(25)	D(PCM(-2))	0.1558	0.0219	7.1006	0.0000
C(26)	D(PCM(-3))	15.8058	21.5464	0.7336	0.4632
C(27)	D(HHI(-1))	0.2007	0.0176	11.4220	0.0000
C(28)	D(HHI(-2))	0.0503	0.0171	2.9473	0.0032
C(29)	D(HHI(-3))	0.0015	0.0003	4.6452	0.0000
C(30)	D(CONJ(-1))	47.1560	21.7057	2.1725	0.0298
C(31)	D(CONJ(-2))	-0.2133	0.0216	-9.8547	0.0000
C(32)	D(CONJ(-3))	-0.1069	0.0226	-4.7308	0.0000
C(33)	C(22)	2.3585	0.8157	2.8914	0.0038
Diagnostic Statistics					
R^2	0.44	Adj-R^2	0.43	D.W	2.31

4.5 VECM based Granger Causality

To find the long-run and short-run causality, we have used vector error correction mechanism-based Granger causality. In VECM, there are two sources of causation i) lagged terms of other variables excluding the lag of dependent variable and ii) lagged cointegrating vector ($\pi\hat{\varepsilon}_{it-1}$) which is not identified in the standard Granger causality test. The null hypothesis of the VECM Granger causality test is rejected when at least one of the sources of causation affects the dependent variable.

Table 9 displays the long-run causality results for SCP Model in the VECM framework. The existence of long-run causality is based on necessary and sufficient conditions for error correction mechanisms. The necessary condition is error correction coefficient must be negative and the sufficient condition is statistically significant (Granger and Lin, 1995). In this table, we have estimated a system of three equations related to the SCP Model in the VECM mechanism. In this system, the first equation is related to PCM (performance) in which we have incorporated three lags[7] of PCM, HHI and Conjectural variations which represent the short-term relationship. The parameter of error correction term (ECT) is negative and significant suggesting that a long-run relationship exists between the HHI (concentration) and conjectural variations (conduct) with PCM (performance).

In the second equation, HHI is the dependent variable and explanatory variables are three-order lags of PCM, HHI and Conjectural variations representing the short-term relationship. The parameter of error correction term (ECT) is also negative and significant indicating that a long-run relationship exists between PCM (performance) and conjectural variations (conduct) with HHI (concentration).

The third equation is related to conjectural variations (conduct) in which we have incorporated three lags of PCM, HHI and Conjectural variations which represent the short-term relationship. The parameter of error correction term (ECT) is negative and significant suggesting that a long-run relationship exists between the HHI (concentration) and PCM (performance) with conjectural variations (conduct). In a nutshell, we may deduce that the parameters of cointegrating vectors are statistically significant in the SCP paradigm and probability values suggest that those coefficients are not equal to zero so there is a long-run bi-directional causality relationship.

To measure the short-run causality, we have applied the Wald test to all the lagged parameters except the lagged dependent variables in each equation shown in Table 9. Table 10 exhibits the short-run causality for the SCP model in the VECM framework. In the PCM model, three lags of HHI and conjectural variations are jointly not equal to zero which validates the short-term causality relationship between HHI, conjectural variations and PCM.

Table 10: Short Run Causality for SCP Model in VECM Framework based on Wald Test

Coefficient Restrictions	H_0	F-Stat.	Prob.
VECM of SCP Model, DV=D(PCM)			
C(5) = C(6) = C(7) = 0	D(HHI(1)) = D(HHI(-2) = D(HHI(-3)) = 0	5.6446	0.1302
C(8)= C(9) = C(10) = 0	D(CONJ(-1)) = D(CONJ(-2)) = D(CONJ(-3)) = 0	3.7812	0.6512
VECM of SCP Model, DV=D(HHI)			
C(13) = C(14) = C(15) = 0	D(PCM(-1)) = D(PCM(-2)) = D(PCM(-3)) = 0	13.9165	0.2751
C(19) = C(20) = C(21) = 0	D(CONJ(-1)) = D(CONJ(-2)) =D(CONJ(-3)) = 0	12.1942	0.5590
VECM of SCP Model, DV=D(CONJ)			
C(24) = C(25) = C(26) = 0	D(PCM(-1)) = D(PCM(-2)) = D(PCM(-3)) = 0	1.2549	0.2145
C(16) = C(17) = C(18) = 0	D(HHI(-1)) = D(HHI(-2)) = D(HHI(-3)) = 0	2.6754	0.3421

In the second equation, we are again unable to reject the null hypothesis of no joint relationship between PCM, conjectural variations and HHI. So, there is evidence of short-run causality among them. The last equation is VECM is related to conjectural variations in which the Wald test indicates that lagged parameters of PCM and HHI are not equal to zero which confirms the short-term causality relationship between PCM, conjectural variations and conjectural variations.

[7] According to the lag selection criteria, lag three has been suggested the optimal lag.

5 Conclusions and Policy Implications

This study aims to explore the Structure-Conduct-Performance (SCP) paradigm under the VAR and VECM-based Granger Causality analysis. We have conducted three types of analyses i.e., the structure-conduct-performance paradigm in a VAR framework, the structure-conduct-performance paradigm in a Granger causality analysis through the VAR framework and the structure-conduct-performance paradigm in a VECM framework. The pairwise Granger causality shows that there is bi-directional causality between structure and performance, conduct and performance and conduct and structure. The block exogeneity Wald test suggests one-way causality in the SCP paradigm. Three-panel cointegration tests i.e., Kao residual cointegration test, Johansen Fisher Panel cointegration test and Pedroni Residual Cointegration test confirm the existence of the long-run relationship. VECM-based Granger causality exhibits the long-run and short-run causality in the SCP approach. The policy implications of the study can be suggested as: There are three agents which are playing their roles in the SCP paradigm. These agents are consumers, producers and the government. As there is bivariate causation or feedback effects in the SCP paradigm so all the stakeholders must devise their policies by recognizing the fact that all factors are not independent but interdependence exist. So policies must be devised accordingly.

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