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Steering Through Uncertainty: Commodity Price Shocks and Pakistan's Automobile Industry

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ABSTRACT

Objective: The paper investigates the impact of commodity price shocks on Pakistan's automobile sector amid recent economic uncertainties.

Research Gap: While abundant studies discover how energy prices impact the automobile industry from different aspects, no well-known study delves into the examination of the impact of seven groups of commodity prices on the automobile industry of Pakistan.

Design/Methodology/Approach: We used monthly data from July 2008 to June 2020 and employed the SVAR model for our analysis.

The Main Findings: The pattern of the response of the automobile industry to commodity price shocks showed that commodity price shocks' impact on Pakistan's automobile industry is dominant on the supply side. Energy, education, and housing price shocks cause an excess supply of automobiles, whereas transportation prices reduce supply. On the demand side, food, clothing, and footwear price shocks negatively affect demand.

Theoretical/Practical Implications of the Findings: This study increases the knowledge of the impact of commodity price shocks on the automobile industry. It is the first study that addresses this issue in Pakistan. It also provides policymakers guidelines and helps them make policies for the development of the automobile industry accordingly.

Originality/Value: This study presents the novel analysis on the importance of different groups of commodity price shocks for an industry. It also provides guidelines to policy makers for the development of the automobile industry accordingly.

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1. Introduction

The automobile sector has a vital role in Pakistan's economic development. It is making substantial contributions to job creation, revenue generation, technological advancements, and the overall growth of industries (Naeem & Sami, 2020). Conversely, commodities are essential economic goods or services that are fungible, hard assets, and interchangeable with the same type (Shahzad et al., 2019). The history analysis suggests that commodities have always had an essential role in developing the wealth and fate of nations, and commodities will continue to play this role in the future (Adams et al., 2020).

Automobile industry demand and supply are highly affected by commodity price shocks, especially energy price shocks. High fuel prices forced consumers to use other alternate transportation sources, resulting in delayed decisions to buy automobiles. Low energy prices will enable them to increase the demand (Hussain et al., 2021). However, energy price shocks are not the only ones affecting the automobile industry's demand and supply (Iram et al., 2022). Consumers spend a large portion of their income on food items, and the shocks in food prices significantly affect their demand for other tangible commodities. On the other hand, some other factors, education and the health of labor, have crucial importance in the production process of any industry. Any shock in the prices of all these essential commodities substantially impacts an economy's production process (Khan et al., 2020). Further, the income effect of commodity prices also affects economic decisions (Lee & Ni, 2002) as it is a well-known fact that the income elasticity of luxury good is higher than the income elasticity of necessary good.

Analyzing the impact of commodity price shocks required consideration of varying price impacts that could occur, conditional on the physical nature or type of the operated commodities. Commodities are characteristically divided into distinct groups, including energy, food, metals and minerals, and agricultural raw materials. However, earlier research regularly assumes a homogeneity in commodity price shocks and supports a one-size-fits-all policy response (Paulo, 2015). However, it is essential to identify that not all commodity price shocks are the same. Given the widespread range of commodities traded in an economy, each commodity price applies a separate level of impact.

Numerous studies have focused exclusively on the effects of energy price shocks, describing probable ways energy prices might affect the macroeconomy (Fardous, 2011; Khan & Ahmed, 2011; Tang et al., 2010). Inappropriately, these studies tend to ignore the impact of other commodity prices. Including the effects of all commodity price shocks on analyzing an industry's performance is vital, as each shock works through a different, unique mechanism. While abundant studies discover how energy prices impact the automobile industry from different aspects (Hussain et al., 2021; Iram et al., 2022; Riaz, 2016), no well-known study delves into the examination of the impact of seven groups of commodity prices on the automobile industry of Pakistan.

This study aims to fill this gap and increase the knowledge of the impact of different commodity price shocks on the demand and supply of the automobile industry in Pakistan. This study is the first attempt to address this issue and acknowledge the importance of different groups of commodity price shocks for an industry. It also provides policymakers guidelines and helps them make policies for the development of the automobile industry accordingly. The next section deals with the literature review. The methodology and data are discussed in section 3, results are reported in section 4 and the study is concluded in section 5.

2. Literature Review

The automobile is an essential industry in Pakistan, with a share of 4.613% in Large Scale Manufacturing Industries (LSMI). However, the overall growth of the automobile industry of Pakistan remained very unstable and needs to be more capable of meeting its accurate potential (Vaz et al., 2017). Considering the importance and challenges of the automobile industry, several studies have been conducted to examine it through different aspects.

Aqil et al. (2014) examine the impact of protection and subsidies on the automobile industry of Pakistan over the period 1995 to 2005. The study results suggest that these protection policies cannot achieve the desired objectives. The study also provides some suggestions for the improvement of the industry. Nag (2017) provides a comparative analysis and forecasts the future of the automobile industry in Pakistan and India. The study's findings revealed that both industries are mutually independent. However, the growth of the automobile industry of India might be able to affect the market of a subpart of the industry where Pakistan is a primary importer.

Vaz et al. (2017) using data from 2004 to 2016, examine the sustainability and the importance of innovation in the automobile sector of Pakistan. The study's finding suggests that both major and minor innovations play an essential role in the automobile sector of Pakistan. However, minor innovations that are not very expensive have less impact on sustainability than significant innovations. Further, the study also revealed that significant innovations are necessary and sufficient conditions for sustainability. Chen et al. (2020) study is among the few studies examining the demand and supply side of the automobile industry. However, this study remained focused on the impact of government policies on China's automobile industry. It outlined the most effective policies for the growth and development of the industry. Wang et al. (2022) examines the impact of oil prices on fuel, electric, and hybrid electric vehicle sales across different time frequencies. It reveals that the relationship between oil prices and vehicle sales varies across different automobile markets. The paper emphasizes the need for government clean energy plans, subsidies for fuel vehicle manufacturers, and reforming China's energy pricing mechanism to mitigate external oil price shocks.

Mustafa et al. (2018) provide a comparative analysis of the new five-year policy 2016-2021 and the old automobile industry policy of the government of Pakistan. It highlights the essential aspects of a new auto policy that can lead to critical improvement in the industry. The results of the study predict that the new policy will not be able to reduce the profitability of the monopolists in the automobile industry, and it cannot lead to an increase in competition. However, the new auto policy has the potential to change consumer behavior and can have a significant impact on the demand side. Agyemang et al. (2019) used survey data and an exploratory approach to recognize the drivers and barriers of the automobile industry of Pakistan at the micro-level circular economy implementation. The study results suggest that profitability, cost reduction, and business principles for the environment are the main three drivers. The top three barriers are unawareness, cost and financial constraints, and lack of expertise.

Naeem and Sami (2020) present a study of the relationship between demand decisions and product brands of automotive customers. It used Honda City and Toyota Corolla Xli for the case study. The study used a cross-sectional quantitative research method for analysis. The study's finding highlights that in today's world of globalization and social media, industries can use several techniques to affect the demand decisions of consumers. Brand loyalty, apparent quality, and price are among the most important factors affecting automobile customers' demand decisions. Moreover, the study also found a positive correlation between brand loyalty, price, quality, and demand decisions.

The relationship between price shocks and the automobile sector is an area of growing interest, as it offers insights into the interconnectedness of economic variables and their impacts on consumer behavior and industrial dynamics. The literature review on the automobile industry of Pakistan suggests that several studies address the importance of the automobile industry in the economic development of Pakistan and try to showcase different aspects that can play a vital role in the improvement of the industry. However, in Pakistan's recent high instability of commodity prices, the automobile industry is badly affected. This study addresses the literature gap and examines the impact of seven commodity price shocks on the demand and supply of the automobile industry in Pakistan.

3. Data and Methodology

This study will utilize the Structural VAR model to investigate the connection between commodity prices and the demand and supply of the automobile industry of Pakistan. According to Sims (2002) the SVAR model in econometrics allows us to predict the impact of policy actions and changes in the economy or known types of interventions. Sims and Zha (1995) developed SVAR models with four applications. Firstly, they analyze how a quantified one-time structural shock affects the variables in the model on average. Secondly, they can measure how a specific structural shock influences data inconsistency by estimating forecast error variance decompositions. Thirdly, the SVAR models can provide decompositions that assess how each structural shock has influenced the progression of variables over time. Lastly, SVAR models enable the creation of forecast scenarios based on classifications of structural shocks (Kilian & Hicks, 2013).

While researchers have widely used VAR models, they have limitations, such as their inability to account for correlations and economic theory considerations. In contrast, based on prevailing theories, the SVAR model can establish correlations between variables more effectively and identify inherent structural errors. Equation 1 stated the structural vector autoregressive model for our model as;

$$B_0 y_t = B_1 y_{t-1} + \cdots + B_p y_{t-p} + Au_t \quad (1)$$

Where y_t is a vector of variables we used in the study, and $u_t$is a vector of the structural economic shocks. The u_t has the property that it is white noise with variance-covariance matrix Ω and zero mean. Constantly, the same model can be written more trimly as;

$$B\ (L) y_t = Au_t \quad (2)$$

Where B (L) = $B_0 - B_1(L) - B_2 L^2 - \cdots - B_p L^p$and $B_i$is a coefficient matrix ($i = 0 \ldots p$) and L is the lag operator. Moreover, for estimation purposes we obtain the reduce form of our SVAR model, for this we pre-multiply both sides of the SVAR model of equation (1) by B_0^{-1}.

$$B_0^{-1} B_0 y_t = B_0^{-1} B_1 y_{t-1} + \cdots + B_0^{-1} B_p y_{t-p} + B_0^{-1} A\, u_t \quad (3)$$

So, the same model can be written as;

$$y_t = Z_1 y_{t-1} + \cdots + Z_p y_{t-p} + \varepsilon_t \quad (4)$$

Where, Z_i=$B_0^{-1} B_i$ and ($i = 1 \ldots p$) and ε_t=$B_0^{-1} A\, u_t$. Consistently the model can also be written compactly as:

$$\mathrm{Z}(L) y_t = \varepsilon_t \quad (5)$$

Where Z (L) = $I - Z_1(L) - Z_2 L^2 - \cdots - Z_p L^p$ and $Z_i$is the coefficient matrix ($i = 1 \ldots p$) and L is the lag operator. Standard methods of estimation just like OLS allows us to attain constant estimates of our reduced form parameters, their reduced form errors ε_t and covariance matrix Σ. Further, as the variance-covariance matrix Ω and the Σ, are linearly related, therefore the structural shocks of any of the variable of our model can be recovered by imposing the efficient identifying restrictions.

We will also employ Augmented Dickey-Fuller (ADF) method for the unit root test in order to check the stationarity of our data. The unit root hypothesis can be written as for equation 6.

$$y_t = B_1 y_{t-1} + u_t \quad (6)$$

The hypothesis is; $H_0: B_1 = 0$ that the series is stationary and $H_1: B_1 \neq 0$ that the series is non-stationary. In order to avoid the problem of multicollinearity we will estimate our SVAR model separately for each commodity price.

The study will use the monthly data of output of automobile industry[1] (sy_auto) and monthly producer price index (sp_auto) of the automobile industry. It will also take into the account the impact of other macro variables of Pakistan economy. The macro variables that are used exogenously in our model are money, interest rate, long bond yield and inflation. Further, we treat commodity prices of seven groups' energy, food, housing, clothing and footwear, transport, health, and education as endogenous with sy-auto and sp_auto.

3.1. Identification of SVAR model

The equation for the automobile price is taken as.

[1] Obtained from Quantum Index of Manufacturing (QIM) monthly publications by the Pakistan Bureau of Statistics (PBS).

$$P_{it} = \beta_1 P_{it-p} + \beta_2 lb_{t-p} + \beta_3 m_{t-p} + \beta_{24} r_{t-p} + \beta_5 cpoil_{t-p} + \beta_6 inf_{t-p} + \beta_7 ip_{t-p} + \beta_8 y_{it-p} + \mu_p \quad (7)$$

The equation for the automobile output is taken as.

$$Y_{it} = \beta_9 Y_{it-p} + \beta_{10} lb_{t-p} + \beta_{11} m_{t-p} + \beta_{12} r_{t-p} + \beta_{13} cpoil_{t-p} + \beta_{14} inf_{t-p} + \beta_{15} ip_{t-p} + \beta_{16} P_{it-p} + \mu_y \quad (8)$$

Our main objective is to examine the impact of commodity price shocks in on automobile industry output and prices; therefore, it is important to insulate them from the impact of other macroeconomic shocks. In order to get this objective, we will treat the other macro-economic shocks as exogenous in our model. Before, moving towards our main analysis we need to identify our automobile industry demand and supply. We will identify our demand and supply in output and price space and address the element of matrix A_{22} [2]of our standard SVAR model as;

$$Y_{it} = a + \sum_{i=1}^{p} \gamma_{1i} Y_{it-p} + \sum_{i=0}^{p} \gamma_{2i} P_{it-p} + \mu_Y \quad (9)$$

$$P_{it} = a + \sum_{i=1}^{p} \gamma_{3i} P_{it-p} + \sum_{i=0}^{p} \gamma_{4i} Y_{it-p} + \mu_P \quad (10)$$

The maximum number of parameters in our matrix A_{22} is 4[3] and maximum number of independent movements is 3[4]. Therefore, our SVAR model requires at least one restriction for full identification. Following the work of Jo et al, 2019 we impose restriction on automobile price equation and first estimate the reduced form VAR model. Then we scaled our automobile output and price data with their particular standard deviations. The technique of scaling the data leads the parameter γ_1 and γ_3 roughly equal to 1. We then re-estimate our SVAR model for equations 9 and 10 and assume that $\gamma_2 = -\theta\gamma_4$. Further, following the work of Lee and Nee, 2019 the value of θ[5] is assumed to be fixed to 2. After the re-estimation of our SVAR model with scaled data the identification of automobile demand and supply equation will be contingent on the signs of estimated coefficients $\hat{\gamma}_2$ and $\hat{\gamma}_4$as the sign of $\hat{\gamma}_1$ and $\hat{\gamma}_3$are positive by construction. Thus if $\hat{\gamma}_4$ is negative then 10 is our industrial supply equation while 9 describes our industrial demand and if $\hat{\gamma}_4$is positive the 10 is industrial demand and 9 is industrial supply.

After the identification of automobile demand and supply we estimate the SVAR model with with three endogenous variables N=3 that are automobile output, price and commodity price[6].For a full identified SVAR model we need to impose at least three restrictions. Thus, we impose two restrictions on commodity price equation and it does not incorporate the impact of movements of automobile industry output and price and one restriction on automobile price equation similar to equation above. The commodity price equation is as follows.

$$CPoil_t = \beta_1 CPoil_{t-p} + \mu_{oilt} \quad (11)$$

The automobile output equation is estimated as.

$$Y_{it} = \beta_2 Y_{it-p} + \beta_3 CPoil_{t-p} - \theta\beta_4 P_{it-p} + \mu_{yt} \quad (12)$$

The automobile price equation is estimated.

$$P_{it} = \beta_5 P_{it-p} + \beta_6 CPoil_{t-p} + \beta_7 Y_{it-p} + \mu_{pt} \quad (13)$$

Thus, the above restrictions can be written in matrix form as;

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[2] The matrix A_{22} describes the contemporaneous relationship between industry specific variables.
[3] N^2=4
[4] The maximum number of independent movements in covariance matrix N(N+1)/2=3.
[5] Jo et.al., 2019 follows the work of Lee and Ni that provide evidence that different values of θ does not affect the estimated results.
[6] We will estimate separate SVAR for each commodity price group.

$$\begin{bmatrix}\mu cp_t\\ \mu y_{it}\\ \mu p_{it}\end{bmatrix} = \begin{bmatrix}a_{11} & 0 & 0\\ a_{21} & a_{22} & -\theta a_{32}\\ a_{31} & a_{32} & a_{33}\end{bmatrix}\begin{bmatrix}\varepsilon cp_t\\ \varepsilon y_{it}\\ \varepsilon p_{it}\end{bmatrix} \quad (14)$$

Where cp is commodity price, y is output of automobile industry and p is price. We will estimate the same model for each commodity price separately[7].

4. Results

This section represents the results of our estimations. Table 1 shows the unit root tests result. Where, sy_auto is output of automobile industry, sp_auto is price of automobile industry, cpe is energy price, cphel is health cost, cpf is food price, cph is housing price, cpt is transportation price, cpcf is cloth and footwear price, cpedu is education price, inf is inflation, ir is interest rate, ib is long term interest yield, m is our money supply and ip is aggregate output[8].

Table 1: Results of Unit Root Test

Variables	ADF Test at Level		ADF Test at First Diff		Oder of Integration
	T Statistics	P Values	T Statistics	P Values	
Output of Automobile Industry	-2.89*	0.04	-	-	I (0)
Price of Automobile Industry	-1.43	0. 561	-9.23**	0.000	I (1)
Energy Price	-2.61	0.09	-11.27**	0.000	I (1)
Food Price	-1.83	0.36	-3.53**	0.000	I (1)
Education Cost	-2.45	0.12	-12.15**	0.000	I (1)
Health Cost	-1.68	0.43	-10.93**	0.000	I (1)
Housing Price	-2.15	0.45	-4.32**	0.000	I (1)
Transportation Cost	-2.47	0.12	-7.86**	0.000	I (1)
Cloth and Footwear Price	-1.88	0.34	-6.89**	0.000	I (1)
Aggregate Output	-3.27*	0.01	-	-	I (0)
Inflation	-1.62	0.40	-10.02**	0.000	I (1)
Money Supply	-3.27*	0.001	-	-	I (0)
Interest Rate	-2.15	0.22	-4.45**	0.000	I (1)
Long Term Interest rate	-2.40	0.14	-3.96**	0.000	I (1)

Source: Authors' compilation

In order to recognize automobile industry demand and supply, we have first estimated the reduced form SVAR model for equations 9 and 10[9]. We then re-estimate the SVAR model for equations 9 and 10 with scale data and assume that $\gamma_2 = -\theta\gamma_4$. Thus, with the help of the estimated parameters of scaled model we have recognized our automobile industry demand and supply equations. Table 2 below shows the results of our scaled SVAR model. The results of table 2 above show that $\hat{\gamma}_4$ is negative for all commodity prices thus 10 is our automobile industry supply while equation 9 defines demand.

Table 2: Identification of Automobile Industry Demand and Supply

Commodity price	Value of $\hat{\gamma}_4$ of equation 10	Identification of Demand and Supply		
Energy	-0.024	Eq 9	(Y)	Demand
	(1 2)	Eq 10	(P)	Supply
Food	-0.023	Eq 9	(Y)	Demand
	(1 1)	Eq 10	(P)	Supply
Education	-0.021	Eq 9	(Y)	Demand

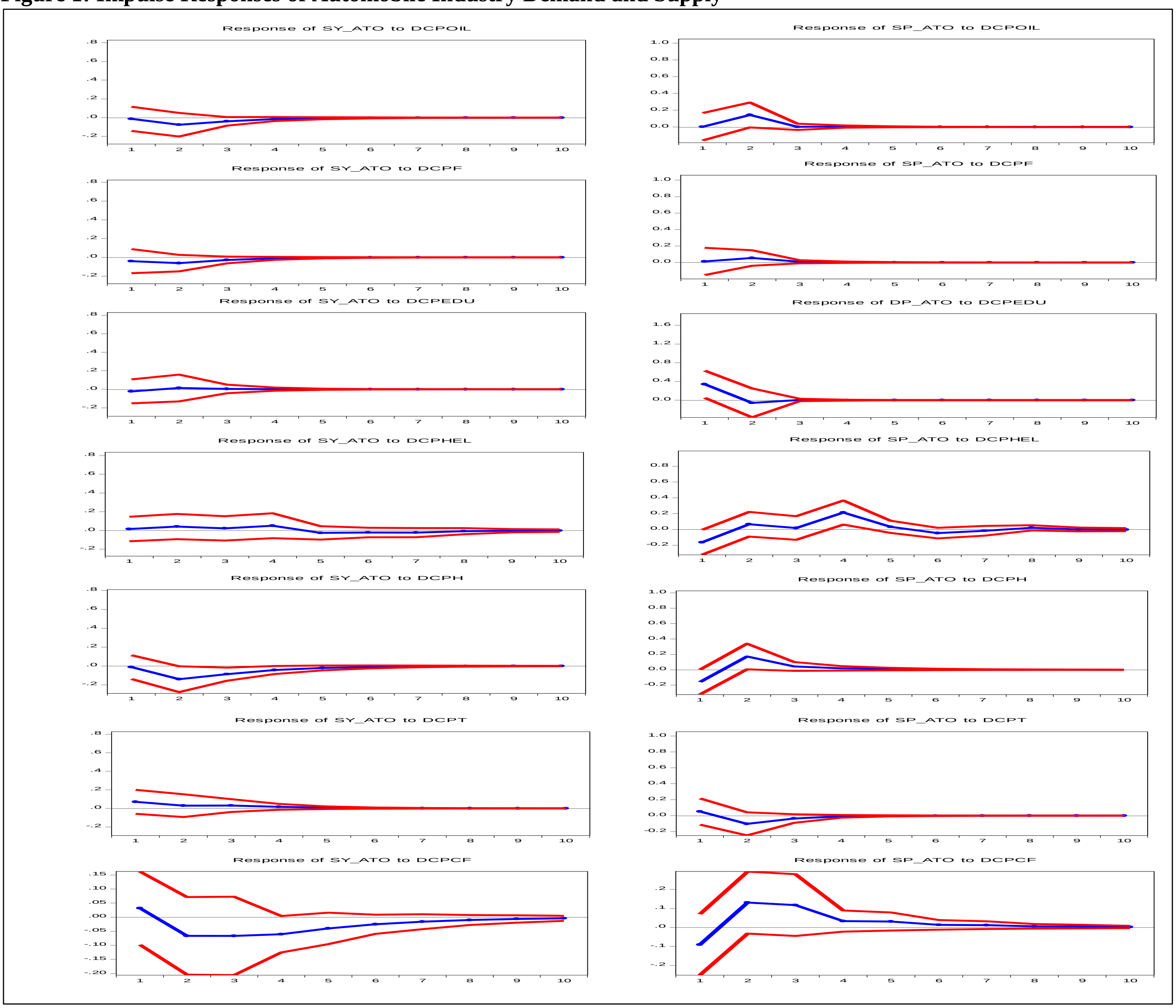
[7] The restrictions for each group of commodity price remain same.
[8] We have used monthly aggregate data of industrial production as a proxy of output as the monthly data of GDP is not available.
[9] We have estimated seven SVAR for seven groups of commodity prices.

	(1 1)	Eq 10	(P)	Supply
Health	-0.017	Eq 9	(Y)	Demand
	(1 1)	Eq 10	(P)	Supply
Housing	-0.028	Eq 9	(Y)	Demand
	(1 1)	Eq 10	(P)	Supply
Transportation	-0.041	Eq 9	(Y)	Demand
	(1 1)	Eq 10	(P)	Supply
Clothing and footwear	-0.022	Eq 9	(Y)	Demand
	(1 1)	Eq 10	(P)	Supply

Source: Authors' compilation
Note: The lag length of each scaled SVAR model has been mentioned in brackets of column 2.

The next step of our examination is to obtain the impulse response of commodity price shocks on identified demand and supply of automobile industry. Figure 1 below shows the impulse response for automobile industry. Figure 1 shows the impulse responses of automobile industry demand and supply to commodity price shocks. Table 3 describes the peak responses to each commodity price shock and the estimated structural coefficients. The effect of commodity price shocks is measured following the rule that if automobile industrial output and automobile industry prices move in the same route, then the dominant impact is on the demand side. If the price and output move in opposite directions, then the dominant influence is on the supply side.

Figure 1: Impulse Responses of Automobile Industry Demand and Supply



Source: Authors' compilation

Table 3:Commodity price shocks effects on automobile industrial demand and supply

Commodity Price (CP)	CP coefficient $\hat{\beta}_3$ (p-value) in equation 12	CP coefficient $\hat{\beta}_6$ (p-value) in equation 13	Peak effect on output	Peak effect on price	Commodity price shocks effects
Energy	-0.154(0.00)	0.159(0.00)	-*	+*	Increase in supply
Food	-0.146(0.00)	0.078(0.00)	-*	Insignificant	Reduction in demand
Education	0.065(0.23)	0.243(0.00)	0	+*	Increase in supply
Health	0.031(0.00)	0.128(0.00)	0	Mixed*	Uncertain impact on supply
Housing	-0.323(0.00)	0.091(0.00)	-*	+*	Increase in supply
Transportation	0.158(0.00)	-0.099(0.00)	Insignificant	-*	Reduction in supply
Clothing & footwear	-0.265(0.63)	0.265(0.25)	-*	Insignificant	Reduction in demand

Source: Authors' compilation

Note: The * is used if the peak responses are significant based on two standard error confidence interval for at least one time period of the study. "+" and "-" is for positive and negative responses respectively. Mixed shows that both+ and - responses are of same magnitude.

The results suggest that energy price shocks significantly decrease automobile demand in the third month. Consumers postpone purchasing new cars in the short run, considering the additional operating cost. Further, the uncertainty about future oil prices also affects the consumer's decision about which car to buy. These results are consistent with the findings of Naeem and Sami (2020). The increase in the prices of automobiles further intensifies the demand reduction.

Moreover, the supply of cars is less elastic in the short run. Therefore, in Pakistan, an energy price shock reduces automobile industry demand and increases its prices, whereas the dominant impact is on the supply side, which grows in the short run. These results are consistent with the findings of Agyemang et al. (2019) which show that cost and financial instability are the significant barriers to the automobile industry of Pakistan that led to the reduction of demand. However, our results are inconsistent with Jo et al. (2019)finding that energy price shocks dominate the supply side of the automobile industry in the USA.

Food is a basic necessity of life, and consumers spend a significant portion of their income on food items. Thus, a positive shock in food prices reduces the purchasing power of consumers, and they decrease the demand for durable like automobiles. These results are consistent with the findings of D'Souza and Jolliffe (2013). Education price shocks have no significant impact on the output of the automobile industry; however, they increase the PPI of cars, which causes excess supply in the short run. The shocks in health prices also have no impact on automobile output. However, they decrease the automobile prices in the first month and then increase in the fourth month; therefore, their impact on supply is uncertain.

The housing price shocks work differently for the economy than other commodity price shocks. As houses are treated as assets, increasing their prices increases the wealth of house owners and, of course, the living cost of renters. A positive shock in housing prices reduces demand for automobiles because consumers find it more beneficial to invest in housing and postpone their demand for autos. On the other hand, renter decisions to purchase new cars are also affected negatively by this increase. Therefore, increased automobile prices and reduced demand cause excess supply in the short run. Transportation price shocks have an insignificant impact on automobile output. However, it reduces its cost significantly in the short run. The reduction of the expenses of automobiles encourages demand and, on the other side, the high prices of transportation increase the profits of public transporters, and they feel optimistic about new purchases of buses and cars. As the supply of automobiles is less elastic in the short run, the reduction in prices and chances of profits boost demand and cause a decrease in stores in the short run. In the fourth month, the shocks in clothing and footwear prices reduced the need for cars significantly. However, it has no significant impact on the supply side.

5. Conclusion and policy Recommendations

Commodity price shocks are one of the most essential shocks resulting from global economic conflicts. Industries like automobiles are always most vulnerable to these shocks. This paper examines the impact of commodity price shocks on the automobile industry of Pakistan. The results of our analysis showed that commodity price shocks' impact on Pakistan's automobile industry is dominant on the supply side. Energy, education, and housing price shocks cause an excess supply of automobile. Whereas, transportation prices reduce supply. On the demand side, food and clothing and footwear price shocks play negative role and reduce demand. The results of the analysis provide useful information to policymaker that will help them to achieve their goals more effectively. For example, if policy makers want to achieve higher production of Pakistan's automobile industry, in this scenario the results of our analysis provide a clear view that which type of commodity price shocks can lead to boom and which to busts to automobile industry.

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