

Highlights



Retail fuel prices are generally adjusted by the concerned government agencies when the price of petrol in the international market shoots up and hover around hundred dollars per barrel (USD 100/barrel) for four to six months, and mostly fuel prices eventually maintain upward trend rather than downward in the country.



Among the types of fuel available, it is diesel whose price volatility has the most impact on food and non-food inflation, as well as shake up and unsettle most of the components of the consumer price index (CPI). As for the other types of fuel, escalated prices of petrol and octane generally exercise minor impact on some components of CPI, and in many cases, the impacts are statistically insignificant.



Given the rate at which fuel prices increased in Bangladesh in the wake of Russian-led Ukraine War, the increase in consumer spending on non-food items and food items is estimated to be 13.19% and 17.4% respectively due to price hike of diesel alone.



The long-run impacts of fuel prices on all the components of consumer spending are not clear cut, but in most cases however, the impact of the initial rise in fuel prices continues throughout, and it sustains in the long run, albeit at a lower impact rate.



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Imported Fossil Fuel Dependent Energy Market of Bangladesh

How Global Energy Crisis Triggered Domestic Inflation?

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1. Introduction and Objectives

With the depletion of domestic natural gas reserves, Bangladesh's energy market has become increasingly dependent on imported energy – mainly petroleum, LNG, and coal. Hence, price unpredictability in the global energy market automatically tends to gradually impact the energy sector as well as the economy as a whole. The Russia-Ukraine War has further aggravated the global energy market crisis both in terms of *energy supply and energy prices* which have multi-dimensional adverse impacts on developing countries. The crisis is likely to be prolonged as major developed and advanced developing economies have been competing with other developing countries and LDCs for trade opportunities amidst large energy resources stock with limited number of countries. Hence the energy-crisis in developing economies including Bangladesh must be exercising further impact on macroeconomic aggregates. Relevant Trade and Energy Literature has explained how global energy crisis led by the Ukraine War has caused an adverse macroeconomic situation including domestic inflation in developed and developing countries (Mohammed, 2022, CUTS International, 2022, The Hindustan Times, 2022).¹

Bangladesh economy has been experiencing a number of adverse impacts on macroeconomic issues including inflation. CPD (2022) has already indicated that due to the Ukraine War and post-COVID recovery process, limited amount of imported energy, particularly petroleum and LNG, would not be sufficient to meet the domestic demand. Moreover, high energy prices in the international market are likely to put pressure on country's foreign exchange reserve. Having an administered market for energy, the public entities responsible for importing energy in their country such as Bangladesh Petroleum Corporation (BPC), RPGCL (Rupantarito Pracritik Gas Company Limited), etc., have to take subsidies from the government. Despite that, the additional cost is difficult to manage with the limited subsidy available for these public entities; hence, there is pressure to pass on a part of additional cost to the consumers in the form of higher retail tariffs. This results in both direct and indirect impact on inflation.

¹According to CUTS International (2022), even before the war, inflation was quite high in South Asian countries. Additional shock in commodity prices due to the war just widened the gap as most of the energies are generated from fossil fuels in South Asia. According to the Hindustan Times, ASEAN and East Asian economies have experienced diverse impact on inflation due to energy crisis led by among others, Russia-Ukraine war. In Vietnam, Malaysia, and Indonesia, the impact of rising oil prices is evident in the transport, housing, electricity, gas and other sectors. Inflation has increased in Japan due to a steady rise in oil prices.

There is no comprehensive study as yet on the war-led global energy crisis and its impact on inflation, where the level of adversity has been measured. Most of the studies are indicative in terms of causal relationships between energy crisis and its impact on macroeconomic aggregates including inflation. Hence, a quantitative analysis is required to show how the global energy market crisis led to domestic inflation, particularly in developing countries. In this backdrop, this Study will seek to estimate the level of inflationary impact on Bangladesh economy due to global energy price volatility.

2. Methodology

For the purpose of the study, firstly, the mechanism through which prices are adjusted is identified, and secondly, the effects of enhanced price of different fossil fuels on inflation have been examined. The basic data analysis has been done through

government through two specific policy instruments: first, by passing a part of the additional expenditure for import onto the consumers in the form of *enhanced energy tariff*, and second, by accommodating a part of the additional expenditure by providing *low-cost loan in the form of subsidy*. Over the years, the government has been using these two policy instruments to adjust and manage the energy market volatility.

In the past ten years, the fuel prices have been changed only seven times; that is, they are not adjusted regularly.² Table 1 shows the changes in fuel prices in the past ten years; except for the Year 2016, fuel prices have been increasing periodically. The highest increase in fuel prices was effective from 6 August 2022, when fuel prices witnessed a 40–50% rise. According to the Key Informant Interviews (KIIs) conducted for this study, this price hike was a direct impact of the rising international fuel prices due to the Ukraine War.

Table 1: Changes in Petroleum Prices at Retail Level in Bangladesh

Year	Date	Diesel		Petrol		Octane		Kerosene	
		Tk/Litre	Changes (%)	Tk/Litre	Changes (%)	Tk/Litre	Changes (%)	Tk/Litre	Changes (%)
2009	Jan-13	44	---	74	---	77	---	44	---
2011	May-06	46	4.55	76	2.71	79	2.6	46	4.55
2011	Sep-19	51	10.87	81	6.58	84	6.33	51	10.87
2011	Nov-11	56	9.81	86	6.18	84	0.0	56	9.81
2013	January	68	21.43	96	11.63	99	17.86	68	21.43
2016	Apr-24	65	-4.42	86	-10.42	89	-10.11	65	-4.42
2021	January	80	23.08	86	0	89	0	80	23.08
2022	Aug-06	114	42.5	130	51.17	135	51.69	114	42.5

Source: Dhaka School of Economics Database.

qualitative as well as quantitative parameters (by using the Error Correction Model, ECM), while data has been collected from the Bangladesh Bank database, Central Bank of the country, BPC and RPGCL. The detailed methodology has been included in the appendix.

3. Overview of Energy Price Adjustment Mechanism in Bangladesh

As mentioned earlier, Bangladesh’s energy market is not fully open and competitive; the energy price for both wholesale and retail level is determined by Bangladesh Energy Regulatory Commission (BERC)—an autonomous body operated under the Government of Bangladesh (GoB) Ministry of Power Energy and Mineral Resources (MoPEMR). Different government agencies (BPC and RPGCL) have full responsibility to import energy to feed the local market. Hence, the impact of global market price fluctuations on the domestic energy market is managed by the

If we look at the pattern of price adjustment in Bangladesh as shown in figure 1, there has been kind of a lagged adjustment to petrol prices, when it is compared to world prices. The blue line depicts price of petrol in the country (in BDT), while the other lines show movements in prices (in USD per barrel) of crude oil. For example, the average price of Brent crude as well as the OPEC basket price started increasing from around \$80/barrel in October 2010 to \$120 in April 2011; as a result, the price of petrol in the country was gradually increased three times in 2011—once in May, then in September, and another time in November. Similarly, when crude oil prices fell to around \$40 per barrel in January, 2015 and fell again in February, 2016 to around \$30 per barrel, domestic petrol prices got decreased in April, 2016. Another noticeable trend is that whenever world oil prices scaled over \$100 per barrel threshold, there has been some sort of lagged adjustment in domestic petrol prices; but when prices fall sharply in the international market, such as during 2020, there is no adjustment in petrol prices in the domestic market.

²IMF reported in March 2012 that the government was expected to adopt an automatic adjustment formula by December 2012, which would ensure full pass-through of changes in international prices; however, that is yet to be implemented.

Figure 1: Fuel Prices in Bangladesh (in BDTk.) and International Prices (in US \$/Barrel)



Source: World Bank (accessed on 1 September 2022) and BBS (accessed on 18 August 2022).

Only when prices again rose above \$100 there was a petrol price hike in 2021, and then again in 2022, as crude oil prices hovered around \$120 per barrel.

When BPC and other relevant fuel energy entities start making huge losses due to rising import costs, prices are generally revised in Bangladesh. But there are very few examples of domestic downward adjustments of fuel prices by BPC in view of its profit-making trends. BPC generally targets a five per cent (5%) margin or markup in their pricing strategy, but sometimes the organizations make more than the five per cent margin or supernormal profits. According to KIIs involving energy experts, BPC alone earned almost BDT 40,000/- crore as profits during last seven-eight years. According to BPC, these profits were deposited to the government coffers; and now they're more or less at break-even point due to a sudden increase in the international fuel prices.

Generally, BPC access loans from state-owned commercial banks, receive budgetary transfers to cover its operating losses, and relies on banks to meet much of foreign exchange requirement, because delayed budgetary transfers result in lack of funds BPC requires to purchase foreign exchange towards oil imports. This happens because generally BPC sells fuel in the domestic market at 20-40% lower prices compared to the import price.

There is no standard parameter or no workable formula based on which the price adjustments are effected; the basis of these adjustments is solely the amount of subsidy the government can provide and the amount of losses borne by the institutions in

question. There is also no cutoff value or parameter related to the losses made by BPC that would help in determining when to raise fuel prices and when to maintain status quo.

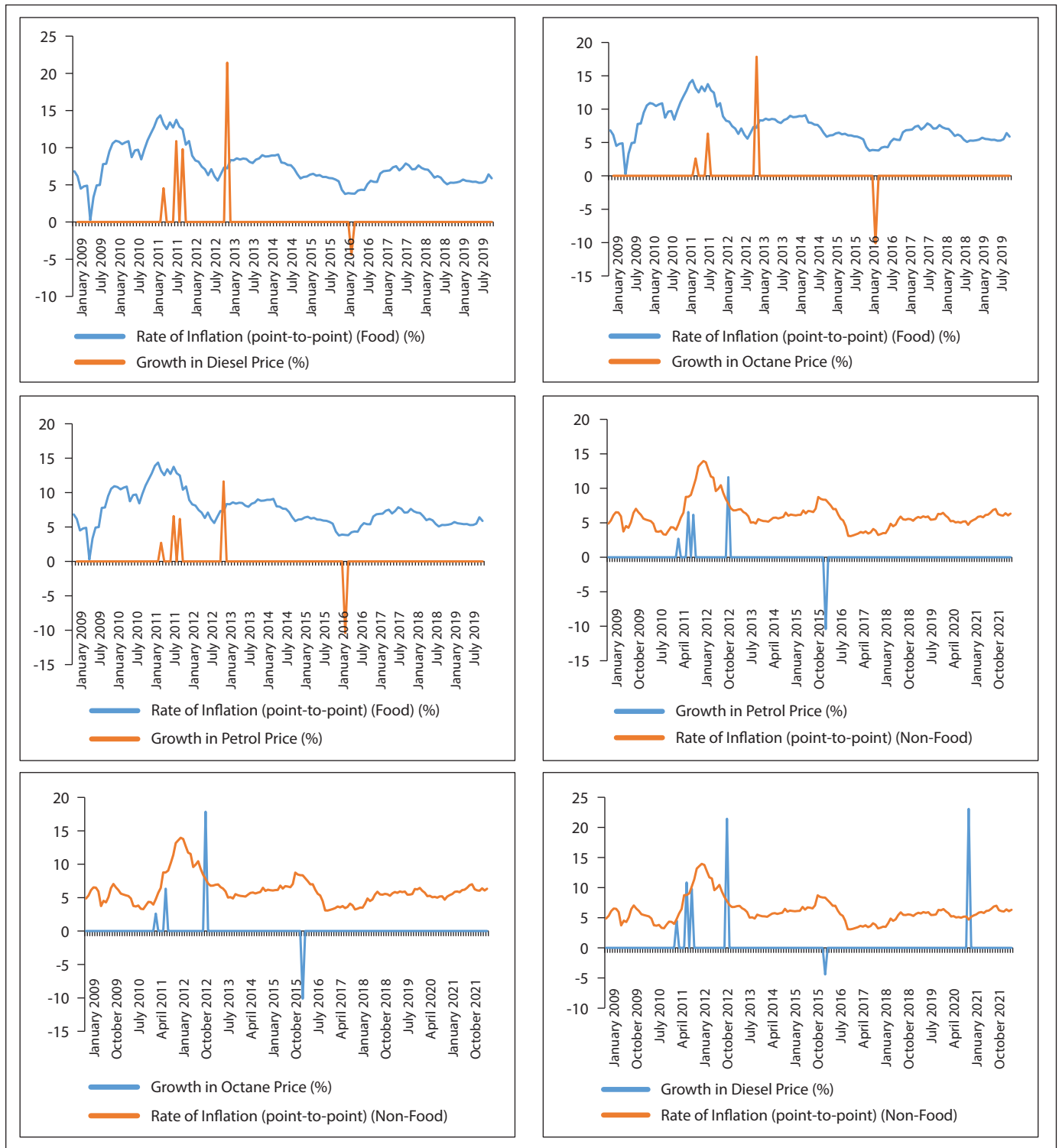
Whatever formula is applied for calculation of prices of petrol, diesel etc. is never revealed by the relevant organizations for public consumption and is treated as confidential information. However, the variables that are considered for adjustment are: Import level duties, VAT, import cost, handling charge at the company level, marketing commission for the company that markets, losses of product due to transportation, carrying/evaporation loss, etc.

4. Impact on Domestic Inflation

Pump level prices of fuel, i.e. prices of petrol, diesel, octane etc. in the domestic market are important factors for food price determination. Theoretically, it can be assumed that fuel price hikes tend to increase the production cost of different food products, leading to eventual price hike of those products. Hence, this should be reflected in inflation rates of the month in which the price hikes occur, or the subsequent months or both.

However, data on the past ten years as shown in figure 2 reveal no noticeable impact of petrol price hikes in general. Inflation in some months does not show any upward rise (as compared to the same month in the previous year) despite enhancement of petrol price in the referred month. The same trend can be observed in case of octane prices as well, which is natural, given the fact that octane and petrol prices generally vary together. Diesel price changes seem to have some impact on inflation of

Figure 2: Inflation Status (point-to-point/in %) and Fuel Price Growth (January 2020–December 2021)



Source: Prepared by the Authors based on World Bank (2022) and BBS (2022) Report.

food items; for non-food items however, the relevant impact on inflation due to changes in diesel prices is not that much apparent. However, decreases in diesel prices seem to have a

decreasing effect on inflation in the next few months, as shown in the figure. But, compared to food inflation, this effect is less prominent, and cannot be easily identified from the figure.

4.1. Results from the Estimated Time Series Model

Table 2 shows the results of the error correction model, as described earlier in the methodology section. The model was applied to two of the biggest sub-groups of Consumer Price Index: CPI (non-food) and CPI (food), where the former measures the changes in spending for a basket of food items consumed by an average consumer, and the latter measures the changes in spending for a basket of non-food items consumed by an

well. Moreover, the error correction term has a negative sign and is statistically significant. This means that the initial price shock caused by the increase in price of diesel is slowly absorbed by the economy in the long run, showing stability of the estimated model. So, the actual recorded increase in CPI (food) in the later months might show lower growth in consumer spending.

The same sorts of models were also estimated for prices of petrol and prices of diesel. But none of them showed any results that

Table 2: Results of Error Correction Model

Dependent Variable	Independent Variables	Coefficient	p-value	Error Correction Term	p-value	R-squared	Prob. > Chi²
CPI (non-food)	Price of Diesel	.2982941	0.0000	-.0225537	0.127	0.5763	0.0000
CPI (food)	Price of Diesel	.4060455	0.0029	-.290149	0.000	0.4328	0.0000
CPI (non-food)	Price of Octane	.1964657	0.338	-.0206104	0.206	.583496	0.0000
CPI (food)	Price of Octane	-.1066868	0.987	-.0012743	0.311	0.2251	0.0004
CPI (non-food)	Price of Petrol	.1964657	0.338	-.0206104	0.206	0.5823	0.0000
CPI (food)	Price of Petrol	-.1066868	0.987	-.0012743	0.311	0.2251	0.0004

Source: Estimated by the Authors.

average consumer. For initial estimations, the effects of the changes in the prices of diesel, prices of petrol and octane were examined.

Impact on Inflation (Food and Non-Food): In the first row, the value in the ‘coefficient’ column is 0.2982941, which indicates that for every increase in diesel price by Taka=1, the value of consumer price index (non-food) will increase by 0.29. In other words, a 1 per cent increase in the price of diesel would result in around a 0.298 per cent increase in consumer spending on non-food items. Given that, consumer spending on non-food items is expected to register a rise by at least 13.19% in the wake of diesel price hike by 42.50% as an immediate aftermath of the Ukraine War. The price of diesel is a statistically significant variable, indicating the importance of the price of diesel vis-à-vis consumer spending on non-food items. The value of R-squared shows that the model is a good fit. The error correction term column indicates how fast the initial impact of the price shock is absorbed in the long run. However, since the error correction term has a negative sign, but it is not statistically significant, the long run adjustment of the model of the price shock on the values of CPI (non-food) is unclear.

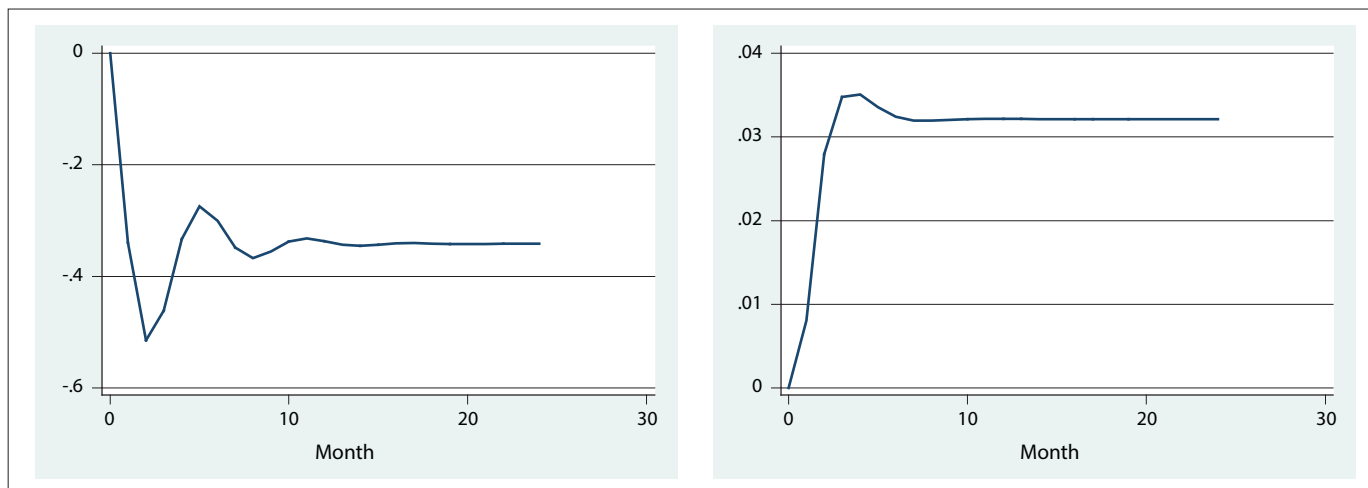
The second row shows the results for estimation of ECM for CPI (food). Here also, the value in the coefficient column shows that the effect of prices of diesel on CPI (food) is statistically significant; and it shows that if diesel price increases by 1 per cent, the value of CPI (food) increases by 0.41 per cent. Again, considering the diesel price increase after the Ukraine War, consumer spending on food items is expected to increase by 17.43 per cent on average. The R-squared value is moderately high but sufficient for concluding that this model is a good fit as

could be counted as statistically significant. This indicates that there is a lesser importance on petrol and octane prices in the economy of Bangladesh compared to diesel prices when broad categories of consumption spending on food and non-food items are considered.

Figure 3 shows the “impulse response function” or the figure of the average reaction of CPI-food to diesel price shocks from the point of impact to 24 months, or two years. More precisely, based on the estimation results of the ECM model (which, in turn, is estimated from monthly data from 2014 till date), the figure shows how CPI-food would behave after a diesel price increase. Here, point zero is the point in time when the diesel price is increased. The figure shows that if diesel price increases by, say one per cent at point 0, in the next two months or so, the impact on CPI-food decreases a bit (by around 0.4%–0.5%); alternative increase and decrease thereafter in the process until it reaches a point where it tends to settle in all the coming months. This means that after the initial ‘ripple effect’, the impact reaches a ‘long run equilibrium’. The figure also shows that the impact, in the long run, is smaller compared to the initial impact, but it settles there, and doesn’t show any tendency to decrease.

These results reflect the commonly perceived impacts in real life as well. Generally, when diesel prices increase, we notice a massive rise in food prices in Bangladesh. Then some measures of control and restriction are generally imposed by government, sometimes more monitoring is introduced, etc. These generally have the effect of curtailing the initial increase in prices. Still, sometimes prices increase again due to constant bargaining of businessmen with the government regarding pricing issues.

Figure 3: Impulse Response of CPI (Food) and CPI (Non-food) due to Diesel Price Shocks



Source: Estimated by the authors.

Finally, after some ups and downs, the prices reach a level where they tend to settle for the coming months, and consumers adjust their spending accordingly. Hence, the figure shows a rather simplified version of what goes on in real life.

However, the long-term impact of diesel price rise or otherwise on CPI (non-food) is not clear-cut, as has been previously mentioned. Still, the following figure shows that rather than decreasing in the long run, the initial impact of a diesel price shock is shown to continue and increase. This shows structural instability, which can result from either structural break in the model, or it may be because initial effects of diesel price increases never reach a long-term equilibrium level.

Impact on other areas in the Economy: The same ECM can be applied to understand how changes in pump level fuel prices increase spending in other sectors of the country, thereby identifying the transmission channels of fuel price movements. For that, sub-groups of CPI, namely Clothing and Footwear; Gross rent, Fuel and Lighting, Furniture, Furnishing & Others; Medical Care & Health Expenses; Transport & Communications; Recreation, Entertainment, Education & Cultural Services; and Miscellaneous Goods and Services have been included in the model. The ECM was also estimated for the CPIs for all the smaller sub-groups as well, and the model has yielded significant results for (i) CPI

(Gross Rent, Fuel and Lighting) (ii) CPI (Education and Entertainment) (iii) CPI (Transport and Communication).

Table 3 shows the estimation results of ECM for CPI-Gross Rent, Fuel and Lighting. According to the first row of the table, an increase in the price of diesel by 1% per cent is expected to bring about a 0.98% per cent (approx.) increase in the value of CPI relating to Gross Rent, Fuel and Lighting; also, diesel price is a statistically significant variable. From this, therefore, it is clear that an increase in diesel price by 42.5% due to rise in international oil prices as a result of the Ukraine War is expected to bring about an almost equivalent increase of 41.65% on average in consumer spending on gross rent, fuel and lighting. For this sub-group of products, the prices of petrol and octane are also statistically significant. However, since petrol and octane prices move almost at the same pace, and most of the time the magnitudes of the price increases are quite similar, the results are same for petrol prices as well as for octane prices.

Table 3 shows that, for one per cent (1%) increase in the price of petrol or the price of octane, the value of CPI involving Gross Rent, Fuel and Lighting tends to increase by around 1.45 per cent. The error correction terms are negative and significant, indicating long-term stability of the model, which in turn means that in the long run, the effect is slowly absorbed into the

Table 3: Results of Error Correction Model (CPI – Gross Rent, Fuel and Lighting)

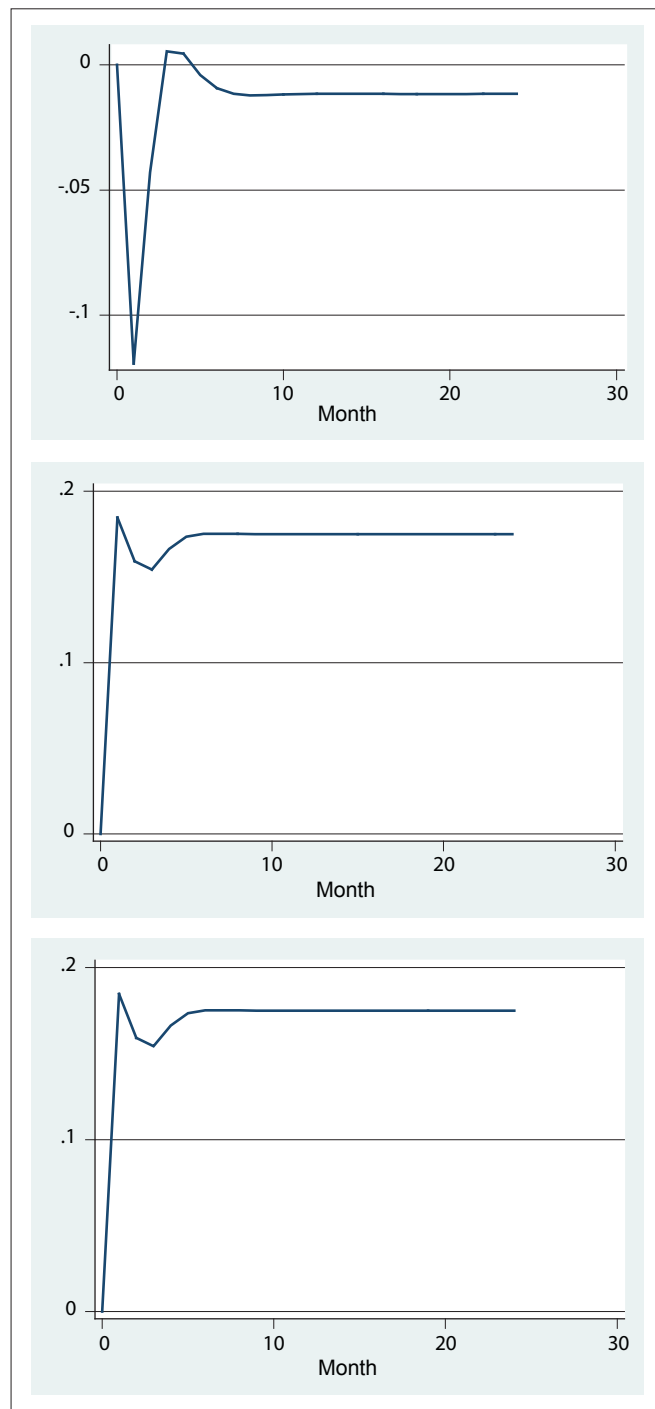
Dependent Variable	Independent Variables	Coefficient	p-value	Error Correction Term	p-value	R-squared	Prob. > Chi ²
CPI (Gross Rent, Fuel and Lighting)	Price of Diesel	.9764547	0.002	-.0434914	0.009	0.2565	0.0001
CPI (Gross Rent, Fuel and Lighting)	Price of Petrol	1.451605	0.011	-.0278736	0.040	0.2449	0.0001
CPI (Gross Rent, Fuel and Lighting)	Price of Octane	1.451605	0.011	-.0278736	0.040	0.2449	0.0000

Source: Estimated by the Authors.

economy. However, the R-squared values are low for all the estimation results in the table, showing the low goodness-of-fit.

Based on the estimation results of the ECM model (which, in turn, is estimated from monthly data from 2014 till date), the following graph in figure 4 shows how CPI in terms of

Figure 4: Impulse Responses of CPI (Gross Rent, Fuel and Lighting) due to Diesel, Petrol and Octane Price Shocks



Source: Estimated by the Authors

Gross Rent, Fuel and Lighting would behave after a diesel price increase. Like the other models before, after the initial 'ripple effect', the impact reaches a 'long run equilibrium', and the impact, in the long run, is smaller compared to the initial impact.

For petrol prices, the impact is however a bit different, as shown in the above figure. Rather than decreasing, the initial impact actually increases after the initial point of impact, then it decreases a bit; but here also, after the initial 'ripple effect', the impact reaches a 'long run equilibrium'. But the only difference is that in the long-term, the impact is expected to be higher than the initial impact. The pattern of long-term adjustment to octane price shocks also follows a similar sort of pattern.

Table 4 shows the estimation results of ECM for CPI involving Recreation, Entertainment, Education & Cultural Services. According to the first row of the table, an increase in the price of diesel by one per cent (1%) is expected to bring about approximately 0.32 per cent increase in the value of CPI (Recreation, Entertainment, Education & Cultural Services); also, diesel price is a statistically significant variable. This means that the real-life impact of diesel price on the value of CPI for this sub-group of products is highly significant. Like the previous results, the error correction term is also significant and has a negative sign, indicating long-term stability of the model.

The prices of petrol and octane are also seen to have a statistically significant impact. However, here also, the results are same for petrol prices as well as for octane prices, since petrol and octane prices move almost at the same pace, and most of the times the magnitudes of the price increases are quite similar. The same table shows that, for one per cent (1%) increase in the price of petrol or the prices of octane, the value of CPI (Recreation, Entertainment, Education & Cultural Services) tends to increase by around 0.45% per cent. The error correction terms are negative and significant, indicating long-term stability of the model, which in turn, means that in the long-term, the effect is slowly absorbed into the economy. However, these results also suffer from the same problem: the R-squared values are low for all the estimation results in the table, showing the low goodness of fit.

Figure 5 shows the "impulse response function" or the graph of the average reaction of CPI (Recreation, Entertainment, Education & Cultural Services) to diesel price shocks from the point of impact to 24 months, or two years. The graph shows that if diesel price increases by, say one per cent (1%) at point 0, in the next two months or so, the impact on CPI (Recreation, Entertainment, Education & Cultural Services) increases a little (almost by 0.1%), then decreases and slowly reaches a long run equilibrium. Here also, the impact in the long-term is larger compared to the initial impact, and it settles there, and doesn't show any tendency to decrease. This means that the initial impact is slowly absorbed by the economy, but a higher burden is transferred.

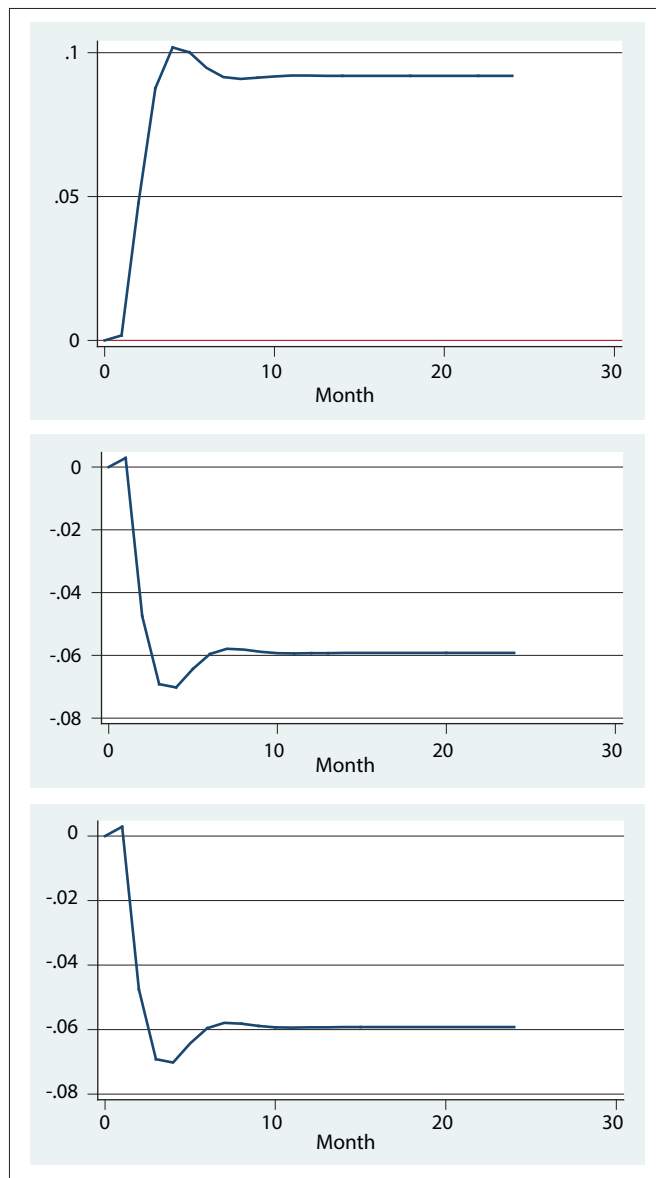
For petrol price rise however, the impact is different; the graph shows that if petrol price increases by, say one per cent (1%) at point 0, in the next two months or so, the impact on

Table 4: Results of Error Correction Model (CPI–Recreation, Entertainment, Education and Cultural Services)

Dependent Variable	Independent Variables	Coefficient	p-value	Error Correction Term	p-value	R-squared	Prob. > Chi ²
CPI (Recreation, Entertainment, Education & Cultural Services)	Price of Diesel	.3155765	0.006	-.0983831	0.000	0.2740	0.0000
CPI (Recreation, Entertainment, Education & Cultural Services)	Price of Petrol	.4520624	0.020	-.1019004	0.040	0.2924	0.0000
CPI (Recreation, Entertainment, Education & Cultural Services)	Price of Octane	.4520624	0.020	-.1019004	0.040	0.2924	0.0000

Source: Estimated by the Authors.

Figure 5: Impulse Response of CPI (Recreation, Entertainment, Education & Cultural Services) in the Wake of Diesel, Petrol and Octane Price Shocks



Source: Estimated by the Authors

CPI (Recreation, Entertainment, Education & Cultural Services) decreases by a lot (almost by -0.07%), then rises again until it reaches a long run equilibrium. This means that, like the other models discussed earlier, after the initial ‘ripple effect’, the

impact reaches a ‘long run equilibrium’. Here also, the impact in the long run is smaller compared to the initial impact, but it continues there, and doesn’t show any tendency to decrease. The impact of octane price shocks on CPI (Recreation, Entertainment, Education & Cultural Services) is also similar to the impact of petrol price rise due to reasons outlined previously.

Fuel prices exert a profound impact on consumer spending on transport and communication, as per the results shown in the (Table 5) in respect of the estimation results of ECM for CPI (Transport and Communications). According to the first row of the table, an increase in the price of diesel by one per cent (1%) is expected to bring about approximately 5.03% per cent increase in the value of CPI (Transport and Communications); further, diesel price is a statistically significant variable. This means that the real-life impact of diesel price rise on the value of CPI for this sub-group of products is highly significant. Like the previous results, the error correction term is also significant but has a positive sign, indicating some sort of instability.

The price hike of petrol and octane does also exercise a statistically significant impact, and the impact is shown to be quite high. However, here also, the results are same for petrol prices and octane prices, since petrol and octane prices move almost at the same pace, and most of the times the magnitude of the price increase in both are quite similar. The table shows that, for one per cent (1%) increase in the price of petrol or the price of octane, the value of CPI involving Transport and Communications tends to increase by around 53% per cent, which is higher than all the other estimation results. The error correction terms are positive and significant, indicating that there might be long run instability in the model. The R-squared results show a moderately good fit of the models to the data.

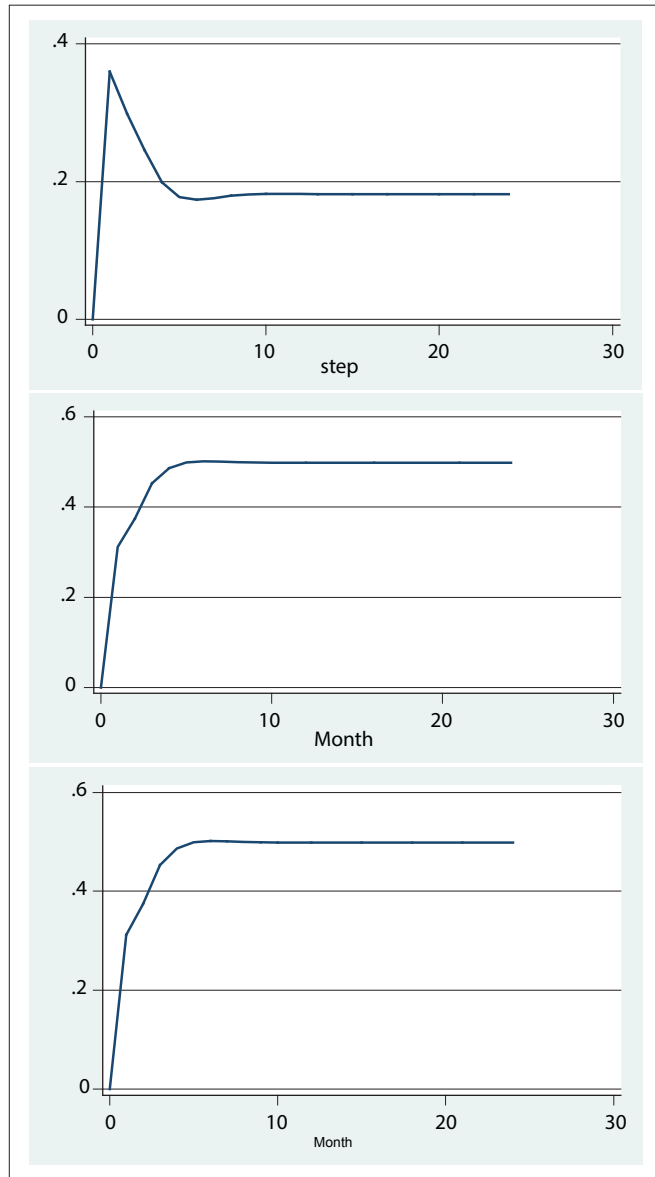
Figure 6 shows the “impulse response function” or the graph of the average reaction of CPI (Transports and Communications) to diesel price shocks from the point of impact to 24 months, or two years. The graph shows that if diesel price increases by, say one per cent (1%) at point 0, in the next two months or so, the impact on CPI (Transports and Communications) increases by almost 0.3%, then decreases and slowly reaches a long-term equilibrium. Here also, the impact in the long-term is larger compared to the initial impact; it continues there and doesn’t show any tendency to decrease. This means that the initial impact is slowly absorbed by the economy, but a higher burden is transferred to the consumers who have to adjust their spending accordingly.

Table 5: Results of Error Correction Model (CPI–Transport and Communications)

Dependent Variable	Independent Variables	Coefficient	p-value	Error Correction Term	p-value	R-squared	Prob. > Chi²
CPI (Transport and Communications)	Price of Diesel	5.025531	0.007	.0138686	0.001	0.4134	0.0000
CPI (Transport and Communications)	Price of Petrol	51.71381	0.003	.0026327	0.000	0.4281	0.0000
CPI (Transport and Communications)	Price of Octane	51.71381	0.003	.0026327	0.000	0.4281	0.0000

Source: Estimated by the Authors.

Figure 6: Impulse Response of CPI (Transport and Communications) due to Diesel, Petrol and Octane Price Shocks



Source: Estimated by the Authors

For petrol prices, the impact is slightly different; the graph (second panel) shows that if petrol price increases by, say one per cent at point 0, in the next two months or so, the effect actually increases, but at a decreasing trend. This means that, unlike the other models before, there is no initial ripple effect.

Also, there is long-term instability, as the error correction terms are positive.

5. Major Findings

The analyses presented in the previous sections have brought about some very important findings. First and foremost, the pump level fuel prices are generally adjusted, as is evident from the data, when the international price of petrol hovers around hundred dollars per barrel (USD 100/barrel) for four to six months, and mostly fuel prices move upward rather than downward in the country. As an immediate aftermath of Russia-initiated Ukraine War, prices of petrol, octane and diesel saw record growth in Bangladesh.

Secondly, as mentioned earlier, rise in the price of diesel had the most telling impact not only on food and non-food inflation, but also on most of the components of the CPI (Table 6). The enhanced price of petrol and octane exercises minor impacts on some components of CPI, and in many cases, the impacts are statistically insignificant. This might be due to the fact that most of the public transport in Bangladesh run on diesel; hence changes in the prices of diesel, and not on petrol and octane, have both a short-term and a long-term effect on the whole economy.

Thirdly, upward change in fuel prices also seem to impact sub-groups of CPI, such as Gross Rent, Fuel and Lighting, Education and Entertainment, Transport and Communication, etc. In other words, diesel prices, and in some cases petrol and octane prices, have a positive relationship with consumer spending on rent, fuel and even education and entertainment. Cost of production, cost of running institutions etc. thus scale up due to increase in fuel prices.

Fourthly, in most cases, the impact of the initial rise in fuel prices continues throughout, and it sustains in the long run, albeit at a lower rate of impact. The long-term impacts of fuel prices on all of the components of consumer spending are not clear cut, but it is crystal clear that rises in consumer spending due to fuel price increases do not decrease much in the next year or so at least.

All these findings indicate that the Ukraine War did definitely have a profound impact on inflation and ultimately on consumer spending in Bangladesh, as have been discussed in the previous sections. Given the rate at which fuel prices increased in Bangladesh due to the War, consumer spending on non-food items and food items did increase by at least 13.19% and 17.4% respectively due to price hikes of diesel alone. Not only has the War caused increases in fuel prices, but this increase has

Table 6: Impact of Fuel Price Increases on CPI Inflation (based on 1% change)

Change in Pump level Price of Fuel	Level of Impact on Inflation (Measured by movements in different sub-groups of Consumer Price Index)			
	ECM		Long Run Behavior	
	Change in CPI	Nature of Impact	Error Correction Term (Sign)	Stability
CPI: Food Items				
1% increase in Price of Diesel	0.4%	Positive and Significant	Negative and Significant	Reaches stability; Initial impact decreases but sustains
1% increase in Price of Petrol	-	Statistically Insignificant	Statistically Insignificant	No statistical evidence of long run stability
1% increase in Price of Octane	-	Statistically Insignificant	Statistically Insignificant	No statistical evidence of long run stability
CPI: Non-food Items				
1% increase in Price of Diesel	0.3%	Positive and Significant	Negative but not Statistically Significant	No statistical evidence of long run stability
1% increase in Price of Petrol	-	Statistically Insignificant	Statistically Insignificant	No statistical evidence of long run stability
1% increase in Price of Octane	-	Statistically Insignificant	Statistically Insignificant	No statistical evidence of long run stability
CPI: Gross Rent, Fuel and Lighting				
1% increase in Price of Diesel	0.98%	Positive and Significant	Negative and Significant	Reaches stability; Initial impact decreases but sustains
1% increase in Price of Petrol	1.45%	Positive and Significant	Negative and Significant	Reaches stability; Initial impact decreases but sustains
1% increase in Price of Octane	1.45%	Positive and Significant	Negative and Significant	Reaches stability; Initial impact decreases but sustains
CPI: Recreation, Entertainment, Education and Cultural Services				
1% increase in Price of Diesel	0.32%	Positive and Significant	Negative and Significant	Reaches stability; Initial impact decreases but sustains
1% increase in Price of Petrol	0.45%	Positive and Significant	Negative and Significant	Reaches stability; Initial impact decreases but sustains
1% increase in Price of Octane	0.45%	Positive and Significant	Negative and Significant	Reaches stability; Initial impact decreases but sustains
CPI: Transport and Communications				
1% increase in Price of Diesel	5.03%	Positive and Significant	Positive and Significant	No statistical evidence of long run stability
1% increase in Price of Petrol	51.71381	Positive and Significant	Positive and Significant	No statistical evidence of long run stability
1% increase in Price of Octane	51.71381	Positive and Significant	Positive and Significant	No statistical evidence of long run stability

* Insignificant values have not been reflected in the Table

Source: Prepared by the Authors based on the estimated results

impacted other sectors, such as food, non-food sector in general, transport, even education, and the impact was found to be significant, as described in the previous section. Basically, increased fuel prices tend to directly increase transportation costs and production costs, which in turn increases the prices of different consumer goods.

6. Policy Recommendations

a) Energy Planning

Addressing human-induced environmental change, financial instability, inequality, unemployment, and other discouraging macroeconomic indicators in a more integrated and analytical manner is most vital, as interactions between these variables have both short-term and long-term impacts (as shown in the study). Hence, the state-owned agencies/corporation(s) like BPC, RPGCL, etc., responsible for determining the quantity of imports, energy pricing etc., should analyse the links between the economy and the energy sector, both at the disaggregated and the aggregate levels as a pre-requisite for energy pricing. Given that the exact formulae applied for the calculation of prices are treated as confidential, there is equally the need for better transparency and responsiveness regarding energy pricing.

b) Automatic Price Adjustments

If Bangladesh could establish an automatic price adjustment system for oil prices covering all the fuel items, then other sectors would also have to develop and apply specific formulae/parameters for price adjustment as well as and when necessary. As per the KIs, transportation costs such as fare for taxis, buses etc., jump upwards at a very high rate following increase in pump level oil prices, and food prices as well as prices of some other commodities are also enhanced by the concerned suppliers/vendors/retailers citing rising production costs due to rising transportation costs as the justified basis. Ironically however, when oil prices are lowered at the domestic level in response to reduced international prices, which has happened only once or twice in the past ten years or so, transportation costs don't go down pro rata to maintain an equivalent state, and food prices do not also decrease much as well. That is to say, the upward pressure on inflation due to rising oil prices do not ease out the least even when oil prices are reduced in the international market; hence, each and every sector should have better coordination with government agencies, with a parameter or formula in place for adjusting the prices. Otherwise, automatic price adjustments would only aggravate the inflationary pressure on the consumers.

c) Targeting All Sectors

All relevant segments of CPI should well be considered vis-à-vis fuel price increase to lessen consumers predicament. The adjustments in prices of fuel during price rise have a direct short-term as well as a long-term impact on many sectors of the economy, such as food, transport, recreation, and culture services, even education and entertainment. Therefore, monitoring and regulation need to be effective in the event of an increase in the prices of fuel. An estimation of how each of the price increases would affect each sector, followed by proper

subsidisation, where required, could help in easing the effects of fuel prices on consumer spending; all of these should be considered while addressing petroleum pricing.

d) Hedging Transaction Risks

Many countries trade in futures and options in order to hedge transaction risks of volatile fuel prices. According to Claessens et al (1991), the basic concept of futures contracts is that the buyer of a futures contract purchases a specific asset at a specified price on a specific date. Contract terms (fuel price, amounts, grades, delivery dates, etc.) are all standardised in futures contracts, and futures are traded only on organised exchanges through clearing house systems. To ensure good performance on these contracts, profits and losses on futures are settled daily, and futures contracts require a small "margin" as collateral. If spot oil prices rise over the planning horizon, so will futures prices. The profit from selling futures contracts back at the higher price will offset the extra cost of importing oil. Conversely, if prices fall lower oil import costs offset the loss on the futures. Trading in options is another way, where an oil call option gives the (State Owned Corporations) SOC the rights, but not the obligation, to buy a futures contract for oil at a predetermined price called the strike price. If the futures price at maturity is higher than the strike price, then the call option is valuable and will be exercised (because the SOC can buy at the lower strike price and sell at the higher market price). But if the futures price at maturity is lower than the strike price, then the option will expire without value. Purchasing call options allows the SOC to lock in maximum prices for imported oil over the planning horizon (subject to basis risk), at the cost of the premiums on the options. Bangladesh could look into these options in order to better manage the risks of price volatility of oil in the international market.

e) Hedging Long Term Risks

A good strategy for hedging long-term risks would be going for longer-dated futures contracts, which would involve buying a series of futures contracts with maturities varying from say three to twelve months. BPC or the other government agencies responsible for importing fossil fuel do have some long-term commitments with different oil exporting countries, but more contracts of this nature with predetermined prices (where trading occurs in future at prices fixed at an earlier date) would be very useful.

f) Gradual Shifting a Part of Energy Requirement to Renewable Energy

In view of the volatile nature of the international market price of most fossil fuels and its immediate repercussions, the government should diversify its energy base by way of considering renewable energy. This would help in ensuring energy security, as it is a more stable source of energy. Many other countries of the world are targeting renewable energy now, since it is environment friendly, and it doesn't deplete like fossil fuel. Bangladesh should also consider better use of renewable energy in the near future. Proper focus should be attached to fiscal measures such as introduction or expansion of FIT's (feed-in-tariffs), RPS's (renewable portfolio standards) which have been successful in attracting green investment in other countries.

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APPENDIX

Model: Modeling energy price shocks is generally carried out in the literature using Vector Auto Regression (VAR) models, Error Correction Models (ECM) etc. All these methods require time series data, and the dataset has to be large enough to ensure proper unbiased estimation of the model. However, VAR doesn't really offer a long run prediction about the movement of the variables. Error Correction Model is thus a more precise method of estimating inflation. Here, suppose it is assumed that CPI inflation is a function of global oil prices (Po), Exchange Rate (Ex), Money Supply (Ms):

$$CPI = f(Po, Ex, Ms) \dots\dots\dots (2)$$

In that case, the error correction model can be shown using the following system of equations:

$$\Delta cpi_t = \beta_0 + \sum_{i=1}^n \beta_i \Delta cpi_{t-1} + \sum_{i=1}^n \alpha_i \Delta p_{0t-1} + \sum_{i=1}^n \gamma_i \Delta Ex_{t-1} + \sum_{i=1}^n \delta_i \Delta Ms_{t-1} + \varphi z_{t-1} + u_t$$

$$cpi_t = \beta_0 + \beta_1 p_{0t} + \beta_2 Ex_t + \beta_3 Ms_t + \varepsilon_t$$

Here, the term z is the error correction term, based on the assumption that inflation might depend on the previous period deviation from a long-run equilibrium, or the error. Other variables, such as GDP, index of production etc., are also used in different specifications of the model.

In case of Bangladesh however, direct effects of international oil prices were not observable because pump level prices are adjusted at a very slow and different rate compared to international prices. Hence, the model used in this study considered domestic prices of petrol, octane, and diesel instead of international prices as regressors in the model; and since international prices are not directly included in the model, exchange rates were not included as regressors, too. Also, to control for domestic demand, quantum index of industrial production (manufacturing) as well as electricity demand have also been included in the model to understand the interactions. As prices of fuel in Bangladesh are administered prices, in order to understand the relationship between international prices and local inflation, the mechanism through which prices are adjusted is examined at first, and secondly, the effects of prices of different fossil fuels on inflation are examined. Hence, international prices would not directly be included in the model, as their effects are generally passed through via increases in pump level prices, and changes in pump level prices happen after long periods.

Data: The main sources of data used in this analysis are both primary and secondary. Primary level data were collected through KIIs from different stakeholders, and secondary level data were collected from the Bangladesh Bank database, BPC and RPGCL. Generally, for the estimation of the models mentioned in the methodology section, monthly/quarterly data on variables such as money supply, GDP, CPI etc., are considered. Monthly data on money supply and CPI is readily available in the Bangladesh Bank database. CPI is currently measured by treating 2005-06 as base year. However, monthly data on GDP is still not available in Bangladesh. Hence, as a proxy for GDP, monthly index of industrial production (manufacturing, electricity, etc.) has been included in the model. All the data has been collected from 2014 till-date, and the data is of a monthly frequency.

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