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An Empirical Study on Asymmetric Exchange Rate Pass-Through to Sectorial Inflation of Pakistan

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ABSTRACT

This study empirically examined the exchange rate pass through (ERPT) in sectoral inflation of Pakistan for the period 2007M6 to M62018 by applying the Ordinary Least Square (OLS) model. The study has used consistent monthly data with 2007-08 base year. The empirical results showed that due to 1 percentage point increase in depreciation of Pak rupee against US dollar, monthly transport inflation increased by 0.90 percentage points, monthly restaurant inflation increased by 0.78 percentage points, monthly food inflation increased by 0.27 percentage points and monthly housing inflation increased by 0.32 percentage points in the long run. It means that exchange rate has positive and significant effect on monthly transport inflation, monthly restaurant inflation, monthly food inflation and monthly housing inflation. All required diagnostic tests have been performed to verify that there is no heteroscedasticity, no autocorrelation, stability of model, and normality of estimated residuals. The study concluded that ERPT may be estimated for inflation in sub-indices of CPI as a regular practice by monetary authorities to rationalize asymmetric effects of depreciation on different sectors of the economy
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1. Introduction

The inflationary consequence of depreciation of domestic currency against foreign currencies is popularly known in the literature as exchange rate pass-through (ERPT) (Goldberg & Knetter, 1997). The ERPT can be defined as "changes in the import prices in local currency due to change in exchange rate" (Menon, 1995), while this definition was extended to change in domestic CPI due to change in exchange rate (Goldberg & Knetter, 1997). Normally the exchange rate increased the producer prices which ultimately increased the CPI of the country. But ERPT may be complete or incomplete, the ERPT is complete if the changes in the exchange rate completely reflect in domestic consumer prices. On the other hand, ERPT is incomplete if change in exchange rate is not completely reflected in domestic CPI. In the starting literature, the ERPT into domestic prices was analyzed by using demand-supply models and it was found that ERPT depends on the elasticities of demand and

supply of imports (Venables, 1990). Elasticity approach assumes perfect competition in the market, complete ERPT for small open economies, and incomplete ERPT for large, closed economies (Campa & Goldberg, 2005). However, since it concludes that modern industries follow imperfect competition and ERPT becomes incomplete, the elasticity approach becomes irrelevant to finding the ERPT in domestic prices. Consequently, the researchers paid attention to the literature based on imperfect competition to find the relationship between ERPT and industrial characteristics such as the nature of competition and market structure. Under imperfect competition, the firms earn more than normal profit and operate above marginal cost in the long run (Frankel et al., 2005). Similarly, the theory of price discrimination states that firms set different prices in different markets depending on the elasticity of demand for a product (Feenstraq et al., 1996). The firms adjust their margins and limit the ERPT in domestic prices to maintain their share in the market to avoid long run losses resulting in incomplete pass through of exchange rate. So, the model of law of one price is altered by introducing a profit margin in the model in the presence of imperfect competition to explain the ERPT into import prices of goods.

Exchange rate changes affect domestic prices through direct and indirect channels. The openness of the economy increases the significance of both these channels (Hufner& Schroder, 2002). The direct channel runs via the external sector of the economy, especially through the relative share of imports in CPI (Muellbauer et al., 2014). The depreciation in the exchange rate increased the prices of imported goods. Then similarly in line the producers and importers increased their prices, and ultimately transferred into producer prices and CPI of the economy caused higher inflation in the economy. The indirect channel of ERPT drives through inflation expectations and changes in level of aggregate demand and wages (Mccauley, 2003). The highest ERPT will be observed, if the changes in exchange rate are professed to be of a persistent nature and expectations of the public are adjusted by the price (Taylor, 2000). Another channel of ERPT runs via increase in aggregate demand of domestic goods. The depreciation of exchange rate causes domestic goods to become cheaper in international market due to which the exports of the country and domestic demand for goods increase. This increase in demand for goods puts pressure on the prices and output in the short run. In the long run, prices will be stable at new levels of high price and decreased output (Ahn et al., 2016). Similarly, if the supply of goods is rigid, the indirect channel of ERPT puts pressure on the supply of goods and exchange rate depreciation will increases the exports causing shortage of the supply of the commodity and ultimately increased the domestic prices (Raisi & Pattanaik, 2005). The direct channel of ERPT to domestic prices dominates on the indirect channel, if the import intensity of export in the economy is higher, faster adjustment in prices and wages takes place. On the other hand, the direct channel of ERPT may be verified to be weak, if the economy is more diversified, and if depreciation increased the production of domestic substitutes, and domestic demand is reduced by the rise in the price of imported goods (Saha & Zhang, 2016).

The ERPT to CPI inflation is always lower than in import prices, as the domestic prices reacted slower than import prices due to depreciation of exchange rate (Bailliu & Bouakez, 2004). The determinants of ERPT to domestic prices remained same to explain the incomplete ERPT to CPI inflation. However, the literature explained the other factors and reasons of low ERPT to CPI inflation than producer price and import price. Microeconomic factors like distribution costs of traded goods, composition of CPI basket and availability of import substitutes are main factors of low ERPT (Berzgonz et al., 2017). The composition of CPI of the country normally consisted of tradable and non -tradable goods and services. Thus, larger the share of non-trade able goods & services in basket of CPI as compared to trade able goods & services, lower the response of exchange rate pass through to CPI inflation (McCauley, 2003).

Moreover, the distribution costs (wholesaling, transportation, and retailing) have been included in CPI and in tradable goods. Thus, in the presence of distribution costs, the response of the tradable goods to change in exchange rate becomes lower. The larger the share of the distribution cost in the price of tradable goods, lower the response of ERPT at consumer level. If the share of the distribution cost is larger in tradable goods, the ERPT to CPI inflation becomes lower (Corsetti & Dedola, 2005).

Moreover, imported goods are substituted with locally produced goods, so the price of these goods purely on the local conditions of the economy and assumed to be independent of depreciation (Bailliu & Bouakez, 2004). Though it did not mean that depreciation did not affect the locally produced goods, however, it explained that the pass through of exchange rate to CPI inflation was not always equal to the share of import prices in consumption basket. Additionally, it is most important to highlight that the impact of ERPT on locally produced goods is a function to factors like nominal wage stickiness, adjustment cost of domestic prices and substitutability with imports. Furthermore, the size of ERPT decreases along with distribution chain, due to the fraction of traded goods in the different stages of distribution chain and gathering over larger number of incomplete ERPT stages. The shock in the exchange rate is more likely to affect the fraction of traded goods. But the impact of ERPT on fraction of traded good tends to decrease with distribution chain.

The estimation of ERPT at aggregate level ignores the heterogeneity in the sub sectors of CPI, which creates the problem in accurately assessing ERPT. The prices of raw material are more flexible than the prices of processed goods and the prices of services are stickier than goods prices (Klenow&Malin, 2011). So, investigation conducted at disaggregated level will capture more accurately the time dynamics involved. There are different studies, which have investigated the pass through of global commodity prices to inflation in different sub-indices of CPI. Analysis by sub-indices of CPI revealed that sensitivity to commodity prices is high among the sectors that have large dependency on imported inputs such as basic metals, electricity, gas, petroleum products and food prices (Kemal, 2016). Similarly, Ibrahim and Said (2011) found that exchange rate changes have different level of pass through for sub sectors of CPI.

The Pak Rupee is being depreciated against US dollar by 74.5% from July 2007 to November 2017 and by 57% from November 2017 to June 2020. Previous literature for Pakistan has provided empirical evidence of ERPT at aggregate level or core and food inflation, and impact of exchange rate on net exports in separate studies (Jaffri, 2010; Hanif, 2012; SBP, 2007; Yasmeen et al., 2018).

Consumer Price Index (CPI) is calculated by Pakistan Bureau of Statistics (PBS) taking 487 items from 40 cities and 76 markets of the country. There are two main groups of CPI, food having 37.5 % weightage and Non-food group having 62.5% weightage share in CPI. The base year of calculating CPI is changing with the passage of time, 1st time CPI was calculated with base year 1947-48 and currently the CPI is calculated with the base year 2007-081.

Table 1 showed that food group of CPI having weightage of 37.5 percent is further divided into 03 groups namely, food products, beverages and tobacco having weightage 34.8 percent, alcoholic beverages having weightage of 1.4 percent and Restaurant & hotels having weightage of 1.2 percent. The nonfood group of CPI having weightage of 62.5 percent is further divided into 09 sub-groups namely, clothing & foot wear having weightage of 7.6 percent, housing, water, electricity, gas and fuel having weightage of 29.4 percent, furnishing & household having weightage 4.2 percent, health having weightage 2.2 percent, transport having weightage 7.2 percent, communication having weightage 3.2 percent, recreation & culture having weightage 2 percent, education having weightage 3.9 percent and miscellaneous having weightage 2 percent share.

Table 1: Composition of CPI in Pakistan with Base 2007-08

Groups	Weightage	Total Weightage
Food Group		37.5
Food Products, Beverages and Tobacco	34.8	
Alcoholic Beverages	1.4	
Restaurant & Hotels	1.2	
Non-Food Group		62.5

1The CPI is calculated by using Laspeyers formula. $I_t = \sum_J W_0^J \left(\frac{P_t^j}{P_0^j}\right)$ Where W_0^j is weight of commodity, I_i is price index, J in the overall basket P_t^j is price in current period t and P_0^j is the price in base year.

Clothing & Footwear	7.6	
Housing, Water, Elec. Gas & other Fuel	29.4	
Furnishing &Household Equip.	4.2	
Health	2.2	
Transport	7.2	
Communication	3.2	
Recreation & culture	2	
Education	3.9	
Miscellaneous	2	
Total		100
Source: Economic Survey of Pakistan 2018-19		

The recent studies conducted for Pakistan on the issue of ERPT to CPI estimated the ERPT to CPI inflation at aggregate level, core inflation and food inflation and found low ERPT to CPI inflation. (Ehsan et al., 2002; Jaffri et al., 2014; Hanif et al., 2017). But less attention on asymmetric pass through of exchange rate to sub-indices of CPI. A growing but needed strand of literature on ERPT deals with estimating pass through at disaggregates level. The studies conducted at disaggregated level found that ERPT in food and housing and furnishing is low but high in transport, restaurants, and communication sectors (Aron et al., 2014; He et al., 2015). There are various reasons of asymmetric pass-through for subcomponents of CPI including degree of financial dollarization, labor market flexibility, food and transport share in CPI basket, fuel intensity and trade openness (Ozmen & Topaloglu, 2017; Gelos & Ustyugova,2017; Kemal, 2016). The study is a significant contribution in the existing literature for Pakistan and provides important policy implications to control inflation and its asymmetric impact on different sectors of the economy.

2. Literature Review

The existence of asymmetry in the influence of shifts in exchange rates on domestic prices has been verified by several empirical studies. Mann (1986), for instance, has analyzed US pass through for aggregate data. During the dollar increase, though, the disparity was statistically insignificant, and the contrasting numbers were greater than during the dollar rise. Khundrakpam (2007) also found higher levels of appreciation than depreciation for its Indian Pass-through Study. Ohno (1989) has considered Japanese export prices to vary more from small changes in exchange rates instead of large, based on the size of the exchange-rate difference. Pollard and Coughlin (2004) pointed out in their research on 30 US sectors that most firms adapt costs with large changes in exchange rates. Khundrakpam (2007) has, by comparison, seen greater success in India for small changes than for large in exchange levels.

Studies examining ERPT in Consumer and Producer Price indices have primarily centered on aggregate price data. This focus on aggregate data offers two distinct advantages. Firstly, composite indexes are built upon a vast number of micro-prices, frequently updated, and carry economic significance due to the varying weights attributed to them, which are drawn from sources like consumer price surveys, as seen in the CPI. In contrast, disaggregated price data experiments often combine these data points with equal weight, sometimes for the sake of convenience or for a specific pricing category that might not necessarily represent the most intensive usage. As a result, the resulting "aggregate" may not closely align with the primary concerns of monetary policymakers. Moreover, adopting a systematic approach through aggregate price indexes can help distinguish external fluctuations from adjustments in exchange rates. This approach can effectively address the feedback effects of monetary policies within ERPT relationships. In contrast, micro-analyses often lack the ability to address these aspects comprehensively.

ERPT studies have been intensively using disaggregated trade prices, mainly for industrialized countries, at industry, business, and product levels. Even in the early study by Menon in 1995, almost half (with a handful at goods' level) studies on import price pass-through used disaggregate data from

the industry. Moreover, standardized international trade-market definitions have facilitated this relative prevalence.

Conducting additional analyses at the micro-level, both in aggregate and within specific sectors, can significantly enhance our comprehension of critical inflation-driving factors. This is particularly vital when dealing with the often volatile and unpredictable food and energy prices that play a pivotal role in shaping inflation patterns in developing nations. In some studies, Exchange Rate Pass-Through (ERPT) is examined concerning primary components of global price indices like the Producer Price Index (PPI) or the Consumer Price Index (CPI) but often over relatively short time frames, as seen in Soffer's work in 2006. Furthermore, Parsley (2012) contributed to the field by estimating ERPT in developing markets, using data that was partly disaggregated from the Economist Intelligence Unit (EIU). A recent strand of the forecasting literature has focused on predicting sectoral inflation within sub-components of the CPI. These studies, conducted by Aron et al. (2014), He et al. (2015), Chuah et al. (2015), have provided valuable insights into the dynamics of ERPT. These sectoral forecasts offer a more detailed understanding of how exchange rate fluctuations impact specific segments of the economy.

Chabot & Khan (2015) estimated the ERPT in domestic price of Canada by using time series quarterly data from 1995-2013. The study concluded that the depreciation have size able boost in the inflation. However, the increase in the inflation was not persistent, it was only for the short term, so the ERPT can exert only transitory effect on the domestic inflation in Canada. Therefore, it is important for the policy makers to monitor the ERPT very closely and distinguish the permanent effect and transitory effect on inflation. The policy makers used the measure of core inflation to isolate the persistent inflation effect, but even this measure is not protected from the ERPT.

Hunegnaw (2015) estimated the ERPT into domestic inflation of Ethiopia for the period 1983 to 2013 by using Autoregressive Distributed Lag (ARDL) model. The study found that the exchange rate is not passing through to domestic inflation. Some other factors like money supply and output growth affect the inflation. The study concluded that the depreciation is not affecting the prices in the country therefore, the Government can use the depreciation as stabilization policy and overcome the problem of current account deficit.

He et al. (2015) estimated the ERPT in sub sectors by using dynamic beysian network technique for the period 1999-2014 of China. The study used local polynomial regression altgorithm to fix the issue of non-stationarity and estimated the ERPT in four price indices of CPI. The study found that ERPT in CPI is significant, but the effect in PPI (Producer Price Index) was not significant. The study finally concluded that although ERPT in CPI was low,but high in different sub-indices, like transport and Restaurants.

Ahn et al. (2016) estimated the ERPT to domestic producer prices by using time series data of Korea and selected European Countries from 1999 to 2014. The study used error correction model (ECM) after constructing the input price indices from sector level price data with sector level information on input output linkages to estimate the ERPT across sectors. The study generated the consistent and efficient indices to estimate the ERPT from imported input prices to domestic PPI. The study found that ERPT varies in cross country and producer price is the main source of inflation.

Saha & Zhang (2016) employed monthly time series data spanning from 1990 to 2011 to estimate ERPT on a disaggregate level within CPI and various sectors across two emerging nations and one advanced economy. The research used a structural VAR model and uncovered disparities in ERPT not only between the aggregate and disaggregate levels in various CPI sub-indices but also within different sectors of these economies. Moreover, the investigation explored the correlation between pass-through effects and the average inflation rate in these countries. The findings indicated that ERPT at the aggregate level was more pronounced in emerging economies compared to developed ones. The study also emphasized the need for a reevaluation of monetary policy in these economies, particularly with regard to controlling inflation, as ERPT in the sub-indices of CPI offered valuable insights into the matter.

Ozmen & Topaloglu (2017) estimated ERPT at a disaggregated level in Turkey. The study analyzed

time series data spanning the years 2005 to 2015. The methodology applied an extended VAR model to examine all 152 sub-indices of the CPI to understand ERPT. The study's findings revealed significant variability across different components of the CPI, emphasizing that ERPT was notably high even within sectors such as food inflation, services, and core inflation in Turkey. A notable conclusion drawn from the study was that relying solely on ERPT at the aggregate level could be misleading due to aggregation bias. The results at the aggregate level might underestimate the actual ERPT. Given the variation in pass-through rates within different sub-sectors of the CPI, the study highlighted the growing importance of gaining a comprehensive understanding of ERPT at a disaggregated level to enhance the formulation of more effective policies. In summary, the study proposed that an in-depth analysis of ERPT within the CPI at a disaggregated level is essential for the improved implementation of monetary policy.

Rahimov et al. (2017) explore the ERPT to domestic prices at aggregate level and in sub-indices by using VAR model for the period from 2003 to 2016. The study concluded that ERPT at aggregate level is low and incomplete. However, at a disaggregated level the ERPT is different in different sectors/ Sub-indices. The study found that the ERPT in food and housing is low, while in transport sector and nonfood the ERPT is high. Similarly, the ERPT in the services sector is also very low. The study concluded that the policy maker should carefully consider the ERPT in domestic prices and concentrate different sectors differently while finalizing the policy for ERPT.

Berzgonz et al. (2017) empirically analyzed the heterogeneity of ERPT in advance and emerging economies by using data for the period of 1995-2016. The study has used the BVAR model to estimate the decrease in the ERPT in different developed and emerging economies. The study found that ERPT in domestic prices is high in those economies where depreciation of currency or rise of exchange rate is due to monetary policy followed by demand shock. The study concluded that these findings have important implication for the policy makers that it is not important to control the ERPT by standard rule of thumb. Instead, it is important to analyze why exchange rates have moved in the first place, then estimate the expected pass through of exchange rate in prices and then adopt the proper policy response. Therefore, the central bank should continuously reexamine the effect of different shocks on the exchange rate and consequent impact on the domestic prices and import prices.

Kim and Lin (2018) conducted a study that examined the rate of ERPT to CPI in the United States. The study utilized monthly data for the period from 1973 to 2017 and employed a VAR model to analyze the data and identified a structural break in the rate of ERPT to CPI in the US. The study found that the downward trend in the ERPT to CPI in for US in floating exchange rate ragime. Frankel et al. (2012), found similar results in international scenario more importantly in developing economies. The study used the data set of 76 countries for the period from 1990 to 2001 and concluded that ERPT in developing economies was more repaid than develop economies. It was due to Blassma-Samuelson-Baumol effect that ERPT declined in develop economies.

Korsa et al. (2018) conducted a study to evaluate Exchange Rate Pass-Through (ERPT) in Ethiopia, utilizing time series data spanning from 1995 to 2017. The research employed an Autoregressive Distributed Lag (ARDL) model to estimate how changes in the exchange rate, output gap, the world commodity price index, and money supply impact domestic inflation. The study's findings revealed that, in the short term, fluctuations in the exchange rate did not significantly affect the domestic Consumer Price Index (CPI). Conversely, global inflation and variations in money supply were found to have a positive impact on CPI during the same time frame. However, the study concluded that in the long run, ERPT was relatively low, with initial changes in these variables having a self-reinforcing effect that diminished over time. This suggests that while certain factors exerted short-term pressures on inflation, their influence waned over the long term.

Asafo, (2019) estimated the ERPT in domestic prices by using VAR model for the period of 2006 to 2015 in Ghana. The study included some feature of Ghana economy in the model like dependence on primary export, dependency on foreign aid to explain the ERPT in domestic prices. The study found that ERPT is high in domestic prices and major cause of inflation. However, the ERPT is incomplete.

The study concluded that to control inflation the policy makers should control the fluctuation in the exchange rate.

Aron et al. (2014) estimated the ERPT by using micro data set of CPI for the period of 2002 to 2007 of South Africa. The study used the OLS regressions to estimate the ERPT in aggregate CPI and in 1006 products of CPI and in different price level of food in different time horizon. Most importantly the study estimated the ERPT in food inflation and into subgroups of food, with heterogeneous specification for each. The study found that ERPT in food at aggregate level is very low but high at product level, similarly the ERPT in overall CPI is also very low. Interestingly, the ERPT in food and different components of food is heterogeneous in different time periods. The ERPT after six months was low than 12 months and 18 months. The study also found that ERPT in transport and Restaurants was high and low in households sub-indices of CPI.

Few studies estimated the ERPT in Pakistan and found low ERPT in domestic prices in Pakistan. Ahmed et al. (2018) estimated the ERPT in oil price, import price, consumer price and interest rate by employing VAR model for the period July 2005 to December 2015 in the context of Pakistani economy. The study estimated the ERPT and causality between variables. The study found that ERPT is low in Pakistan, but causality exist between exchange rate, money supply and discount rate. The study also concluded that exchange rate mainly explained by money supply and CPI in Pakistan and policy makers should take steps with accordance to explanation of exchange rate by different sectors.

Sheikh & Hussain (2012) estimated the ERPT in wholesale prices, aggregate CPI, large scale manufacturing and fuel & lightening by using VAR and impulse response model for the period of 2005 to 2011 for Pakistan economy. The study found that ERPT in wholesale price is very high, while in aggregate CPI very low for the period. Hyder & Shah (2004) conducted a study to assess the Exchange Rate Pass-Through (ERPT) concerning both Consumer Price Index (CPI) inflation and wholesale price inflation in Pakistan. They analyzed time series data spanning from January 1988 to September 2003. To gauge ERPT into CPI inflation, the study employed a VAR model, impulse response analysis, and variance decomposition. The study's findings revealed that ERPT to CPI inflation was relatively low, exerting a moderate influence. In contrast, the ERPT into wholesale prices exhibited a higher impact over a 12-month long-term period. Interestingly, the study made a significant observation that ERPT to CPI inflation notably weakened after July 2000, coinciding with a change in Pakistan's exchange rate regime. Furthermore, the study highlighted that within the wholesale price category, the ERPT was particularly prominent in the "fuel & lighting" and "transport & communication" sectors. These insights contribute to a better understanding of how exchange rate fluctuations affect price dynamics, both in the broader consumer economy and specific industries.

3. Methodology

The models of ERPT were based on the prices of imported goods and behavior of the firms that export goods in the domestic firms (Bailliu & Fuji, 2004). We will consider the simple static profit maximization problem. The equation follows is as under.

$$\underset{P}{Max}\pi = A^{-1}pq - c(q) \qquad (1)$$

Where π shows profit, A is exchange rate, P is price of goods, q is quantity demand and C(.) is cost function in foreign currency. The first order condition of the model is as below.

$$P=AC_q\mu \qquad (2)$$

In the given equation, 'Cq' represents the marginal cost of the product, and 'μ' stands for the markup over the marginal cost. Equation 3 illustrates that change in the domestic price of goods can be attributed to changes in the exchange rate as well as fluctuations in a firm's marginal cost. Notably, changes in a firm's marginal cost or markup are self-contained, not contingent on variations in the exchange rate. Instead, it's the modification in input costs that affects the marginal cost. Furthermore, external factors like demand shocks in foreign countries can lead to adjustments in the exporter's

markup. Therefore, it becomes crucial to incorporate these factors into the model when estimating Exchange Rate Pass-Through (ERPT). This broader perspective ensures a more accurate understanding of the dynamics involved in ERPT. The reduced form of the equation will be as follows.

$$P_t = \alpha_{1+} \alpha_2 A_t + \alpha_3 W_t + \alpha_4 Y_t + \mathcal{E}_t Eq\ (3)$$

In the above equation $W_t$is markup of exports and $Y_t$is demand in importing country. α_2 measures ERPT. The variant of above equation is widely used in the empirical literature (Goldberg &Knetter ,1997)

So, the equation 3 in modeling/ equation can be written as

$$INF_t = \alpha + \sum_{i=1}^{n} \delta_i\, INF_{t-i} + \sum_{i=0}^{n} \phi_i\, YG_{t-i} + \sum_{i=0}^{n} \theta_i\, GINF_{t-i} + \sum_{i=0}^{n} v_i\, ER_{t-i} + \varepsilon_t (4)$$

In this equation INF_t represents the percentage change in the Consumer Price Index for Pakistan. YG denotes the output gap, which is calculated as the difference between the manufacturing index and its trend. GINF signifies the percentage change in the global consumer price index. Lastly, ER corresponds to the exchange rate between the Pakistani Rupee and the US Dollar.

The long run of ERPT is calculated as follows.

$$PT_{ER} = \frac{\sum_{i=0}^{n} v_i}{1-\sum_{i=1}^{n} \delta_i} \quad (5)$$

The same model will be used at aggregate level of CPI and in sub- indices of CPI. In adopting the variables in the model, there are several issues which are kept in consideration. First it is generally the exchange rate and other variables are not stationary at level. Therefore, the different model will be used to estimate the ERPT.

Secondly, the literature showed that inflation has inertial behavior. But it is not easy in theoretical models to capture engaging adoptive expectations. So, this issue can be solved by backward rule of thumb. So in empirical research, this theoretical challenge is overcome by including the lags of inflation as explanatory variable in the model.

Third, in the final model we need to use the variable which is suitable for both consumer and producers. This issue is solved by using output gap to proxy for domestic demand condition. Finally, the price of global commodity is also used in the model as external inflation.

3.1. Estimation Technique

The research conducted a unit root test and determined that all the variables employed in the models exhibit an I(0). After considering various econometric methods suitable for this data type, the study opted to employ the Ordinary Least Squares (OLS) technique to assess the long-term relationship regarding ERPT.

3.2. Data Source

The study estimated the ERPT to CPI inflation and inflation of selected sub-indices of CPI and used the consistent time series monthly data from July 2008 to June 2018 with the base year of 2008-09. The month on month (MOM) data of consumer price index (CPI) inflation, Food & non beverages inflation, Housing inflation, Transport inflation, Restaurant inflation, and exchange rate of Pak Rupee against US $ are obtained from Pakistan Bureau of statistics (PBS) while data of global commodity index obtained from International Finance Statistics (IFS). The monthly data of GDP is not available; therefore, the study used the manufacturing index as proxy of GDP. Many studies have used manufacturing index as proxy of GDP (Jaffri,2010).

4. Results and Discussion

The study estimated the ERPT to transport inflation (INF_1), Food & nonalcoholic beverages inflation (INF_2), housing & furnishing inflation (INF_3) and Restaurant inflation (INF_4) of CPI sub-indices. To estimate the ERPT at disaggregated level, the study has followed the same model of Gelos & Ustyugova (2017) to compare the results of ERPT at disaggregate level with the result of ERPT at aggregate level. In estimation of all models the independent variables remain same only dependent variable changed. The stationarity of all the variables have been checked by Applying the

Augmented Dickey Fuller (ADF) test and results are shown in table 2.

Table 2: Stationarity Tests (ADF) for Models of ERPT At Disaggregate Level

Series	With Intercept	With Intercept and Trend	Level of Integration
INF_1	-7.95(0)***	-7.92(0)***	I(0)
INF_2	-10.64(0)***	-11.06(0)***	I(0)
INF_3	-3.88(0)***	-3.91(0)***	I(0)
INF_4	-3.88(0)***	-3.91(0)***	I(0)
YGAP	-3.78(0)**	-3.79(0)**	I(0)
DLGEPI	-7.32(0)***	-7.29(0)***	I(0)
DLER	-7.15(0)***	-7.21(0)***	I(0)

Note:*** showed that series is stationary at 1%, and ** showed that series is stationary at 5%. The results of INF_1 (Transport inflation), INF_2 (Food &non alcoholic beverages inflation), INF_3 (Housing furnishing inflation), INF_4 (Restaurant inflation), YGAP (Output gap), DLGEPI (Global energy price inflation) , and DLER(Exchange rate of Pak rupee against US $) are significant at 1% with intercept and with intercept and trend.

The table 02 showed that showed that all the variables are stationary at level with intercept and with intercept & trend. So the most suitable technique to estimate the ERPT in the long run is OLS.

Model-I: The ERPT to Transport Inflation

In the disaggregated model the study estimated the model of transport inflation. The transport index has 7.32 % weight in the CPI basket of goods. Since all the variables in the model exhibit stationarity at the level, as indicated in Table 3, the study employed the Ordinary Least Squares (OLS) method to obtain the results.

Table 3: Estimation Results (OLS) Model-II (Dependent Variable: INF_1)

Variables	Coefficients	t-values	Probability
C	0.001045	0.66	0.5086
INF_1(-1)	0.226581	2.25**	0.0272
INF_1(-2)	-0.228509	-2.49***	0.0149
YGAP	0.013026	0.89	0.3717
DLER	0.250529	1.95**	0.0544
DLER(-1)	-0.027254	-0.18	0.8509
DLER(-2)	0.309292	2.14**	0.0354
DLER(-3)	0.118606	0.77	0.4381
DLER(-4)	0.088736	0.58	0.5597
DLER(-5)	-0.216086	-1.44	0.1520
DLER(-6)	-0.454782	-3.02***	0.0034
DLER(-7)	0.350111	2.04**	0.0449
DLER(-8)	0.448274	2.63***	0.0104
DLGEPI	-0.005177	-0.24	0.8086
DLGEPI(-1)	0.085703	3.92***	0.0002
DLGEPI(-2)	0.025361	1.10	0.2741
DLGEPI(-3)	-0.012045	-0.53	0.5950
DLGEPI(-4)	0.044430	2.05**	0.0435
DLGEPI(-5)	0.037364	1.80*	0.0757

Note:-*** showed that coefficient are significant at 1%, ** showed that coefficient are significant at 5% and *showed that coefficient are significant at 10%. The study used 12 lags of all the variables and applied general to specific technique to finalize the model. The above results showed that 1st& 2nd lag of INF_1, 2nd, 6th , 7th and 8th lag of exchange rate,1st, 4th and 5th lag of global energy inflation are significant.

The table 02 showed that all the variables are stationary at level, therefore, most suitable technique to test long run ERPT to transport inflation is Ordinary Least Square (OLS) model. The study used the monthly data, and the best model is selected by adopting general to specific methodology for lag selection of dependent and independent variables taking maximum 12 lags.

According to the results provided in Table 03, the model displays predominantly correct signs for the maximum coefficients, and a significant portion of these coefficients holds statistical significance. The study's estimation of the long-term Exchange Rate Pass-Through (ERPT), as per Equation 3.6, stands at 0.90. This implies that, over an extended period, specifically within 12 months, a 1 percentage point depreciation of the Pakistani rupee against the US dollar results in a 0.90 percentage point increase in transport inflation.

Table 04 showed the results of diagnostic test applied on the model-I. The diagnostics for testing the stability of the model revels that the model is stable over the period of analysis and these findings can be considered consistent.

Model-II: The ERPT to Food & Non-alcoholic Beverages Inflation

In disaggregated models , the study estimated the model ERPT to food & non alcoholic beverages index having highest weightage in the CPI almost 38%. The study used the same model to estimate the ERPT with same independent variables i-e output gap, exchange rate of Pak rupee against US dollar, and global energy price inflation.

Table 4: Estimation Results (OLS) Model-III (Dependent Variable: INF_2)

Variables	Coefficients	t-values	Probability
C	0.003046	1.31	0.1932
INF_2(-1)	-0.062957	-0.57	0.5682
INF_2(-2)	-0.234010	-1.98**	0.0503
INF_2(-3)	0.094922	0.86	0.3872
INF_2(-4)	0.175521	1.59	0.1155
INF_2(-5)	0.076715	0.73	0.4703
INF_2(-6)	0.264443	2.52***	0.0136
YGAP(-1)	-0.001444	-0.05	0.9582
YGAP(-2)	-0.064196	-2.03	0.0455
YGAP(-3)	0.140531	5.30***	0.0000
DLER	-0.228431	-1.66	0.1004
DLER(-1)	0.132382	0.85	0.3924
DLER(-2)	0.230782	1.48	0.1403
DLER(-3)	0.057154	0.36	0.7196
DLER(-4)	-0.093085	-0.57	0.5700
DLER(-5)	-0.094151	-0.57	0.5661
DLER(-6)	-0.162614	-0.99	0.3213
DLER(-7)	0.043210	0.28	0.7789
DLER(-8)	-0.036277	-0.22	0.8237
DLER(-9)	0.267467	1.76*	0.0806
DLGEPI	0.007912	0.36	0.7215
DLGEPI(-1)	0.022075	1.05	0.2979
DLGEPI(-2)	-0.006151	-0.29	0.7706
DLGEPI(-3)	0.003121	0.15	0.8809
DLGEPI(-4)	-0.009936	-0.48	0.6349
DLGEPI(-5)	0.036711	1.76*	0.0812

Note:- *** showed that coefficient are significant at 1%, ** showed that coefficient are significant at 5% and *showed that coefficient are significant at 10%. The study used 12 lags of all the variables and applied general to specific technique to finalize the model. The above results showed that 2^{nd}& 6^{th} lag of INF_2, 9^{th} lag of exchange rate,

and 5th lag of global energy inflation are significant.

The table 02 showed that all variables are stationary at level, therefore, most suitable technique to test the long run ERPT to food inflation is Ordinary Least Square (OLS) model. The study used the monthly data and the best model is selected by adopting general to specific methodology for lag selection of dependent and independent variables taking maximum 12 lags.

As indicated in Table 04, the majority of coefficients exhibit the correct signs and most of the coefficients are statistically significant. The outcomes above illustrate that the ERPT in food inflation is relatively low, specifically at 0.27. This is attributed to the fact that food prices within this group are subject to administrative controls. In practical terms, this implies that a 1 percentage point increase in the depreciation of the Pakistani rupee against the US dollar leads to a mere 0.27 percentage point increase in monthly food inflation over the long run.

Table 07 showed the results of diagnostic test applied on the model-III. The diagnostics for testing the stability of the model revels that the model is stable over the period of analysis and these findings can be considered consistent.

Model-III: The ERPT to Housing & Furnishing Inflation

In disaggregated model, the study estimated the ERPT to Housing and Furnishing inflation. The housing & furnishing index has 4.21 % weightage in the CPI basket of goods. Housing and furnishing sector is one of the major area for job producing in Pakistan economy. Government of Pakistan has also announced to construct 5 million houses in 5 years (2018-2023). It increased the importance of this sector.

Table 5: Estimation Results (OLS) Model-IV (Dependent Variable: INF_3)

Variables	Coefficients	t-values	Probability
C	0.001371	2.44***	0.0181
INF_3(-1)	0.069503	0.56	0.5767
INF_3(-2)	0.078219	0.65	0.5178
INF_3(-3)	0.249329	2.50***	0.0157
YGAP	0.018205	2.00**	0.0503
YGAP(-1)	0.014796	1.52	0.1327
YGAP(-2)	0.004491	0.62	0.5360
YGAP(-3)	0.006645	0.90	0.3710
YGAP(-4)	0.024393	2.79***	0.0075
YGAP(-5)	0.011217	1.26	0.2130
YGAP(-6)	-0.006760	-0.94	0.3538
YGAP(-7)	0.012172	1.67	0.1008
YGAP(-8)	0.013603	1.39	0.1692
YGAP(-9)	0.021664	2.22**	0.0311
DLER	0.027658	0.95	0.3462
DLER(-1)	0.017664	0.54	0.5895
DLER(-2)	-0.033440	-0.96	0.3425
DLER(-3)	-0.059073	-1.58	0.1204
DLER(-4)	0.112572	2.95***	0.0049
DLER(-5)	-0.006929	-0.18	0.8596
DLER(-6)	-0.014954	-0.38	0.7063
DLER(-7)	-0.028461	-0.73	0.4659
DLER(-8)	-0.030191	-0.78	0.4362
DLER(-9)	0.083260	2.13**	0.0384
DLGEPI	0.004284	0.75	0.4542
DLGEPI(-1)	-0.007468	-1.29	0.2021
DLGEPI(-2)	0.008847	1.56	0.1252
DLGEPI(-3)	0.000319	0.06	0.9549

DLGEPI(-4)	0.000166	0.029	0.9766
DLGEPI(-5)	0.015130	2.73***	0.0089
DLGEPI(-6)	-0.011745	-2.28**	0.0270

Note:- *** showed that coefficient are significant at 1%, and ** showed that coefficient are significant at 5% . The study used 12 lags of all the variables and applied general to specific technique to finalize the model. The above results showed that 3rd lag of INF_3, 4th& 9th lag of exchange rate,5th& 6th lag of global energy inflation are significant

The table 02 showed that all variables are stationary at level, therefore, most suitable technique to test the long run ERPT is Ordinary Least Square (OLS) model. The study used the monthly data and best model is selected by adopting general to specific methodology for lag selection of dependent and independent variables taking maximum 12 lags.

According to the findings presented in Table 05, maximum coefficients in the model exhibit the expected signs, and majority of them are statistically significant. The estimated long-run Exchange Rate Pass-Through (ERPT) is 0.32. This means that a 1 percentage point increase in the depreciation of the rupee against the US dollar results in a 0.32 percentage point increase in monthly housing and furnishing inflation over the long run, specifically within a 12-month period.

Table 9 showed the results of diagnostic test applied on the model-IV. The diagnostics for testing the stability of the model revels that the model is stable over the period of analysis and these findings can be considered consistent.

Model-IV: The ERPT to Restaurant Inflation

In the fifth model, the study estimated the ERPT to restaurant inflation, the study has used the same model of ERPT and same independent variables i-e output growth, exchange rate US $ to Pak rupee, and global energy price index. The model is finalized by using general to specific technique and initially included 12 lags of all the variables and the results of final selected model are shown in table 4.9.

Table 6: Estimation Results (OLS) Model-V (Dependent Variable: INF_4)

Variables	**Coefficients**	**t-values**	**Probability**
C	-5.81E-05	-0.058374	0.9537
INF_4(-1)	0.365042	3.30***	0.0018
INF_4(-2)	0.134743	1.12	0.2674
INF_4(-3)	-0.048577	-0.40	0.6843
INF_4(-4)	0.281723	2.38**	0.0210
INF_4(-5)	-0.251478	-2.10**	0.0403
INF_4(-6)	-0.104744	-0.85	0.3975
INF_4(-7)	0.252461	2.14**	0.0367
INF_4(-8)	0.254335	2.05**	0.0451
INF_4(-9)	-0.205458	-1.74	0.0864
INF_4(-10)	-0.016887	-0.15	0.8816
INF_4(-11)	0.194834	1.84*	0.0708
YGAP	0.004803	0.58	0.5614
YGAP(-1)	0.023318	2.71***	0.0091
YGAP(-2)	-0.018482	-2.09**	0.0419
YGAP(-3)	0.025317	2.76***	0.0081
YGAP(-4)	0.000190	0.02	0.9832
YGAP(-5)	-0.016448	-1.81*	0.0760
YGAP(-6)	-0.003184	-0.35	0.7246
YGAP(-7)	0.029969	3.53***	0.0009
DLER	0.038043	1.13	0.2629
DLER(-1)	0.025703	0.62	0.5346

DLER(-2)	-0.003635	-0.08	0.9343
DLER(-3)	-0.046861	-1.03	0.3098
DLER(-4)	0.093089	2.15**	0.0363
DLGEPI	0.007870	1.27	0.2092
DLGEPI(-1)	-7.46E-05	-0.01	0.9908
DLGEPI(-2)	-0.005299	-0.82	0.4148
DLGEPI(-3)	0.006332	0.97	0.3366
DLGEPI(-4)	-0.003932	-0.62	0.5383
DLGEPI(-5)	0.002155	0.33	0.7390
DLGEPI(-6)	-0.011625	-1.91*	0.0615

Note:- *** showed that coefficients are significant at 1%, ** showed that coefficients are significant at 5% and *showed that coefficients are significant at 10%. The study used 12 lags of all the variables and applied general to specific technique to finalize the model. The above results showed that 1^{st} ,5^{th} , 7^{th}& 11^{th} lag of INF_4, 4^{th} lag of exchange rate,6^{th} lag of global energy inflation are significant

The table 2 showed that all variables are stationary at level, therefore, most suitable technique to test the long run ERPT is Ordinary Least Square (OLS) model. The study used monthly data and the best model is selected by adopting general to specific methodology for lag selection of dependent and independent variables taking maximum 12 lags.

Based on the findings presented in Table 06, the coefficients in the model display the expected signs, and a majority of them are statistically significant. The estimated long-run Exchange Rate Pass-Through (ERPT) is 0.78. This suggests that a 1 percentage point increase in the depreciation of the rupee against the US dollar leads to a 0.78 percentage point increase in the long run, specifically within a 12-month period.

Table 07 showed the results of diagnostic test applied on the model-V. The diagnostics for testing the stability of the model revels that the model is stable over the period of analysis and these findings can be considered consistent.

Table 7: Diagnostic Tests (Model-II, III, IV and V)

Model	1I	III	IV	V	Model	II	III	IV	V
R^2	0.61	0.37	0.74	0.70	Adjusted R^2	0.53	0.19	0.55	0.52
F-stat	6.95	2.02	4.03	3.78	Prob.	0.0000	0.0000	0.0000	0.0000
Breusch-Godfrey Serial Correlation LM Test									
F-stat	0.02	0.734	0.7353	1.4704	Prob. F(2,87)	0.9780	0.4826	0.4849	0.2400
Chi-Square	0.05		2.5712	4.7916	Prob. Chi-Square(2)	0.9719	0.3807	0.2765	0.1911
Breusch-Pagan-Godfrey Test of Heteroskedasticity									
F-stat	1.04	1.03	0.8079	0.1600	Prob.	0.3082	0.4419	0.3714	0.6901
Chi-Square	1.06	25.78	0.8198	0.1637	Prob.	0.3032	0.4194	0.3652	0.6857
Jarque-Bera Test of Normality									
Jarque-Bera Stat	1.88	0.061	2.00	1.87	Prob.	0.3902	0.9698	0.3668	0.3925

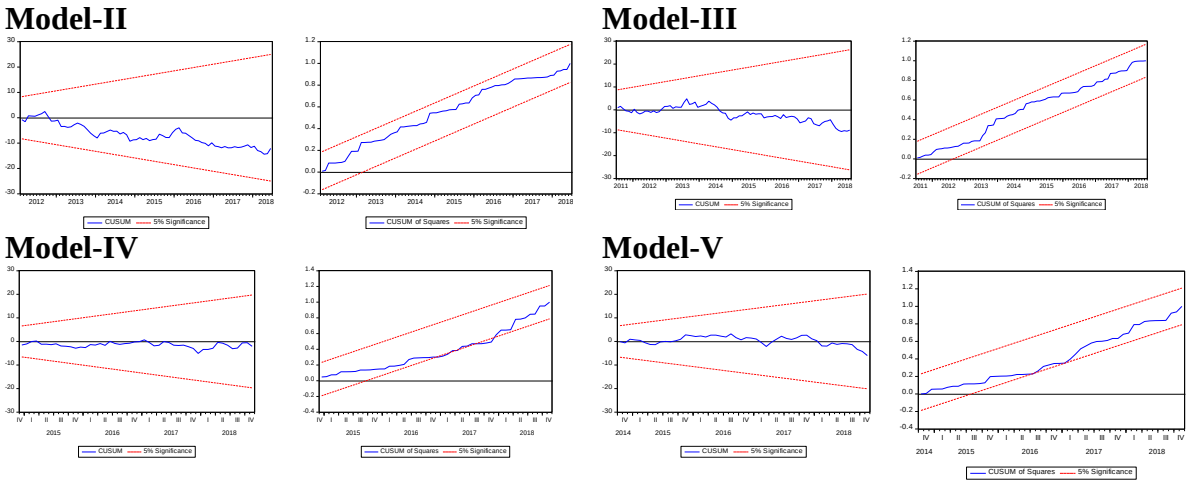

Figure 2: CUSUM and CUSUM Square Tests (Model-II, III, IV, V) At Disaggregate level.

Comparison of ERPT to Domestic CPI Inflation and Inflation of sub-indices of CPI.

This study estimated the ERPT at disaggregated level in inflation of sub-indices of CPI and compare the results with ERPT at aggregate CPI inflation estimated by (Shahzad & Jaffri 2019). (Shahzad &Jaffri, 2019) estimated long run ERPT in aggregate level was 0.42 percentage point by using data set of same time period and employed same estimation technique for Pakistan. The results of this study showed ERPT showed different behavior at dis-aggregate level in CPI sub-indices. The ERPT in transport inflation was highest and lowest in food and beverages inflation. The comparison of the ERPT at aggregate level and at disaggregate level in the sub-indices of CPI shown in the table 08.

Table 8: Comparison Between ERPT at Aggregate Level and at Disaggregate Level

	Long Run
INF	0.42
INF_1	0.90
INF_2	0.27
INF_3	0.32
INF_4	0.78

The above results showed that at aggregate the ERPT was 0.42 percentage point. However at disaggregate level ERPT in transport inflation was high 0.90 percentage point and ERPT in Restaurant inflation was 0.78 percentage point while in food inflation was 0.27 percentage point and in housing inflation was 0.32 percentage point. The above results showed that ERPT to CPI inflation was low but high in transport inflation and Restaurant inflation and low in housing and food inflation.

5. Conclusion

This study has empirically investigated existence of ERPT, SRE and TDER in case of Pakistan using time series data. The ERPT, SRE and TDER are interrelated problems, however, recent empirical studies for Pakistan have dealt them separately. Several studies on ERPT in Pakistan estimated pass-through at aggregate level and found evidence of low pass-through in CPI inflation (Hanif et al., 2017; Jaffri et al., 2014; Ehsan et al., 2002). These studies have ignored the fact that apparently low aggregate ERPT might have variations in ERPT for inflation in subgroups of CPI depending on level of dependence on imported inputs used for the production of baskets of goods and services pertaining to sub-indices of CPI. Further, low pass-through at aggregate level might be due to high share of food

items in overall basket of commodities.[2] Pass-through of food inflation might be low in first round but the possibility of SRE is an important question for policy effectiveness for monetary authorities of Pakistan. The previous studies on ERPT in Pakistan have less focused on questioning benefits of depreciation in improving net exports due to trade disconnect with depreciation of rupee. The current study has addressed above discussed gaps in the literature in three separate but interrelated themes.

(Shahzad &Jaffri, 2019) found that the long run ERPT in domestic CPI inflation at aggregate level was 0.42 percentage point. It means that 1 percentage point increase in the depreciation of rupee against US dollar, monthly inflation in CPI (MOM) increased by 0.42 percentage point in 12 months. However, this study estimated ERPT in sub-indices of CPI which showed different behavior for inflation in selected sub-indices. The ERPT in food and housing inflation was lower than at aggregate level, while in transport and restaurant CPI inflation the ERPT was high. Due to 1 percentage point increase in depreciation of rupee against US dollar, monthly transport inflation increased by 0.90 percentage point, restaurant inflation increased by 0.78 percentage point, food inflation increased by 0.27 percentage point and housing inflation increased by 0.32 percentage point in the long run. The literature on ERPT points out various reasons of asymmetric pass-through for subcomponents of CPI including degree of financial dollarization, labor market flexibility, food and transport share in CPI basket, fuel intensity and trade openness (Ozmen & Topaloglu, 2017, Gelos & Ustyugova,2017; Kemal, 2016). The results of the study are consistent with studies conducted for the other countries (Aron et al., 2014; He et al., 2015). The study concluded that ERPT may be estimated for sub-indices of CPI as a regular practice by monetary authorities to rationalize asymmetric inflationary effects of depreciation on different sectors of the economy. Furthermore, the low ERPT does not reflect that exchange rate fluctuations are less significant for macroeconomic instability. Policy makers should remain vigilant in assessing the ERPT in different sub-indices of CPI and focus on those sectors where ERPT is high.

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[2] Pakistan Bureau of Statistics (PBS) publishes monthly data on CPI based on 487 commodities and share of food items in overall basket is 38 percent.

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