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Date: 14/10/2022

To,
The Deputy Registrar (Academics),
The Maharaja Sayajirao University of Baroda,
Vadodara – 390002, Gujarat, India.

Sub.: Submission of Synopsis

Respected Sir,

I, the undersigned, am herewith submitting the Synopsis of my Ph.D. thesis titled "Exchange Rate Pass Through in India". My PhD Registration No. is FoC/278 dated 17/05/2015. I have duly completed my PhD Coursework requirements and have duly paid the fee for all the terms till date. The PhD coursework certificate number is FOC/278, dated 15/02/2020 issued vide Letter No. ACA7/926 dated 18-02-2020.

Sir, I am attaching the following documents along with this forwarding letter to your good office:

1. Synopsis of the thesis.
2. Copy of the PhD Registration Certificate.
3. Copy of the PhD Coursework Completion Certificate.
4. Copy of the Renewal Letter.
5. Copy of the Last Term Fee Slip.

Sir, I humbly request your good office to please do the needful in this regard.

Thanking You,

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Synopsis

Of the Ph.D. Thesis Titled

Exchange Rate Pass Through in India

To be submitted by

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I. Background and Introduction

The phenomenon of inflation occupies a strong place in both popular and policy discourses across the globe. There is a voluminous literature exploring the nature, determinants and implications of inflation at both microeconomic and macroeconomic levels (Lopez-Villavicencio and Mignon, 2016). Literature has proposed many forces that can possibly explain why inflation behaves the way it does and what factors are responsible for its movements. The broad consensus in the macroeconomic discourse is that there are multiple factors causing inflation and that the nature of inflation can be different depending on whether one looks at a relatively closed economy versus a considerably open economy. The open-economy macroeconomics literature has investigated inflation and particularly its external sources with a special emphasis on the inflationary impact of exchange rate movements. Unlike a closed economy model, an open economy framework must account for not only domestic shocks but also external shocks. The primary channel for the transmission of external shocks to domestic inflation is the exchange rate.

A large volume of empirical evidence exists on the ways in which the exchange rate transmits external shocks to domestic inflation. The relationship between the exchange rate and domestic inflation is the so-called Exchange Rate Pass-Through (ERPT). The existence of ERPT has been recognized long ago and more so since the Bretton Woods era. Early debates on the fixed-versus-flexible exchange rate regimes resulted in the "fear of floating" (Baquerio, 2003). This fear manifests itself in the belief that flexible exchange rate regimes have to absorb a large amount of volatility and thus can cause excessive instability in domestic inflation. However, empirical evidence has not fully corroborated this belief. Countries that moved towards flexible regimes, at least on paper, did not observe the feared instability in domestic inflation despite the high volatility of exchange rates. This finding has led to an increased focus on the entire mechanism through which exchange rate movements pass over to the domestic economy, and especially to domestic inflation (Mallick and Marques, 2006).

The early focus in this regard in the Indian context was on the role of exchange rates in the trade balance adjustment process. The early 1990s saw increased attention on locating empirical evidence for the fulfilment of the Marshall-Lerner conditions. Simultaneously, the empirical literature on Purchasing Power Parity (PPP) revealed that the implicit assumption of

complete pass-through of exchange rate shocks to domestic inflation was not always true. Incomplete pass-through was found to be the norm for the advanced economies while the small open economies showed evidence of complete or even more-than-complete pass-through. As the smaller economies began integrating into the international trade and financial networks, the need to understand how exchange rates would affect the domestic economy gained traction. The Indian economy has been no exception to these developments.

The gradual easing of the exchange rate controls since the economic reforms of 1991 increased the attention on the fears of floating regimes and forced the attention of analysts to the nexus between exchange rate movements and domestic economic conditions (Levy-Yeyati and Sturzenegger, 2005). One of the most debated issues in this regard was the ways in which exchange rates could impact domestic prices both in the short and long runs. The nexus between exchange rate and domestic prices have profound implications for a host of macroeconomic processes. The Balance of Payments adjustment process, fulfilment of the interest parity conditions, nature of trade balance adjustment, fulfilment of the PPP conditions, and several other matters are strongly dependent on implicit assumptions about the nature of ERPT. Moreover, monetary policy management requires control over domestic prices and the exchange rate channel can distort this control and possibly cause serious misalignment between the policy objectives and policy outcomes. These factors have resulted in a large literature on ERPT, including estimating its level for different kinds of economies, analysing its determinants, studying its short and long-run dynamics, and other related matters.

The early literature on ERPT in India adopted the standard macroeconomic framework of estimating an import price function that was grounded in macroeconomic theory. With the emergence of the new open economy models, ERPT models began incorporating the pricing dynamics of foreign exporters into the theoretical frameworks. The fundamental idea behind the theory of ERPT is that exchange rate changes induce changes in trade prices, i.e. both the imports and exports prices, and import prices in turn cause changes in domestic prices as imported goods are a part of domestic consumption – both as inputs and as final goods. However, this channel of transmission is not as neat as it seems and there are several leakages in this transmission process that can cause deviations in the behaviour of ERPT from theoretical expectations. The impact of exchange rates on import prices is generally termed the stage-I pass-

through while the impact of import prices on domestic prices due to exchange rate shocks is termed stage-II pass-through. It is very much possible that the quantitative extent of both types of pass-throughs may be different. In general, it has been found that stage-I pass-through is larger and more rapid than stage-II pass-through in the Indian context.

The analysis of stage-I pass-through has important implications for several open economy macroeconomic issues. First, stage-I ERPT directly shapes the demand elasticities of imports and exports and thus has an important impact on the fulfilment of the so-called Marshall-Lerner conditions. Second, this implies that the efficacy of exchange rates in enabling adjustments in trade balance depends in part on the extent of ERPT. If ERPT is complete, for example, quantity changes in imports and exports would be possibly higher and thus allow smoother and quicker trade balance readjustments in the wake of external shocks. Third, the PPP hypothesis requires that ERPT is complete and one of the components of the full ERPT process is the stage-I pass-through. Fourth, fiscal management focuses on the trade balance and in the Indian context, the current focus on substituting domestic production for imports, the extent of stage-I pass-through is an important factor to be taken into account. Fifth, the tariffs and taxes levied on imports are essential tools to regulate the demand for imports in the country. The extent of stage-I ERPT has sizeable implications for the efficacy of these trade restricting policies. For example, if the ERPT to import prices is low, the Government will have to largely depend on tariffs in order to induce a shift in domestic consumption away from imported inputs and final goods. In case ERPT to import prices are high, such tariff policies may end curbing the imports and their growth excessively, which can also be equally harmful.

The analysis of stage-II ERPT has even more profound macroeconomic implications. First, as stated earlier, the fulfilment of PPP and interest parity conditions require complete pass-through and this warrants an analysis of the actual extent of ERPT. Second, the RBI has adopted a managed float for a long period. With interventions in the FOREX market only when necessary, India has moved towards a more flexible exchange rate regime. However, the challenge of the 'impossible trinity' results in policy trade-offs that need to be accounted for while designing the monetary policy (Joshi, 2003). In the Indian context, price stability has been the primary aim of the central bank and thus it is necessary to know the empirical extent of ERPT to determine the extent of required forex market interventions. In case of a high ERPT to

domestic prices, the RBI will be forced to assume larger exposures to the foreign exchange markets and vice-versa. Third, trade and tariff policies require knowledge of the degree of market power that domestic sellers enjoy relative to foreign sellers. Asymmetry in market power between domestic sellers (Indian exporters) and domestic buyers (Indian importers) can have sizeable implications on how well the tariff barriers act in shifting domestic consumption to domestic goods and also in thwarting competitive pressures from foreign sellers in the domestic market. One way in which the policymakers can gauge the degree of market power enjoyed by domestic agents in the international market is to analyze the extent of ERPT (Przystupa and Wróbel, 2011). High ERPT to import prices generally implies higher market power for foreign sellers in the domestic market while higher ERPT to export prices implies for a country implying lower market power of foreign consumers and higher power for Indian exporters. Fourth, as a logical corollary to point third, it can also be ascertained that the success of export promotion policies depends on the extent of ERPT to export prices charged by Indian exporters in terms of foreign currency. If export promotion measures allow domestic producers higher cost advantages, the reduction in the costs should be passed over to the prices charged in foreign currencies to exploit this advantage. However, if Indian exporters do not enjoy higher market power in the international markets, then possibly they will not be able to pass over much of the reduced costs to foreign prices. In case the ERPT to export prices is high, this policy-induced cost reduction could be passed over to foreign prices and thus possibly induce a sizeable shift in the international demand towards domestic production. Similar inferences can be drawn concerning foreign sellers and the extent of ERPT to import prices in India. There are a host of other macroeconomic and industrial policy issues that can be shown to be closely dependent on the extent of pass-through to domestic prices.

It is thus not an overstatement to suggest that the analysis of ERPT has profound implications for not only the behaviour of exporters, importers and domestic consumers but also for the aggregate economy and how macroeconomic objectives manifest themselves via policy interventions. The empirical knowledge of ERPT can enable policymakers to better integrate external shocks into the ambit of domestic macroeconomic management. A lineage of analysts has delved very deep into the nature of the ERPT process while focusing on its determinants, time-series behaviour, spatial heterogeneity and nexus with other macroeconomic phenomena. However, the primary focus of these analyses has generally been the advanced industrial

economies and only recently has there been increased attention towards emerging economies. The literature on emerging economies is relatively recent and has been quite limited to economies that are seemingly on the verge of transforming into more advanced economies. The lack of focus on emerging economies is primarily due to data constraints. India has not been an exception to this. It is only recently; in the early 2000s that ERPT began getting attention among policymakers. Despite the attention to this issue, its analysis has been limited to estimating its empirical extent and possibly its determinants. Compared to the scope of analysis on the advanced economies in this regard, considerable room remains open for more detailed insights.

The recent episodes of continuous depreciation of the Indian rupee are a matter of concern for not only the analysts and policymakers but also the public at large. It appears that the fears of a floating regime are resurfacing again and one of the most important factors causing this seems to be the fear of increased inflation due to external shocks. While these fears are genuine and grounded in rational theoretical expectations, the empirical story is far from the expectations. Evidence in the Indian context does not suggest any clear consensus on the ability of exchange rate shocks to change the inflation momentum. A voluminous literature has developed on this matter and there has not been any clear indication as to whether the stage-I ERPT is complete or partial, or to put it differently, whether it is high or low. The framework built by Campa and Goldberg ignited the expectations of complete pass-through to import prices for small open economies like India, but that has not been fulfilled by data which seems to show partial ERPT to import prices for the Indian economy. New open economy macroeconomic models have tried reasoning that low ERPT is also a sign of high market power of the foreign sellers against Indian importers. They argue that the existence of market power with foreign sellers allows them to absorb exchange rate shocks for maintaining the market share or perhaps for other economic objectives. Such reasoning seems to be a good explanation of the observed data. However, the same 'market power' school also suggests that the extent of stage-I ERPT and the degree of market power with foreign sellers are positively correlated. Both, low and high ERPT may be associated with high market power on the part of foreign suppliers in the Indian import market and this essentially reduces the explanatory uniqueness of this theory.

The opposing school argues that the excessive focus of the new open economy models on purely microeconomic logic needs to be replaced with a higher thrust on "purely" macroeconomic forces that may provide a better explanation of why ERPT behaves the way it

does in the Indian context. The functional specifications produced by this line of analysis are mostly composed of factors such as oil price shocks, inflation persistence, exchange rate volatility and monetary policy stance. Another set of studies has managed to synthesize both these schools into hybrid models whose specifications are derived from both microeconomic and macroeconomic logics. In summary, there is a rich stock of knowledge on the analysis of ERPT in the Indian context that can be further enriched with a study of a larger scope that accounts for not only the extent of ERPT but also takes a holistic account of the nature of the ERPT process. This study is primarily directed toward such an attempt in the Indian context.

II. Objectives and Motivations

This study shall delve into the estimation of pass-through of exchange rate movements into domestic prices in India at the aggregate level. The focus on the aggregate level is imperative given the macroeconomic nature of the ERPT phenomenon while the empirical specification of the ERPT function shall be approached from a synthesis of both the microeconomic and macroeconomic frameworks. The fundamental issue of contention is the hypothesis that ERPT to domestic prices for a small open economy must theoretically be complete, given the lack of market power enjoyed by importers in such economies. The problem with this theorization is that low import-price ERPT may also be interpreted as possible proof of the low market power of importers as import suppliers might be absorbing exchange rate shocks to maintain market share or possibly due to other competitive pursuits. Thus, a macroeconomic framework to explain ERPT is also equally necessary particularly when an aggregate analysis is to be undertaken. The focus on macroeconomic models of ERPT is primarily driven by the fact that aggregation results in a more complex relationship between exchange rate and domestic prices that may not be fully explained by micro-level factors such as marginal cost shocks, changes in market power and mark-up variations. Accordingly, this study shall focus on the following objectives:

1. To systematically analyze the extant wisdom on ERPT estimation in the Indian context.

There are many issues that have been debated in the Indian context. The stock of knowledge on this subject is considerably vast and thus one of the main objectives of this study will be to provide a detailed summary of what has been done so far, from a critical perspective. Such an

exercise will provide some degree of systematization to the debates, disagreements and consensus on the analysis of ERPT in the Indian context.

2. To empirically measure the extent of ERPT with requisite econometric exercises in the Indian context.

The first step in the analysis of ERPT is to estimate whether it is partial or complete or in some cases even more than complete. The main approach to undertaking this exercise is to estimate the so-called ERPT coefficient. The ERPT coefficient is defined as the exchange rate elasticity of domestic prices, or more specifically, the change in domestic prices per unit change in the exchange rate. The closer this coefficient is to unity, the more complete the extent of pass-through. The closer it is to zero, the lower the pass-through impact of exchange rate changes on domestic prices. In some cases, this coefficient can be larger than unity, indicating more than complete pass-through. There is limited evidence on the exact cause of such behaviour of ERPT, but some studies have found that the phenomenon of exchange rate overshooting may be responsible for a larger-than-unity ERPT coefficient.

This study will undertake an empirical estimation of the ERPT coefficient. The most important elements in this exercise are the variables used for measuring exchange rates and domestic prices. Literature has found considerable robustness in the estimates of the ERPT coefficient to alternative definitions of the exchange rate. Both the bilateral and nominal effective index has been employed in the Indian context and researchers have largely found that the pass-through coefficient to different prices remains fairly similar. However, the choice of the domestic price variable is a different matter altogether in this regard. Literature has found that there is a fall in the extent of the pass-through coefficient as one moves across the pricing chain, starting from the dock prices to the retail prices. An important explanation of this empirical observation is that there are leakages along the distribution chain with different intermediaries absorbing some portion of the exchange rate shock due to competitive pressures and preserving the market shares. Perhaps, this is the best explanation of this matter in the Indian context so far.

Accordingly, this study shall investigate how the bilateral, as well as the Nominal Effective Exchange Rate (NEER), impacts import prices, producer prices and consumer prices – the traditional trio in the ERPT literature. Investigating the ERPT phenomenon using these

different variables will also allow checking for the robustness of the findings and retesting the current empirical consensus on this matter.

3. To investigate the macroeconomic factors affecting ERPT in the context of open economy macroeconomics literature

While the empirical estimates of ERPT are essential building blocks in the larger macroeconomic analysis of this issue, one also needs to locate the factors that can explain the estimated ERPT coefficients. The knowledge of the empirical impact of these factors on the ERPT coefficient can then be used for designing policies that can utilize these factors and control the inflationary impact of exchange rate variations. The literature on this matter consists of two schools, as discussed earlier. One focuses on locating microeconomic determinants in terms of marginal costs, degree of market power and mark-up variations to explain why ERPT behaves the way it does. However, growing dissatisfaction with this unilateral focus on industry and individual agents-based approach has allowed the macroeconomic school to emerge. In terms of the macroeconomic factors, as discussed above, several key determinants have been located in the Indian context. The third school that has emerged in this regard takes into account both the microeconomic and macroeconomic factors together in the ERPT estimation. In this approach, the fundamental equations of import prices, producer prices and consumer prices at the aggregate level are derived as aggregations of the microeconomic pricing behaviour of foreign suppliers. These equations are then expanded to account for macroeconomic factors such as oil prices, exchange rate volatility, inflation persistence, degree of openness, and others. Accordingly, this study shall adopt the third approach and will examine the factors that can explain the estimated ERPT to import and consumer prices in the Indian context.

4. To estimate whether there exists asymmetry in the behaviour of the ERPT relationship.

In recent times, it has been recognized in the ERPT literature on the Indian economy that the reaction of domestic prices to exchange rate shocks differ depending on whether it is an appreciation or a deprecation shock. The difference in the empirical extent of ERPT for exchange rate appreciation versus its depreciation is termed "asymmetry" in the ERPT literature. Asymmetric ERPT particularly poses a challenge to monetary policy as the stance of the central bank has to be determined depending on the direction of the exchange rate shock. In such a

scenario, it is very much plausible that depreciations may increase the existing domestic inflation while appreciation may fail to bring any sizeable reduction in inflation whatsoever. Such concerns are raised by the existence of asymmetric ERPT.

This study shall test the hypothesis of the existence of asymmetry in the Indian context and also the difference in the ERPT coefficients for appreciation versus depreciation shocks. This information can be useful for designing both the exchange rate and monetary policies. In particular, policymakers can gauge the inflationary tendencies brought by exchange rate depreciations and design appropriate interventions in the forex market. Similarly, if appreciation shocks are able to reduce inflationary pressures, then the same can be exploited by the central bank in maintaining price stability. Such possibilities are conditional, however, on the extent of asymmetry in the ERPT coefficient and the relative difference between the ERPT for appreciation versus depreciation shocks.

5. To analyze the existence of nonlinearity in the behaviour of ERPT for the Indian economy.

The ERPT literature in the global context has recognized the fact that domestic prices can react differently to exchange rate shocks – whether appreciation or depreciation, depending on whether the size of the shock is small or large. In general, the literature on advanced economies has found that there is a threshold level below and above which the ERPT coefficient value may differ considerably. This issue has received relatively lesser focus in the Indian context, which may be because the literature on ERPT has started growing only recently in emerging markets in general. The expectations of complete pass-through for small open emerging economies as laid down in Campa and Goldberg (2002) have only recently been critically looked at. Data has revealed that this expectation is not always true.

The idea of non-linearity implies that not all exchange rate shocks are equally important for domestic price behaviour. Large exchange rate shocks have generally been found as more important in inducing permanent changes in the time path of domestic inflation as compared to small changes. The primary debate in this regard is on defining the "small" and "large" changes. Yet another issue of contention is locating the "threshold" level of exchange rate change that is the source of non-linearity in ERPT. Linearity, in this context, is generally conceptualized as the stability of the ERPT coefficient across any quantum of exchange rate change – whether large or

small. In other words, a single estimate of the ERPT coefficient should be applicable across all sizes of exchange rate changes. However, evidence in the Indian context has provided some indication that this may not always be the case. Structural breaks may occur in the behaviour of the ERPT coefficient over time when large exchange rate swings occur. Literature has suggested that larger changes are more prone to inducing permanent changes in the ERPT coefficient while smaller changes may be perceived as temporary shocks by import suppliers who may choose not to pass over the same to the Indian markets. Hence, this study shall delve into the existence of the non-linear behaviour of ERPT in the Indian context and also analyze the possible factors causing the same.

III. Review of Literature

Analysis of ERPT has spanned several decades, particularly since the economic reforms of the 1990s. The earlier focus was on estimating the pass-through of exchange rate variations to import prices, with a special focus on the aggregate level analysis. Increasingly, the focus has also been put on commodity-level data, though the aggregate analysis continues to dominate the literature in the Indian context.

One of the early attempts at ERPT analysis was by Krishnamurthy and Pandit (1996) who undertook a macroeconomic analysis of India's trade flows at a disaggregated level for the period 1971-1991. They employed a simultaneous equations model to analyze the determinants of trade flow and trade balance in India while incorporating the pass-through effects of exchange rate variations to import prices. ERPT was accounted for in the import demand and supply function. They found that ERPT to import prices had a substantial impact on the trade balance adjustment following an exchange rate shock.

In a similar vein, Dholakia and Saradhi (2000) examined the empirical effects of exchange rate and exchange rate volatility on aggregate export prices, import prices and trade quantities for the period 1980-1996 using quarterly data. They also used a simultaneous equations approach. They found that the stage-I ERPT to import prices for the full sample period was complete. However, pass-through to export prices was found to be complete only after 1991 and there was evidence of lags in pass-through of exchange rate variations to import prices. Patnaik, Kapur and Dhal (2003) studied the nexus between the monetary policy stance of the

RBI and exchange rate pass-through for the sample period 1947 to 2002. They employed a Structural VAR approach and concluded that the RBI had been successful in containing the pass-through effects of the exchange rate on domestic inflation during the sample period.

Using panel data from 1980 to 2001, Mallick and Marques (2006) studied the aggregate as well as sector-specific ERPT to trade prices, i.e. both the import and export prices, in pre-reforms (1980-90) and post-reforms (1991-2001) eras for India. Their main finding was that the hypothesis of complete ERPT to import prices could not be rejected. They also found evidence of incomplete pass-through for export prices at the aggregate level. At the sectoral level, they found that Indian exporters exhibited considerable variations in their pricing behaviour across the sample period. They also concluded that there was a structural break in the behaviour of ERPT to export prices in the year 1991 though a similar conclusion could not be drawn for the import price pass-through.

Khundrakpam (2007) investigated stage-I ERPT and found that there was no statistically significant evidence of a decline in the magnitude of import-price ERPT in India after the reforms of 1991. The study found evidence for the existence of asymmetry in the value of ERPT between episodes of exchange rate appreciation and depreciation, as well as for small and large changes in the exchange rate. Concerning the determinants of the observed non-decline in ERPT, the study concluded that inflation persistence was the primary determining factor.

Ghosh and Rajan (2007) examined the aggregate level ERPT to Consumer Price Index (CPI) in India using quarterly data for the period 1980-2005. They also analyzed the existence of structural breaks in ERPT in terms of economic reforms. The authors employed the Co-integration and Error Correction methods (ECM) and found that the ERPT was incomplete and insignificant regarding the pass-through of NEER variations into the CPI. They further concluded that the bilateral exchange rate played a more important role than NEER in explaining aggregate-level ERPT. Lastly, they found a slightly higher pass-through for the post-reforms period, though it was not economically significant.

Bhattacharya et al. (2008) undertook an empirical investigation of the pass-through effects of the exchange rate along with a study of the impact of oil and commodity prices on domestic inflation in India. Their sample period included 1997 to 2007 and the authors employed

VAR and VECM methods to undertake to estimate both the short-run and long-run ERPT coefficients. Their key conclusion was that the ERPT was partial and moderate to domestic prices and that there were less than proportional effects of exchange rate shocks on the CPI and WPI.

Khundrakpam (2008) analyzed ERPT for Indian imports and exports with a special focus on the post-reforms era. The author used monthly data from 1990 to 2005. The rolling regression method was employed. The study found a rise in ERPT and also found that a reduction of quantitative restrictions on trade, changing composition of imports, increased inflation persistence and uncontrolled movements in government deficit were the significant determinants of the rising ERPT during the sample period. It was also concluded that ERPT coefficients were higher for appreciation versus the depreciation of the rupee in terms of both the NEER and the bilateral exchange rate. The study also found that ERPT was higher for small absolute changes as against large absolute changes in the exchange rate.

Mallick and Marques (2008) examined the impact of economic reforms on exchange rate pass-through to India's export prices using sector-level panel data. This data was divided into two sub-periods – one for the pre-reform period, i.e. 1980-90, and another for the post-reforms period, i.e. 1991-2001. The authors found that the pass-through of NEER into India's export prices was incomplete. They also found that a larger number of export-oriented sectors displayed incompleteness in ERPT while concluding that the market power of Indian exporting firms increased in international markets during the post-reforms period.

Dash and Narasimhan (2011) analyzed the stage-I ERPT under an imperfect competition model to study the behaviour of trade prices in India under a changing currency value. They undertook this task by relating trade prices to the core components of the pricing equation under monopolistic competition – namely markups and production costs. Co-integration approach and Error Correction Models (ECM) were employed using quarterly data for the period 1993 to 2004. Their main conclusions were that pass-through for India's export prices was incomplete while it was more than full for India's import prices with the foreign cost of production contributing the most to the high observed ERPT to Indian import prices.

Roy and Pyne (2011) studied the first stage of ERPT to export prices of India at the aggregate level as well as at a product-specific level for the period 1960 to 2000. They employed a simultaneous equation model for exports to estimate the extent passed through at both the aggregate and moderately disaggregated levels, i.e. at the level of product categories for manufactured exports. Their study found significant and incomplete short-run pass-through to export prices, while similar results were also found at the level of manufactured product categories. Furthermore, they found statistically insignificant improvement in the pass-through, i.e. no decrease in the degree of incompleteness for the post-reforms period.

Kapur and Behera (2012) attempted to understand the exchange rate channel for monetary policy transmission and particularly the role of ERPT both in the short and long run in helping the Indian central bank achieve its monetary policy objectives. Quarterly data was used from April 1996 till March 2011. The noteworthy results included the evidence of incomplete ERPT for India, insignificant effects of rupee-dollar ERPT on Non-Food Manufactured Product (NFMP) inflation but significant effects of NEER on NFMP inflation. The study implicitly concluded that the rupee-dollar exchange rate had a higher and more significant impact on overall inflation for India as compared to NFMP inflation.

The ERPT dynamics in the post-reform era for India were analyzed by Kumar (2014) for the period 1995 to 2013 using monthly data. Using a SVAR approach, the study evaluated the behaviour of ERPT to domestic prices with a special emphasis on oil prices and the Index of Industrial Production (IIP). The study also examined the relationship of ERPT with a host of macroeconomic variables such as CPI, monetary aggregates, and a few others. It concluded that there was an insignificant and less-than-full pass-through to domestic prices during the sample period, and found statistically significant effects of global oil prices on ERPT for India.

Mendali and Das (2017) undertook an analysis of the ERPT issue with special reference to the impact of the 2007 crisis on the same. Monthly data were employed for the period 1992 to 2010. ERPT coefficient was estimated within the VAR framework via the impulse response functions. The VAR model consisted of five variables - exchange rate, oil price, output gap, money supply and wholesale price index. ERPT to import prices and domestic prices were found to be incomplete with significant lags involved in the transmission process. In terms of the determinants of ERPT, rising WPI and oil price shocks were found to be the most important

determinants. The authors also found evidence of a structural break in November 2007 in ERPT and thus found that the Global Financial Crisis had a significant impact on the nature of the pass-through transmission mechanism in India. The study also found that the aggregate size of the imports, higher composition of inputs in the import bill, exchange rate volatility and moderate levels of domestic inflation were the primary causes of the low ERPT as found by the study. The study, however, focused on the WPI only and did not account for CPI inflation.

Moving beyond the estimation of the ERPT coefficients, Patra et al. (2018) focused on the existence of asymmetry, non-linearity and temporal instability of the ERPT relationship for India during the period 2005 to 2016 using monthly data. The authors employed a Dynamic Stochastic General Equilibrium (DGSM) Model under the assumptions of imperfect competition for a small open economy. The study found evidence of asymmetry in the response of ERPT as small depreciations were found to be causing the largest impact on domestic inflation as compared to larger depreciations and appreciations. The study also found that small changes caused a higher ERPT as compared to larger changes while ERPT was observed to be unstable across time.

Balcilar et al. (2021) investigated the asymmetry in ERPT for the BRICS economies including India for the period 1986 to 2018 using monthly data. The main issue under consideration was whether ERPT and Oil price pass-through were asymmetric and state-dependent for the selected economies. The non-linear Vector Smooth Transition Autoregressive model was employed to test for the existence of asymmetry in the ERPT process. It was found that when exchange rate and oil price shocks were above the threshold level, the extent of ERPT was considerably larger than when the shocks were below the threshold.

Dua and Goel (2021) examined the issue of ERPT within the larger analysis of the macroeconomic determinants of inflation in India. Both the supply and demand side macroeconomic factors were accounted for in the analysis of the factors that induce variations in domestic inflation. Inflation was measured in terms of both the WPI and CPI-Industrial Workers (CPI-IW), while the exchange rate was measured in terms of both the bilateral exchange rate and the NEER. Using cointegration analysis, they found that there existed a long-run relationship among the macroeconomic factors that were modelled as possible determinants of domestic inflation in India. Evidence was found that the chosen factors, including exchange rate, granger

caused inflation in terms of both the variables, i.e. WPI and CPI-IW. The exchange rate was found to be an important determinant of domestic inflation in terms of the normalised variance decomposition. The determinants of food inflation were also analyzed and it was found that international oil and fuel price shocks were the most essential determinants of the same rather than exchange rate variations.

IV. Key Issues and Hypotheses

Given the review of the evidence as laid down in the previous sections, this study attempts to address some fundamental questions about the nature of the ERPT mechanism, its determinants and its stability over time in the post-reforms period. Following are the important issues and the underlying hypothesis to be examined in this study:

1. Estimation of the empirical value of the ERPT coefficient linking the exchange rate variations to import price variations.

The first issue under consideration shall be the estimation of the stage-I ERPT coefficient. Exchange rate variations are expected to change import prices at the dock due to a host of microeconomic and macroeconomic factors. The main linkage between both of them is provided by the nature of trade contracts among the domestic importers and foreign firms supplying the goods. Under the assumption of an imperfectly competitive imports market with a small open economy as a buyer, it is expected that the stage-I ERPT is complete. In other words, a 10 percent depreciation is expected to induce a 10 percent increase in import prices. This implies an ERPT coefficient of the value "one". This assumption has been frequently challenged in the Indian context. Stage-I ERPT is complete in all the cases and this implies that further empirical analysis is required to examine the empirical value of the ERPT coefficient.

Null Hypothesis: The extent of pass-through of exchange rate variations to import prices is complete, i.e. the value of the ERPT coefficient is one.

2. Estimation of the empirical value of the ERPT coefficient linking the exchange rate variations to domestic inflation.

The larger issue under consideration in this study is the estimation of the complete ERPT process, i.e. the relationship between exchange rate variations and domestic inflation. Often, the

stage-II ERPT is used as synonymous with the "complete ERPT" process which is incorrect. Stage-II analysis should analyse the impact of import prices on domestic inflation after exchange rate shocks have affected import prices. Hence, the analysis of how exchange rate variations affect domestic inflation is a larger issue and shall include both the stage-I and stage-II processes simultaneously within its ambit. Estimation of the stage-I pass-through is essential to estimating the complete process and also to finding out the value of the stage-II coefficient. In general, it is expected that the pass-through of exchange rate variations to domestic prices will be lower than that of stage-I pass-through. In the literature, this is primarily attributed to the distributional leakages that may occur as different agents across the value chain can absorb exchange rate shocks for competitive objectives such as maintaining market shares or due to the classic staggered pricing problem wherein the pricing contracts are pre-determined and can be changed only after certain intervals rather than instantaneously. Thus, the ERPT coefficient, in this case, is expected to be less than one in value.

Null Hypothesis: The ERPT coefficient linking exchange rate variations to domestic inflation is equal to one.

3. Analysis of asymmetry in the stage one ERPT process.

As discussed earlier, ideally, the value of the ERPT coefficient is expected to be symmetrical, i.e. the impact of exchange rate changes on import prices should exactly be the same irrespective of whether there is an appreciation or a depreciation of the exchange rate. However, recent evidence has suggested that this may not always be the case. It has been found that deprecations in the exchange rate have caused a larger response in import prices as against appreciations. Thus the stage-I ERPT coefficient is expected to be unequal for appreciation and depreciation episodes of exchange rate variations. In general, the stage-I ERPT coefficient for depreciation is expected to be larger than that of appreciation. This implies that foreign sellers tend to pass over inflationary changes much more than deflationary changes to India's import prices. Thus, it is expected that $\mathrm{ERPT}_{\mathrm{depreciation}} > \mathrm{ERPT}_{\mathrm{appreciation}}$ when $\Delta EXR \neq 0$ concerning the effects of exchange rate variations on import prices for India.

Null Hypothesis: ERPT coefficient for depreciation will be equal to the ERPT coefficient for appreciations in the exchange rate.

4. Analysis of non-linearity in the stage one pass-through process.

The issue of non-linearity has been discussed earlier in the previous sections. The underlying issue is that exchange rate changes must cross a certain threshold level above which there shall be enough incentives for foreign firms in passing over the exchange rate variations to Indian import prices. The main debate rages over the correct approach to determining the threshold level. In other words, when $\Delta EXR > Threshold\ level,$ Stage-I ERPT coefficient will be larger as against when $\Delta EXR < Threshold\ level.$

Null Hypothesis: ERPT coefficient for changes in exchange rate above the threshold will be equal to the coefficient for exchange rate changes below the threshold level.

5. Analysis of asymmetry in the full ERPT process.

Similar to hypothesis 3, literature has found that domestic prices tend to react differently to appreciation versus depreciation of the Indian currency. This occurs for at least three reasons: one, there is an asymmetry in the stage-I ERPT process; two, there may be an asymmetric impact of import prices on domestic inflation, and three, domestic inflation itself reacts differently in direct connection to the exchange rate variations. The second reason states that the import price elasticity of domestic inflation may be different depending on the direction of change in the exchange rate. The first reason has been explained in the third hypothesis, and the third reason implies that exchange rate variations may cause changes in domestic inflation via channels other than import prices. If the third reason is the primary cause, then one has to move beyond the ambits of ERPT analysis and look into other issues such as oil-price pass-through. The extant literature has located several justifications for such behaviour of domestic prices in connection with exchange rate shocks in different directions. Among the many factors, one reason can be that the domestic consumption basket is not much import oriented – either in terms of foreign goods or in terms of imported inputs. Thus, depreciation may induce inflation in import prices but due to the low imported content of the domestic consumption basket, such changes may not pass over at all. While, in case of appreciation, import prices may deflate and this could induce a shift in domestic consumption towards foreign goods and inputs thereby causing a reduction in the inflation level as consumption is shifted towards cheaper imported substitutes. However, the extant wisdom on this issue is in the very early stages of debate. The current belief is that

depreciation should cause a larger impact on domestic inflation as compared to appreciation because imported components have a sizeable space in India's domestic consumption basket. Moreover, it has been observed that given the low market power of Indian importers, i.e. the lack of monopsony, the probability of inflationary changes being passed over to domestic prices is much larger than deflationary changes. The basic hypothesis in this regard within the Indian context is as below. $\mathrm{ERPT}_{\mathrm{depreciation}} > \mathrm{ERPT}_{\mathrm{appreciation}}$, when $\Delta \mathrm{EXR} \neq 0$

Null Hypothesis: The ERPT coefficient for depreciation in the exchange rate will be equal to the pass-through coefficient for appreciation in the same concerning the impact of exchange rate variations on domestic inflation.

6. Analysis of non-linearity in the full pass-through process.

As explained in hypothesis four, not all exchange rate changes are expected to induce an equal response in domestic prices. Larger changes, generally defined as above the threshold level, are expected to cause much larger and economically significant reactions from domestic prices as compared to smaller changes, roughly defined as those exchange rate changes that are below the threshold level. When $\Delta \mathrm{EXR} > Threshold\ level$, the ERPT coefficient for the full pass-through process will be larger as against when $\Delta \mathrm{EXR} < Threshold\ level$. Thus, the hypothesis to be tested in this regard is as below.

Null Hypothesis: ERPT coefficient for changes in exchange rate above the threshold will be equal to the pass-through coefficient for changes below the threshold level concerning the effects of exchange rate variations on domestic inflation.

7. Determinants of the coefficient of the full ERPT process linking exchange rate variations to domestic prices.

Literature has found that there are several important microeconomic and macroeconomic factors that can explain the observed ERPT coefficient. A host of variables have been located as determinants in this regard. Thus, several nested hypotheses may be located in this regard. The important hypotheses among these are explained below.

Null Hypotheses:

7.1. Macroeconomic determinants cannot explain the coefficient of the ERPT process significantly.

7.2. Oil price shocks are not significant in explaining the estimated ERPT coefficients. Positive oil price shocks will not cause the ERPT coefficient to be larger even though oil and fuel occupy a very large share of the domestic consumption basket.

7.3. Exchange rate volatility is not a significant factor in explaining the estimated ERPT coefficients. Higher volatility of the exchange rate will not cause lower pass-through of exchange rate shocks to import prices and thus to domestic inflation. Lower volatility of the exchange rate will not cause lower pass-through of exchange rate shocks to import prices and thus to domestic inflation

7.4. The degree of trade openness is not a significant explanatory variable in this regard. A higher degree of openness will not tend to increase the value of the ERPT coefficient.

7.5. Changes in monetary policy behaviour do not have a significant impact on the extent of ERPT to domestic prices.

7.6. Variations in international crude oil prices do not have a significant impact on the extent of ERPT to Indian import prices.

7.7. Persistence of a high inflation rate does not have any significant effect on the extent of ERPT to domestic price inflation. Thus, with consistently higher inflation rates, the impact of exchange rate variations on domestic price inflation will not be affected in any direction.

The hypotheses enlisted above are only indicative of the key issues to be investigated in this study. However, there will be additional issues that shall be investigated in the thesis to be submitted hereafter.

V. Theoretical Model

Underlying the empirical work to be undertaken in this study is a theoretical model that attempts to examine the macroeconomic foundations of the ERPT process. Analysis of ERPT has to be

undertaken via the price functions, i.e. the equations that describe the nature of the pricing of imports and domestic wholesale and retail prices. When analysed at the firm and industry level, the analysis assumes a largely microeconomic approach wherein the variables of interest are marginal costs and mark-up variations and their determinants. However, aggregation across firms produces a theoretical function that accounts for not only the disaggregated but also the macroeconomic forces that may impact the marginal costs and mark-ups at the aggregate level. The traditional approach to aggregate-level ERPT estimation relies on a single-equation approach wherein, depending on the stage of ERPT under consideration, an import price function or a domestic price function is specified in terms of macroeconomic variables that are considered standard determinants in the empirical literature. The alternative approach is to model multiple equations simultaneously or through stage-wise regression. While the multiple-equations models can provide additional insights into the ERPT mechanism, literature has generally applied the parsimony principle when undertaking aggregate-level analysis. The single equation models have been found sufficient for aggregate ERPT analyses. The explanatory power and the econometric properties of the single-equation estimators have generally been reliable in both the international and Indian contexts. Moreover, multiple-equation models have been found as more suitable for disaggregated and firm-level analyses rather than aggregate analyses.

The standard single equation domestic price function on which this study shall develop the further empirical models using time-series data is developed by Campa and Goldberg (2002) which may be expressed in terms of the variable of interest, the price and inflation variables, as a function of the exchange rate variables and a set of primary and secondary control variables. The choice of the variables shall be explained in the section to follow. However, the specification implied in the framework developed by Campa and Goldberg (2002) expresses the standard approach to ERPT estimation. This specification is generally derived from the pricing constraints of a typical monopolistic exporting firm which is expected to sell products to a small open economy. Literature has largely conceptualized small open economies as price-takers in the international market. Indian economy, in terms of the ERPT analysis, is found to display price-taking behaviour in the imports markets, through which the exchange rate shocks are expected to affect domestic prices. The main idea behind equation one is to model the ERPT process as a pricing decision of a typical import supplier having some degree of market power and who supplies goods to buyers of a small open economy. The control variables are specified in

aggregate terms to represent the entire imports supplying the country with the imports demanding the country. Hence, firm-level pricing behaviour is used as the basis for arriving at a specification that links macroeconomic aggregates. The price variable is the primary issue of interest in this approach. How are the import price and thereafter the domestic price variables affected by exchange rate shocks while controlling for a set of macroeconomic variables? This question can be empirically investigated using the specification laid down in Campa and Goldberg (2002). Indeed, there are many nested models within their framework and depending on underlying hypotheses; newer specifications can be generated using the same theoretical specification. Moreover, an advantage, in this case, is that with further modifications, one can analyse the asymmetric and non-linear responses of domestic prices to exchange rate variations.

Similar to the discussion above, the fundamental ERPT relationship between exchange rate and domestic prices, the so-called full ERPT process, can also be explained by modifying the import price equation to account for domestic prices. There are at least two approaches to this task. In the first approach, one may adopt a two-stage framework and thus specify a second equation as an extension to the first equation in which domestic price is treated as the dependent variable while the value of the estimated pass-through coefficient as per equation one is treated as a determinant along with the macroeconomic variables of the first equation. The second approach is to directly and separately estimate the full pass-through process without including the estimated pass-through coefficient from the import price function. However, import prices are included as a determinant in this second approach. Another extension of this approach is to include the interaction term of import prices and exchange rate as an additional determinant to broadly capture the combined impact of both on domestic prices. In general, the disaggregated studies which have higher degrees of freedom have found the first approach more suitable while the second approach seems to be more suitable for aggregate analyses.

VI. Data, Variables and Sources

The models to be employed in this study shall employ a host of macroeconomic variables. For analysing the impact of exchange rate variations on import price inflation and domestic price inflation, the following variables shall be analysed within the appropriate time series econometric framework.

Table 1: List of variables to be employed in the study

Sr No.	Nature of the Variable	Variable	Source
1	Domestic Price Variables	Import Unit Value Index, DGFT, Government of India	DGFT, Government of India
2		Wholesale Price Index for All Commodities	RBI Handbook of Statistics on Indian Economy
3		Consumer Price Index	RBI Handbook of Statistics on Indian Economy
4	Exchange Rate Variables	Bilateral Rs. per US $ rate	FBIL India and the RBI
5		NEER (36 currency trade-weighted)	FBIL India and the RBI
		REER (36 currency trade-weighted)	FBIL India and the RBI
6	Key Macroeconomic Variables	Oil Price	IMF Database; Ministry of Commerce and Industry
7		Degree of Trade Openness	RBI Handbook of Statistics on Indian Economy
8		Exchange Rate Volatility	Office of the Economic Adviser, Ministry of Commerce and Industry ; FBIL, RBI
9		Output Gap	To be estimated using data from online databases of the MoSPI and RBI
10		Inflation Persistence	To be estimated using data from the online database (DBIE) of the RBI
11		Composition of imports	DGFT, Ministry of Commerce and Industry
12		Import Penetration Ratios	DGFT, Ministry of Commerce and Industry; RBI Handbook of Statistics on Indian Economy
13		Inflation Variability	Office of the Economic Adviser, Ministry of Commerce and Industry, Government of India; RBI Handbook of Statistics on Indian Economy
14		Trade Distortions	Department of Commerce, Ministry of Commerce and Industry
15		Real GDP	RBI Handbook of Statistics on Indian Economy; Database on the Indian Economy, RBI; IMF International Financial Statistics
16		Money Stock (M3)	Database on the Indian Economy, RBI
17		Foreign Capital Flows	Database on the Indian Economy, RBI

Source: Author's analysis of the literature

The variables enlisted in table one are selected based on a host of factors. Primarily, these variables have consistent theoretical links with the behaviour of ERPT. Each of the enlisted variables has been found as a non-trivial determinant of ERPT in both the global and Indian

contexts. The selected variables are also representative of the major forces that shape the empirical behaviour of ERPT. Given the aggregative approach adopted in this study, the above set of control variables is found to be strongly correlated with both the exchange rate and the imports and domestic inflation during the study period, except in a few cases such as the oil price variable, where the observed correlation was rather weak. Furthermore, as explained in the previous section, each of these variables is capable of explaining a significant proportion of the ERPT relationship. Both the theory and literature strongly support the use of these variables in the pass-through analysis irrespective of the methodology employed.

The domestic price variables consist of two sets of variables, namely – the import price variable and the prices in the domestic markets. The measurement of import prices has been a thorny issue in the international as well as Indian literature. The general consensus has been that direct measurement of import prices from disaggregated commodity-level data is rather problematic due to a lack of consistent, exhaustive and at times even representative disaggregated data. In the Indian scenario particularly, estimates of import prices for various commodities are based on the data collected by customs union offices across the ports of the country. These data in themselves are sampled and may not always reflect the true price and quantity of the imported commodities. Hence, any aggregate index constructed from these data shall at best be representative with at least some degree of error. The extent of this error shall be determined by the nature of price collection and recording procedures adopted by the customs offices. The unanimity in the empirical literature on this account has been to depend on the official import unit value index which measures the average price of a typically imported commodity. The primary criticism of this variable has been that it represents an average price of a representative imported commodity and does not emerge from the aggregation across commodity-level prices. While separate import price indexes can be constructed using commodity-level data, the aggregation problems in such a procedure including the unreliability of the available disaggregated price data of imports make the use of the import unit value index a better choice. Accordingly, this study shall employ the import unit value index as the measure of import price inflation in India.

The price inflation in domestic markets is captured primarily by the Wholesale Price Index for All Commodities with 2011-12 as the base year. The base year represents the latest

rebasing undertaken by the Ministry of Commerce and Industry. Wholesale Prices tend to represent the bulk of business activities in a country. These prices are broadly determined in the wholesale markets in the country and are thus considered a better representative of inflation in the factor markets. As compared to consumer prices, these prices are less distorted by transaction costs involved in the distribution of goods to the retail markets and the final consumer. Another relative advantage of the WPI is that the imports in terms of final goods as well as in terms of inputs are accounted for in this measure of domestic inflation. The CPI is also used as one of the measures of domestic inflation in this study, but it is primarily done to assess the robustness of findings to alternative measures of domestic inflation and also to study the behaviour of ERPT at different levels of the supply chain in domestic goods markets.

In the Indian context, the exchange rate is measured by two approaches – namely, the two-currency bilateral rate, and the effective exchange rates. The bilateral exchange rates of the Indian rupee are provided in terms of the major currencies such as the US dollar, Pound Sterling, SDRs and a few others. The effective exchange rates are provided in two forms. The first is the older 36-currency-based effective exchange rates which have been recently complemented with a newer 40-currency-based form. However, given the lack of sufficient past data for the new 40-currency basket-based NEER, the 36-currency NEER has been employed in this study. Effective exchange rates can either be export-oriented or trade-oriented. The difference between these two approaches is the choice of weights to aggregate the individual currencies. Lastly, effective rates are available in nominal and real terms, the latter being adjusted for the effects of inflation. This study shall primarily employ the 36-currency trade-weighted Nominal Effective Exchange Rate (NEER). It shall also use the 36-currency trade-weighted Real Effective Exchange Rate (REER). Effective exchange rates amass a larger amount of information on the performance of the Indian currency as the behaviour of the rupee is compared to a host of currencies. These exchange rates also take into account the relative importance of each currency in terms of the share of each corresponding country in the trade basket of India. These facts render NEER and REER some degree of an analytical edge over the bilateral exchange rate. Literature has also found considerable differences in the ERPT coefficients for bilateral versus effective rates. To investigate the effects of using the bilateral versus the effective exchange rates on the ERPT relationship, the bilateral exchange rate of the Indian rupee against the US dollar shall also be considered.

Lastly, this study has employed a host of macroeconomic variables as enlisted in table one. Each of the chosen variables represents the underlying theoretical model as elaborated earlier and the broad consensus found in the literature. Oil prices represent the international shocks that can affect import prices and via it domestic inflation. Their inclusion is to account for the international price pressures on the import prices as crude oil occupies a large share in India's import basket. Trade openness measures the extent to which the Indian economy is integrated with the international markets. Higher openness implies that the economy has a sizeable dependency on international trade. Literature has found that a higher degree of openness induces a larger reaction from import price inflation and domestic inflation when the exchange rate changes. This is due to the higher participation of the domestic economy in international markets and thus the exchange rate changes can be easily incorporated into the import contracts by the foreign suppliers. Another critical factor affecting the ERPT relationships found in the literature has been the exchange rate volatility. Beginning with the seminal works of Dornbusch (1976), literature has recognized that the exchange rate tends to display excessive volatility, at least in the short run, due to its tendency to overshoot above its equilibrium level following an economic shock. Thereafter, the literature on ERPT also incorporated this phenomenon and the role of exchange rate volatility in the ERPT process was well recognized by the works of Peltzman, Campa and Goldberg, among others. Higher volatility in the exchange rate is generally expected to produce a larger pass-through coefficient for import prices as well as for domestic prices. Another important variable is the output gap which measures the business cycle movements. The theory of ERPT suggests that the pass-through of exchange rate changes to import price and domestic price inflation is affected by cyclical movements in the economy. In periods when recessionary tendencies exist, and market shares are unstable due to lack of sufficient aggregate demand, pass-through of exchange rate variations to import prices and domestic prices tends to be lower, particularly for exchange rate depreciations. Foreign suppliers avoid increasing the prices in order not to negatively affect their market shares. On the other hand, when the economy is experiencing an upswing in the business cycle, passing over the depreciations to domestic prices becomes relatively easier as aggregate demand is sufficiently high.

The persistence of inflation, in terms of the average inflation rate prevailing for a given time period, is also found to be an important factor in the ERPT process. When inflation is high and persistent in an economy, exchange rate changes tend to be easily passed over to domestic

prices. Not only the rate of inflation but also its variability has been located as an important determinant of the ERPT to domestic prices. High variability of domestic inflation may cause foreign suppliers of imports to avoid passing over changes in the exchange rate that they perceive as temporary. Hence, both inflation and exchange rate variability are intertwined in this regard. If an exchange rate change is perceived as a permanent change, and if inflation is not much volatile, ERPT to domestic prices will tend to be higher. If, however, the exchange rate changes are perceived as temporary, due to excessive volatility in the same, and the inflation rate is also highly volatile on the domestic front, then the ERPT to domestic prices will tend to be considerably lower. These are two extreme cases. The outcomes of the intermediate cases with different combinations of exchange rate and inflation variabilities need to be further investigated and the same has been undertaken in this study. Literature in the Indian context has also found that the share of oil imports versus non-oil imports has important implications for the size of the ERPT coefficient. The same has been investigated in this study. Import penetration has also been located as a significant determinant of the stage one pass-through relationship. Accordingly, it has been incorporated into this study. Trade distortions in the form of import tariffs can cause the extent of ERPT to be over or under its true extent. Higher tariffs can induce a much larger impact of exchange rate variations on domestic prices, and in many cases may even cause domestic inflation without much exchange rate variations. This aspect has been accounted for in this study. Finally, monetary policy variables are taken into account in the form of the M3 measure of the money stock, whose movements are found to be important for the pass-through of exchange rate variations to domestic inflation.

VII. Methodological Issues

The analysis of ERPT in the Indian context has largely been conducted using two major approaches as noted earlier. First, a single equation framework has been employed wherein the ERPT coefficient is estimated under a structural approach for estimating the specification given by Campa and Goldberg (2002). In this approach, the ERPT coefficients are estimated with the dependent variable being the imports unit value index, in case of the first stage pass-through, and domestic price variables such as the WPI and CPI, in case of the second stage pass-through. In either case, an exchange rate variable is included as a regressor and its coefficient is the primary estimate of interest. In the Indian context, the trade-weighted NEER has been the most frequently

employed indicator of the exchange rate variable in ERPT analysis. The second set of methods that have been frequently employed in the Indian context to estimate the ERPT coefficients fall under the time series approach. Within this approach, the Vector Autoregressive (VAR) and Vector Error Correction Models (VECM) are the most frequently employed in the Indian context. The primary interest under the time series approaches is also the ERPT coefficient but the economic nature of the pass-through coefficient is considerably different than the one estimated via the structural approach. In this case, the ERPT coefficient is a result of the impulses generated by an exchange rate shock within a system of variables whose ordering matters critically. Unlike the opposing framework, this approach conceptualizes the ERPT coefficient in both short-run and long-run terms. The advantage of the second approach over the first one is primarily that it allows one to capture the short-run and long-run behaviour of ERPT. Moreover, by linking variables into an interconnected system where shocks are allowed to propagate and affect other variables, a richer understanding of the dynamics in the ERPT process can be obtained. A host of VAR models have been employed in the Indian context such as the traditional VAR models and the Structural VAR models.

While the estimated ERPT coefficients from both these methods cannot be directly compared, the literature in the Indian setting has found that the second approach produces more reliable estimates while also explaining the process behind the pass-through coefficients. Another methodological approach in this regard has been the estimation of the ERPT process within a simultaneous equation framework. This approach has been frequently employed in case of the advanced economies, but a similar trend is not visible in the case of the Indian economy. Currently, the time series models are the major approaches in this regard.

In terms of the reliability of results for further research as well as for policy purposes, it is necessary to establish the robustness of the estimated ERPT coefficients to alternative methods. If there are diametrical differences in the estimated pass-through coefficients to alternative plausible methods, the results from any one of the methods may not be solely reliable. Establishing some degree of consistency in the broad results can help to lend more credibility to the final inferences. Accordingly, this study shall estimate the ERPT relationship using a host of econometric methods so as to test the methodological robustness of the findings. Literature has

found that irrespective of the econometric approach utilized, the size of the ERPT coefficient shows stable behaviour and the economic inferences remain largely the same.

VIII. Key Findings

The empirical analysis undertaken in this study has revealed important dimensions on how the ERPT process has been working in the Indian context. This study examined the ERPT process in terms of the pass-through of exchange rate changes to import price inflation and domestic price inflation. The empirical size of the ERPT coefficient in both cases has been estimated using the appropriate time series methods. Furthermore, the factors which are important in determining the extent of ERPT to import price inflation and domestic price inflation have also been investigated. Lastly, the issues of asymmetric and nonlinear behaviour of pass-through relationships have been examined.

Exchange Rate Pass Through to Import Price Inflation

The analysis of the relationship between exchange rate changes and import price inflation has revealed that there is strong evidence of the impact of the exchange rate on import price inflation. The pass-through effect of the exchange rate, as measured by the 36-currency NEER, to import prices, is found to be strong but not complete. Both the short and long-run coefficients are significant but differ considerably. The long-run coefficient is higher than the short-run ERPT coefficient in this context. The analyses conducted in this regard do not delve much into the real sector and its connection to the pass-through process to import prices. The estimation of the coefficient of pass-through effects of exchange rate on import price inflation was conducted while accounting for key macroeconomic variables as discussed in section VI.

There is strong evidence of high import dependency in India during the study period of 1991-92 to 2021-22. Even during the sub-periods, import dependency of the Indian economy continued to be high. The share of crude oil has been the highest in terms of the commodity-level distribution of the aggregate imports of India. Higher import dependency of the Indian economy has been found as a critical determinant of the observed extent of ERPT to import price inflation. It has also been found that inflation persistence is present and this has caused the ERPT to import prices to be higher in the long run. Lastly, exchange rate overshooting has been prevalent and the

study has found supporting evidence for the same. The basic findings in this regard remain stable irrespective of whether the bilateral or the nominal effective exchange rate variable is employed.

Exchange Rate Pass Through to Domestic Inflation

This study has also estimated the empirical extent of ERPT to domestic price inflation. As explained earlier, the WPI for all commodities has been employed as a measure of domestic inflation. The empirical exercises on this issue have been undertaken by accounting for both the real and monetary variables as discussed in section VI.

It is found that exchange rate variability is an important factor in shaping the empirical behaviour of ERPT to domestic inflation. Both the real and monetary variables such as real GDP growth rates, the composition of imports, inflation variability, trade distortions, and the degree of trade openness are found to be strongly influenced by exchange rate variability. Exchange rate variability in turn has a strong and significant association with inflation dynamics. Both, the exchange rate variability and inflation variability, Granger cause each other. The analysis further revealed that monetary policy variables are strongly affected by exchange rate variations rather than by real variations. Hence, the monetary policy behaviour in India during the study period appears to have been shaped considerably by the behaviour of the Indian currency in the forex markets, and probably this suggests that there exists a constant trade-off between maintaining the exchange rate values and achieving price stability for the RBI during the study period. Furthermore, the degree of trade openness and exchange rate variability is found to be significantly linked, and the degree of trade openness seems to be playing a critical role in determining the extent of ERPT to domestic prices. Lastly, the exchange rate pass-through to domestic inflation is found to be partial and incomplete during the study period though its extent has shown some degree of difference across the sub-periods, though the broad conclusions remain the same.

Asymmetry and Non-linearity in the ERPT behaviour

It is well-recognized in the ERPT literature that the impact of exchange rate variations on import prices and domestic prices is conditional upon the direction and size of the exchange rate change. Large exchange rate fluctuations seem to produce a larger impact on domestic prices as compared to smaller changes. Similarly, appreciation in the exchange rate is found to produce a

weaker impact on domestic prices as compared to depreciations in the exchange rate. Economic theory, *per se*, does not discriminate between the direction and the size of changes (Peltzman, 2000).

However, in the ERPT literature, domestic prices are found to be reacting asymmetrically to the size and direction of exchange rate movements. Using time series econometric analysis, this study investigated the differences in the ERPT relationship for appreciation and depreciation as well as for small versus large changes. ERPT to both the import prices and domestic inflation is found to be significantly different for appreciation shocks as compared to depreciation shocks. One percent depreciation has a larger impact on import price inflation as well as on domestic price inflation as against an equivalent appreciation shock. Similarly, the pass-through effects of small exchange rate variations are found to be lower than those of larger exchange rate alterations. The interaction between asymmetry and nonlinearity and their combined impact on ERPT to import prices and domestic prices has also revealed some important insights. Large depreciation shocks on average induce a larger change in import prices and domestic prices though the impact on domestic prices is lower than on import prices. Similarly, small appreciation shocks are found to have the least impact on domestic prices.

Limitations

This study has investigated several macroeconomic dimensions of the ERPT process in India during the period 1991-92 to 2021-22. While there are a host of valuable findings obtained by the empirical exercises in this study, the conclusions of this study must be seen while keeping its limitations in cognizance.

This study has primarily analysed the macroeconomic nature of the ERPT process while accounting for a host of real and monetary variables. However, the analysis is restricted to macroeconomic analysis and does not delve into the micro-foundations of the observed ERPT behaviour observed in this study. It must also be caveated that the interactions between the real and monetary sectors and their impact on the ERPT relationships are investigated briefly. Future works can analyse in depth how such interactions affect the behaviour of ERPT to import and domestic prices. It must also be recognized that this study has taken an aggregate approach to the ERPT issue, and focuses on the time series framework while not getting into the disaggregated

dynamics of the pass-through process. Commodity-level and regional analyses can provide valuable knowledge about the intra-industry and inter-industry relationship between exchange rate variations and prices.

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