ESSAYS ON EXCHANGE RATE PASS THROUGH

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CERTIFICATE

Certified that the thesis titled "**Essays on Exchange Rate Pass Through**" submitted by me for the award of the degree of Doctor of Philosophy in Arts at Jadavpur University is based upon my work carried out under the supervision of Professor Saikat Sinha Roy, Department of Economics, Jadavpur University, and neither this thesis nor any part of it has been submitted before for any degree or diploma anywhere/elsewhere.

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CHAPTER 1

OVERVIEW

1.1 Introduction

This thesis is a collection of essays, exploring various aspects of exchange rate pass-through in India. The essays are largely empirical but are theoretically grounded. ERPT, broadly defined, refers to the degree to which fluctuations in exchange rates are transmitted into domestic prices, particularly import prices and consumer price indices. Goldberg and Knetter (1997) formalized this notion as the percentage change in the domestic currency price of imported goods induced by a one percent change in the exchange rate between importing and exporting countries. The conceptual simplicity of ERPT belies its profound policy relevance: the extent and speed of pass-through determine the effectiveness of exchange rate adjustments in restoring external competitiveness, shape the inflationary consequences of currency volatility, and influence the transmission of global shocks to the domestic economy. These issues are particularly salient for emerging economies like India, where inflation targeting and increasing global integration coexist with exchange rate volatility, commodity price shocks, and complex domestic structural features.

The relevance of ERPT to macroeconomic stability in open economies is well established. Changes in exchange rates feed directly into import prices, altering firms' input costs and ultimately the consumer price index (CPI). Beyond direct effects, exchange rate fluctuations propagate through supply chains, raising production and transportation costs and, in turn, influencing domestic price levels and household purchasing power. In economies where imported intermediate goods comprise a significant share of production, as is increasingly the case in India, the exchange rate-price nexus becomes even more critical. For policymakers, the degree of pass-through not only determines the trade-off between exchange rate management and price stability but also constrains the space available for countercyclical policy. For firms, ERPT affects competitiveness, pricing strategies, and profit margins, while for households it governs real income dynamics. Understanding ERPT is thus central to the design of monetary frameworks, the calibration of fiscal responses, and the strategic decisions of private actors.

Despite its centrality, ERPT remains incompletely understood, particularly in the context of emerging economies. The classical frameworks of the law of one price and purchasing power parity (PPP) predict full and immediate pass-through. Yet a large body of empirical literature documents systematic deviations, with ERPT typically incomplete, delayed, and heterogeneous across countries, time periods, and goods. Taylor (2000) famously argued that lower inflation environments tend to be associated with lower ERPT, as firms are less willing to adjust prices in response to exchange rate changes when inflation expectations are anchored. This has been corroborated in advanced economies, where declining inflation and credible monetary policy have contributed to a secular decline in ERPT. However, the applicability of this stylized fact to emerging economies is far from straightforward. Structural features such as less developed financial markets, greater exchange rate volatility, weaker institutional credibility, and higher dependence on imported intermediates imply that ERPT may be stronger, more asymmetric, or more variable in economies like India.

The Indian context presents particular puzzles and research opportunities. Episodes of large currency depreciations—such as those in the mid-2000s—did not result in commensurate increases in CPI inflation (excluding fresh food), whereas more recent depreciations have been associated with noticeable increases in domestic prices. This apparent variation in ERPT over time raises critical questions: has pass-through become stronger with India’s deepening integration into global value chains, or do differences in monetary policy regimes and credibility account for the divergence? With India’s trade-to-GDP ratio rising from 15 percent in 1991 to nearly 48 percent in 2023, and imported components now constituting approximately 23 percent of the CPI basket, understanding the dynamics of ERPT has become not only academically pressing but also practically unavoidable for policy.

Three broad gaps in the literature—both globally and for India—motivate the present study. First, the non-linear and asymmetric nature of ERPT has been insufficiently explored. Evidence suggests that depreciations and appreciations have different effects on prices, reflecting downward nominal rigidities, pricing-to-market behavior by exporters, or asymmetric policy responses. Yet, with few exceptions, empirical studies continue to rely on linear frameworks that implicitly assume symmetry. For India, systematic evidence on such asymmetries is virtually absent, despite their obvious relevance to policy, particularly in an environment characterized by frequent depreciations.

Second, heterogeneity across products and sectors remains under-researched. While aggregate ERPT estimates provide useful averages, they obscure considerable variation across goods depending on tradability, demand elasticity, invoicing practices, and integration into global production networks. For instance, fuel imports may exhibit almost full pass-through due to dollar invoicing and global pricing, whereas machinery or pharmaceutical imports may display significantly lower ERPT due to differentiated products and pricing-to-market. Few studies for India systematically analyze product-level ERPT elasticities, despite the fact that such heterogeneity has direct implications for inflation management and industrial policy.

Third, theoretical and structural modeling of ERPT remains limited in the Indian context. While a vast empirical literature has employed reduced-form econometrics, the use of Dynamic Stochastic General Equilibrium (DSGE) models to embed ERPT within broader general equilibrium dynamics has been rare. Beyond the study by Patra, Khundrakpam, and John (2018), little work has been done to analyze how ERPT interacts with demand and supply shocks, monetary policy rules, and structural rigidities in India. This lack of theoretical integration hampers our ability to generate policy-relevant counterfactuals or to situate ERPT within the broader dynamics of inflation, output, and trade balances.

Beyond these specific gaps, a broader motivation for this study arises from the evolving exchange rate regimes and policy frameworks in India and globally. Under fixed exchange rate systems, ERPT is often muted as exchange rates are managed by monetary authorities, but the eventual adjustments tend to be large and abrupt, amplifying pass-through when they occur. Flexible exchange rate regimes, by contrast, generate more frequent exchange rate fluctuations, potentially inducing continuous though smaller pass-through effects. India's transition from a heavily managed exchange rate regime in the early 1990s to a more market-determined system today, alongside the adoption of a formal inflation targeting regime in 2016, implies that the dynamics of ERPT cannot be assumed constant across time. These institutional and policy changes provide both a backdrop and a motivation for re-examining ERPT in the Indian context, situating it within the broader literature on regime shifts, credibility, and monetary transmission.

The global literature also underscores the importance of considering structural and cyclical factors together. Pass-through has been shown to vary with inflation environments, monetary policy credibility, and openness to trade, the composition of imports, and the invoicing currency of trade. Recent studies emphasize the growing role of dominant currency pricing—particularly the role of the U.S. dollar as the currency of invoicing for a majority of global trade flows. This phenomenon has significant implications for ERPT in India, where much of the import bill, including oil, is dollar-denominated. In such contexts, exchange rate movements vis-à-vis the dollar have disproportionate effects on domestic prices, while bilateral exchange rate changes against other currencies may have muted impacts. Yet the implications of dominant currency pricing for ERPT in India remain underexplored, presenting another important research gap.

Taken together, these issues provide a strong rationale for this thesis. By combining time-series econometrics, panel data methods, and structural DSGE modeling, the essays that follow aim to address several of the key deficiencies in the literature on ERPT in India. They explore symmetric and asymmetric dynamics, sectoral heterogeneity, and general equilibrium interactions with demand and supply shocks, thereby offering a multi-dimensional and policy-relevant account of pass-through. In doing so, the thesis seeks to contribute not only to the empirical literature on India but also to broader debates in international macroeconomics concerning the determinants, variability, and policy implications of ERPT in emerging economies.

1.2 Changes in Exchange Rate Policy in India

Indian exchange rate management has undergone extensive changes over the decades, and such changes are major steps of macroeconomic policy reforms towards globalization. One can trace the process of exchange rate reforms in India in broad successive phases, each of which is marked by changing policy goals and external restrictions.Prior to 1991, India had a fixed exchange rate system under which the rupee was first pegged to the pound sterling and then to a basket of currencies. It was marked by tight foreign exchange control as required under the Foreign Exchange Regulation Act (FERA) of 1973, with the Reserve Bank of India (RBI) controlling the determination of the exchange rate through administrative mechanisms. The exchange rate system during this period was largely used as a defense mechanism for scarce foreign exchange reserves and balance of payments condition.

Table 1.1: Evolution of Exchange Rate Regimes in India

Period	Regime Type	Key Features
1947–1975	Fixed Peg	Rupee tied to GBP; minimal volatility (₹3.3–₹8.4/USD)
1975–1980	Basket Peg	Managed against a currency basket; gradual depreciation (₹8.4–₹31.4/USD)
1980- 1990	Crawling Peg	Managed incrementally within strict bands
1993–Present	Managed Float	Market-determined rates with RBI intervention; high volatility post-2008

Post-Independence, the Indian rupee was fixed to the British pound till 1975. In this Bretten Woods period, was an era of exchange controls and restricted trade. After the Bretton Woods system collapsed in the early 1970s, India changed to a basket peg. Beginning in the early 1980s, the rupee was placed under a crawling peg arrangement, with policy subsequently oriented towards real exchange rate targeting (Joshi & Little, 1994). This involved periodic downward adjustments of the nominal rate, allowing for a gradual depreciation of the currency.A decisive shift occurred in the 1990s with the transition towards a market-determined exchange rate regime. The process commenced with a nominal devaluation of approximately 18–19% in 1991, followed by the introduction of a dual exchange rate system in 1992. In March 1992, the Liberalized Exchange Rate Management System (LERMS) was implemented, under which 60% of current account receipts were converted at market-determined rates, effectively replacing the Exim Scrips scheme. Within this framework, the Reserve Bank of India (RBI) announced its reference rate, while the Foreign Exchange Dealers Association of India (FEDAI) disseminated indicative market rates for major international currencies, including the US dollar, German mark, Japanese yen, and British pound. To diminish the role of informal currency markets, LERMS also permitted the importation of gold.

Further reforms followed in 1993, guided by the recommendations of the High-Level Committee on Balance of Payments chaired by Dr. C. Rangarajan. The adoption of a unified exchange rate system, the abolition of foreign exchange budgeting, and the removal of restrictions on imports constituted significant initial steps towards current account convertibility. The final step was taken in August 1994, when additional liberalization of invisible transactions and relaxation of foreign exchange controls—within specified limits—completed the transition. Collectively, these measures laid the foundation for a more liberalized and market-oriented exchange rate regime in India.

The economic liberalization initiated in 1991, following a balance of payments crisis, was a turning point in India's exchange rate policy. India shifted to a market-determined exchange rate regime in March 1993, albeit with the active intervention of the RBI. It was a qualitative shift in India's strategy on exchange rate management from relying on the exchange rate as an implicit policy tool to permitting market forces to play a larger role in determination.The central bank intervenes in the foreign exchange market to offset disorderly market conditions, undue volatility, and to prevent destabilizing speculative attacks on the currency but without targeting any predetermined level of exchange rates. The regime has been referred to as a "managed float without a predetermined path." With the transition to the managed float regime, the RBI policy thus has been characterized by pragmatic flexibility as opposed to any predetermined framework. (Panchmukhi, 1984; Pradhan, 1992, 1993; Pattanaik, 2003, 2021,; Dua and Sen, 2006; Sengupta and Sinharoy, 2018). Volatility under the managed float regime, the Indian exchange rate policy has sought to balance a number of objectives:

1. External stability maintenance: RBI acts to avoid excessive volatility that would disturb trade and investment flows.

2. Competitiveness maintenance: While there is no direct emphasis on gaining competitive exchange rates, the interventions also steer clear of sudden appreciation that could damage export competitiveness.

3. Controlling inflation: Effects of exchange rates are significant in monetary policy choices, especially considering the effect of exchange rate fluctuations on import prices and general inflation.

4. Foreign exchange interventions have moderated the accumulation in reserves, which act as a buffer against external shocks and volatility in capital movements.

The RBI's intervention approach has evolved from being largely undertaken through direct intervention in the spot market to using a wider range of instruments, including the forwards and futures markets. This is because India's financial markets have become increasingly sophisticated and because the central bank wishes to reduce the potential costs and distortions of interventions.

India's exchange rate management policy is different from that of most of its emerging market counterparts. Differing from countries that adopted formal inflation targeting with freely floating exchange rates like Brazil, Chile, and South Africa or more fixed exchange rate arrangements like China's managed peg, India has retained a balanced approach that support flexibility. This is similar to exchange rate management policy followed by other Asian economies like South Korea and Thailand, which also prioritize exchange rate stability with allowing gradual adjustments.

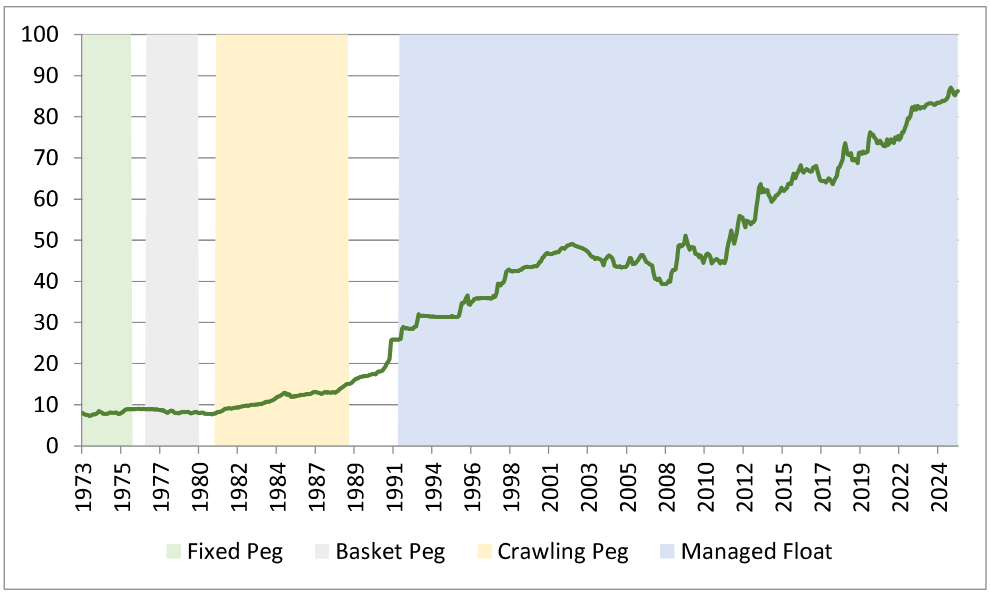
During recent years, especially after the RBI moved to an inflation-targeting regime in 2016, there is greater focus on permitting higher exchange rate flexibility with curbing excessive volatility. However, exchange rate issues remain relevant to monetary policy actions because of the large influence of exchange rate movements on Indian inflation, external balance, and financial stability. India's exchange rate regime has significant implications for exchange rate pass-through. The evidence is that very flexible exchange rate regimes have low pass-through since firms in those regimes expect exchange rate volatility and adjust their price responding to expectations of the volatility (Jongrim et al., 2019; Ha, 2019) However RBI intervention to prevent excessive volatility can lower the incentives of firms to invest in hedging contracts, so that pass-through would be higher than would be the case with a purely floating regime.

India's development of exchange rate policy is consistent with significant changes in the country's trade arrangements, import pattern, and monetary policy framework, all of which have pass-through implications. With increased integration into global value chains and increased dependence on imports in some segments, the exchange rate shocks are likely to get transmitted to domestic prices, both in magnitude and speed.

1.3 Stylised Facts on Exchange Rate Pass-Through in India

Understanding exchange rate movement of India is crucial to explore the dynamics of exchange rate pass-through. This section provides some stylized observations about the history of the exchange rate of the Indian rupee. The nominal currency value of Indian rupee in relation to the major global currencies, particularly the US dollar, has witnessed a secular decline. From around 17 rupees per US dollar in 1990, to more than 85 rupees per US dollar in 2025. This nominal decline however not been consistent, there have been times of relative stability with intermittent bouts of abrupt adjustment (see Figure 1.1)

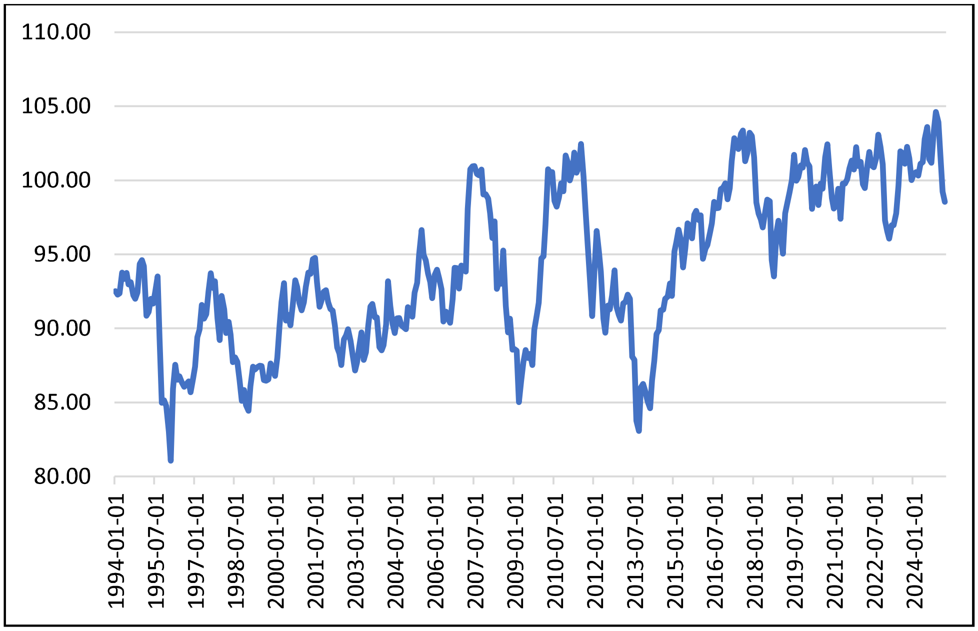
Figure 1.1 Nominal Exchange Rate of India (INR/USD) (1973-2025)



Source: Board of Governors of the Federal Reserve System (US) via FRED

The long-term depreciation trend reflects several fundamental factors at work including inflation differential, productivity differential and current account dynamics among others. Das and Sinha Roy (2025) has shown that a stable long-run relationship exist between the monthly spot exchange rate and some macroeconomic variables, including the income differential, interest rate differential, money supply differential, foreign exchange reserves and trade balance.Despite the nominal depreciation over the long run, the real currency measured by real effective exchange rate (REER) has had a consistent record, with periods of real appreciation followed by periods of real depreciation. This is the implication that realignments of the nominal exchange rate have, to some degree, moderated the effect of inflation differentials over the period.

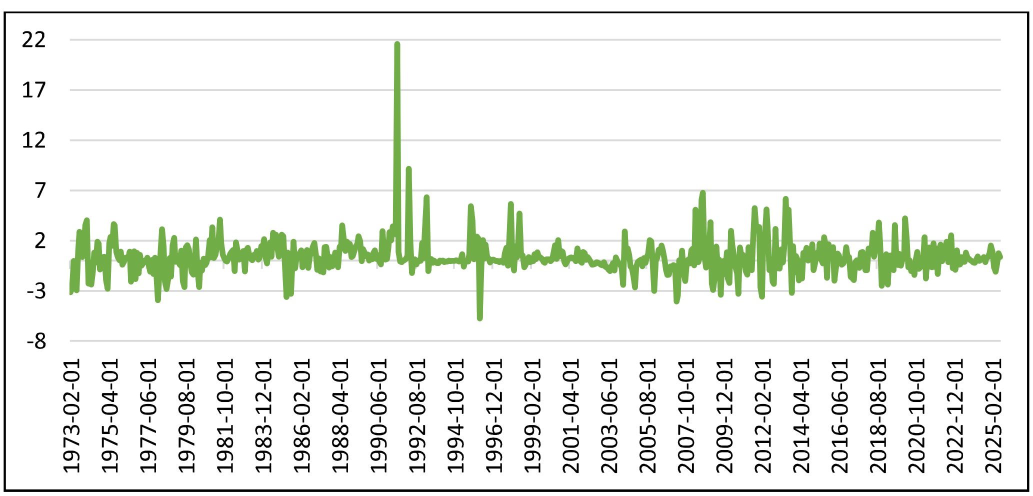
Figure 1.2: Real Effective Exchange Index (1994-2025)



Source: Bank for International Settlements via FRED

Volatility of India's nominal exchange rate has changed dramatically post-liberalization, the volatility pattern is given in the diagram below.

Figure 1.3: Volatility of Nominal Exchange Rate (INR/USD) (1994-2025)



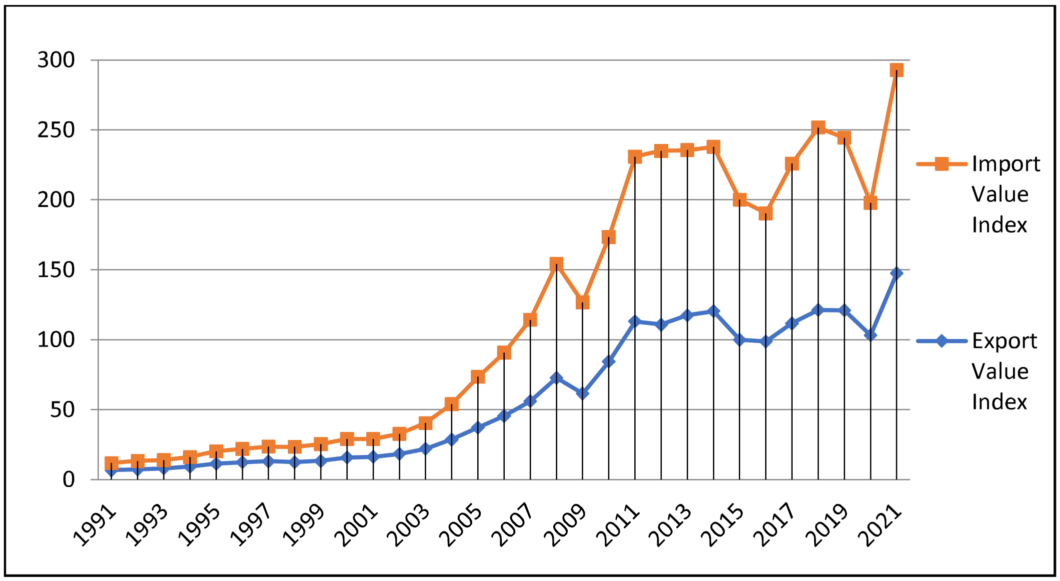
Note: Data sourced from Bank for International Settlements via FRED

Rather than exhibiting continuous volatility, the rupee exchange rate has been characterized by bouts of relative stability punctuated by bouts of heightened volatility. These spikes in volatility have typically followed external shocks to the economy, including the Balance of Payment Crisis (1991), Asian Financial Crisis (1997-98), the Global Financial Crisis (2008-09), the "Taper Tantrum" (2013), and, most recently, the COVID-19 pandemic (2020) and the FED rates hike and Oil Shock (2023). According to Das and Sinharoy (2021, 2024) the foreign exchange markets are affected by several crises and the persistence of the overall cycle is uniformly higher for bear regime as compared to the bull regime.

While a lot of importance is normally placed on the rupee-dollar exchange rate, India's effective exchange rate is independent of trade performance vis-à-vis a large range of partners. The rupee has shown diverging patterns of volatility vis-à-vis a number of currencies, including the euro, pound sterling, yen, and the emerging market trading partners' currencies. There has been some asymmetry in the RBI's intervention pattern with greater tolerance of gradual depreciation in contrast to lower tolerance of sharp appreciation. Although there have been occasional surges, underlying exchange rate volatility has actually decreased over time. Such decline in structural volatility has important implications for pass-through effects since it could reduce the incentive for importers to continuously update prices in response to exchange rate movements.

The pass-through dynamics are set against the backdrop of the relationship between the rupee exchange rate and key macroeconomic variables. Unit values or average price of tradables have changed over time with that of exports and imports, increase significance since early 2000s only to relatively stagnate from 2011 onwards. For imports, when a country's currency depreciates, imported goods become more expensive in domestic currency. The extent to which import unit values rise indicates the degree of ERPT. However, on account of price stickiness and strategic pricing by foreign exporters, this pass-through is often partial. These exporters may maintain stable prices in the buyer's currency to retain market share (partial pass-through), or they may adjust prices in full, leading to complete pass-through. Consequently, low ERPT suggests that domestic inflation is less responsive to exchange rate changes, while high ERPT indicates a stronger inflationary effect from currency depreciation.

Figure 1.4: Trends in Unit Value Index (Imports and Exports)

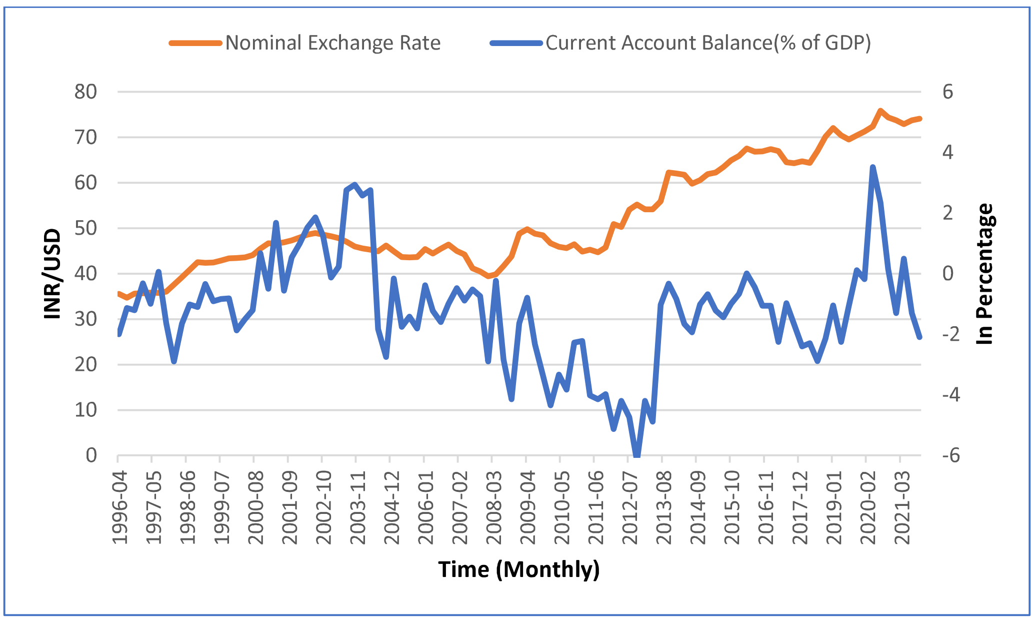


Source: WITS database

On the export side, a depreciated domestic currency typically makes goods cheaper for foreign buyers, potentially boosting demand. The degree of ERPT into export prices depends on whether domestic firms adjust their prices in foreign currency. Firms practicing pricing-to-market behavior may keep foreign-currency prices stable to stay competitive, resulting in low pass-through. Conversely, if they raise prices in line with exchange rate changes, the ERPT is higher. Strong pass-through in export unit values enhances competitiveness during depreciation, supporting export growth. In contrast, weak pass-through may reduce the potential benefits of a weaker currency, limiting gains in external demand.

It needs to be recalled that the country has undergone significant trade policy along with wide shifts in exchange rate regimes since the early 1990s[1]. As India seeks to manage external account deficits and achieve macroeconomic stability, understanding ERPT becomes increasingly crucial. During this period, with reductions in tariff and non-tariff barriers, India has experienced improvement in export performance; however, current account deficits persist, largely due to trade price sensitivity to exchange rate fluctuations

Figure 1.5: Nominal Exchange Rate and Current Account Balance in India



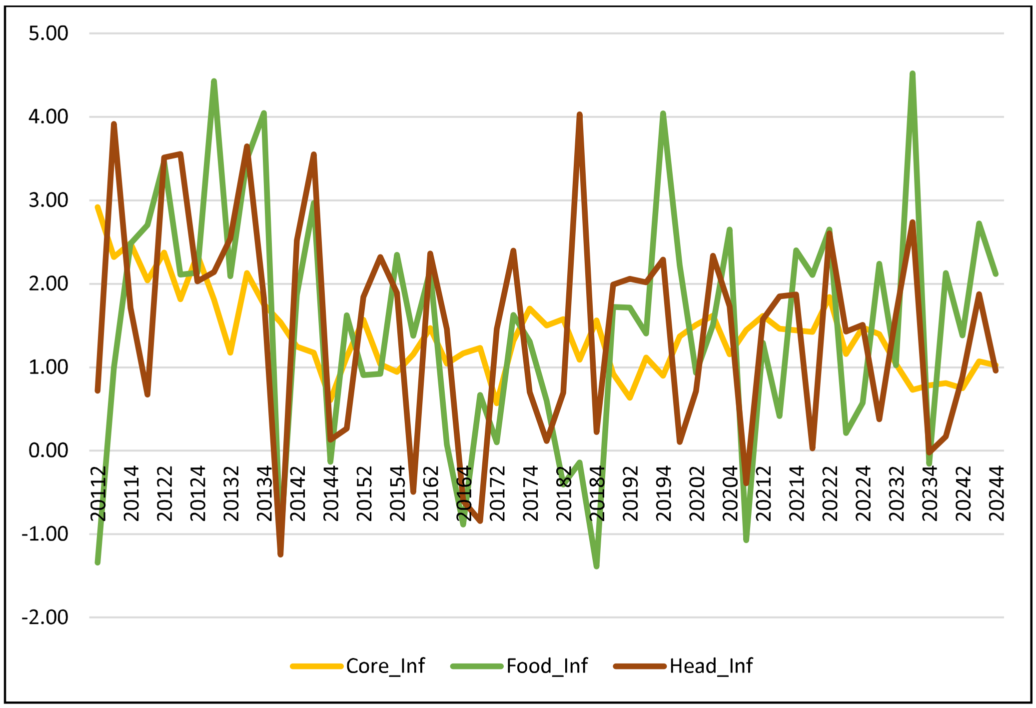
Source: Authors calculation using International Financial Database, IMF.

ERPT is critically shaped by the nature of shocks driving currency movements, the inflation expectations they generate, and their consequent impact on price-setting behavior. Supply-side shocks, such as oil price surges or commodity shortages,

[1] For detailed review of trade policy changes see Sengupta and SinhaRoy (2018)

typically exert strong and immediate effects on domestic prices by raising input costs, thereby amplifying ERPT (Campa and Goldberg, 2005; Choudhri and Hakura, 2006). By contrast, demand-side disturbances or capital flow reversals often produce weaker direct cost pressures, yet they can significantly influence ERPT indirectly through expectations: if households and firms anticipate persistent currency weakness, they adjust price- and wage-setting behavior upward, reinforcing inflation persistence and raising the overall degree of pass-through (Taylor, 2000).

Figure 1.6: Trends in Core, Food and Head line Inflation Rate of India



Source: Bank for International Settlements via FRED

The impact on ERPT also depends on the perceived duration of the shock, with temporary disturbances leading firms to partially absorb costs, while permanent shocks induce more complete price adjustments (Goldberg and Knetter, 1997). Crucially, monetary policy credibility mediates this transmission: in economies with well-anchored inflation expectations under robust policy frameworks, shocks tend to have a dampened effect on ERPT, whereas in contexts of weaker policy credibility, even transitory shocks can generate disproportionate pass-through by destabilizing confidence in future price stability (Devereux and Yetman, 2010).

The stylized facts presented above on India's exchange rate movements form the empirical foundation of the study on exchange rate pass-through in the Indian setting. The features of depreciation, volatility, and responsiveness to different shocks collectively determine how the movements in exchange rates impact domestic prices and economic agents' expectations regarding future prices and exchange rates.

1.4 Literature Review

The study of Exchange Rate Pass-Through (ERPT) has evolved considerably over the last few decades, with theoretical and empirical models adapting to reflect the complexities of international trade, macroeconomic adjustment, and pricing behavior under uncertainty.

1.4.1 Theoretical Literature on Exchange Rate Pass-Through

The theoretical literature on Exchange Rate Pass-Through (ERPT) has evolved considerably, moving from classical formulations that assumed full pass-through under idealized conditions to modern frameworks that account for incomplete, asymmetric, and state-dependent dynamics. Early theoretical approaches were grounded in the law of one price (LOOP) and purchasing power parity (PPP), both of which implied complete pass-through under conditions of perfect competition, flexible prices, and frictionless markets (Dornbusch, 1987). In such a framework, a change in the nominal exchange rate was expected to translate fully and instantaneously into domestic-currency prices of imports and exports. Yet, as empirical evidence accumulated, these strong assumptions came under scrutiny, generating a literature dedicated to explaining incomplete and heterogeneous ERPT outcomes.

One of the earliest systematic theoretical rationales for incomplete ERPT emerged from the mark-up pricing framework. Krugman (1987) introduced the concept of pricing-to-market (PTM), highlighting that exporters often adopt strategic pricing across different destination markets in response to exchange rate changes. Rather than transmitting exchange rate fluctuations fully into prices, exporters may instead adjust their markups, absorbing part of the shock in their profit margins. This implies that the degree of pass-through depends on market characteristics, particularly the elasticity of demand and the degree of competition. Knetter (1993) provided empirical validation of this theoretical construct, suggesting that exporters are more likely to internalize exchange rate movements in high-elasticity or highly competitive markets. Dornbusch (1987) further formalized this framework, showing that monopolistic competition provides firms with pricing power that allows discriminatory pricing across markets and currencies. However, Athukorala and Menon (1994) offered a counterpoint, arguing that PTM does not apply universally, and in particular, Japanese exporters were less inclined to follow such strategies, indicating that ERPT behavior is highly context-dependent.

A second major theoretical strand emphasizes the role of nominal rigidities. Calvo's (1983) staggered price-setting model and Taylor's (1980) wage-contract framework introduced the idea of sticky prices and wages, whereby firms cannot continuously adjust their prices in response to shocks, including exchange rate fluctuations. Under such conditions, ERPT is likely to be delayed or dampened in the short run, even if it converges toward higher levels in the long run. This line of argumentation provided the theoretical underpinnings for New Keynesian open-economy models, where nominal rigidities, combined with imperfect competition and market power, generate predictions consistent with the empirical observation of incomplete pass-through.

The choice of invoicing currency constitutes another critical theoretical determinant of ERPT. Theoretical frameworks distinguish between Producer Currency Pricing (PCP)—where export prices are set in the producer's currency—and Local Currency Pricing (LCP)—where prices are set in the importer's currency (Obstfeld & Rogoff, 1995; Devereux & Engel, 2004). Giovannini (1988) and Marston (1990) argued that pass-through is systematically lower when invoicing is conducted in third-party or exporter currencies rather than in the importer's currency. Under PCP, exchange rate changes are fully reflected in import prices, whereas under LCP, import prices remain insulated from exchange rate fluctuations, leading to incomplete pass-through in the short run. Bacchetta and van Wincoop (2002) extended this framework, showing that in highly competitive markets, exporters tend to invoice in their own currency, further constraining ERPT.

The theoretical literature has recently gravitated towards the Dominant Currency Pricing (DCP) paradigm, pioneered by Gopinath (2015) and elaborated by Gopinath et al. (2010, 2020). According to this framework, global trade is increasingly invoiced in a single dominant currency—principally the U.S. dollar. This dominance of dollar invoicing reduces the transmission of bilateral exchange rate fluctuations to import and export prices, thereby muting ERPT. The DCP hypothesis has sizable implications for global trade dynamics and inflation, as it implies that the strength of the dollar has systemic consequences beyond U.S. borders.

Macroeconomic environments and monetary policy credibility also figure prominently in theoretical models of ERPT. Taylor (2000) argued that pass-through is critically dependent on the inflation environment. In low-inflation regimes, firms are less inclined to adjust prices in response to exchange rate shocks, generating lower pass-through. This idea, now widely referred to as the Taylor hypothesis, links macroeconomic stability, credible monetary policy, and declining ERPT. Devereux, Engel, and Tille (2003) developed models in which credible inflation-targeting regimes anchor inflation expectations, further reducing ERPT.

Finally, the development of Dynamic Stochastic General Equilibrium (DSGE) models has significantly advanced theoretical understanding of ERPT. These open-economy frameworks, which integrate micro-founded household and firm behavior with nominal rigidities and real frictions, have been used to simulate how exchange rate shocks propagate under alternative monetary policy rules (Lane, 2001; Corsetti, 2005; Ca'Zorzi, 2017). By embedding staggered pricing, wage contracts, and financial frictions, DSGE models capture the state-dependent and non-linear nature of ERPT. Importantly, they highlight that ERPT is not constant but contingent upon prevailing economic conditions, monetary policy credibility, and the invoicing currency structure.

1.4.2 Empirical Literature on Exchange Rate Pass-Through

Empirical research in advanced economies has consistently challenged the theoretical prediction of complete ERPT. Goldberg and Knetter (1997) documented significant heterogeneity in pass-through across industries and countries, initiating a rich empirical literature. A central finding of this body of work is that ERPT is incomplete, asymmetric, and time-varying.

Taylor's (2000) hypothesis—that declining inflation environments are associated with lower ERPT—has been confirmed repeatedly. Bailliu and Fujii (2004), employing reduced-form models across panels of industrialized economies, found that pass-through declined systematically over time, reflecting improved policy credibility. Similarly, Ca'Zorzi, Hahn, and Sánchez (2007) reported lower ERPT in advanced economies with strong monetary institutions.

Methodologically, single-equation models were initially favored but criticized for their inability to capture dynamic feedback and asymmetries (Cicco & Schmidt, 2020). Consequently, Vector Auto Regression (VAR) techniques gained prominence. Campa and Goldberg (2005) applied VAR methods to OECD countries, demonstrating incomplete ERPT to import prices and variation depending on openness and import composition. Choudhri and Hakura (2006) found a positive correlation between pass-through and average inflation rates, reinforcing the Taylor hypothesis. Ito and Sato (2008) extended this to East Asian economies, showing considerable cross-country variation in ERPT depending on inflation regimes.

Firm and product-level evidence further nuanced the empirical understanding. Gopinath, Itskhoki, and Rigobon (2010) analyzed U.S. import data at the transaction level, revealing that invoicing choice strongly determines ERPT: dollar-invoiced goods display minimal pass-through, whereas goods invoiced in other currencies exhibit higher pass-through. Marazzi et al. (2005) confirmed the growing dominance of dollar invoicing as a driver of declining ERPT to U.S. import prices. Otani et al. (2003) and Shioji (2012) documented heterogeneity across industries, finding that ERPT depends on competition intensity, tradability, and supply chain structures.

Longitudinal studies reveal that ERPT has been on a declining trajectory in advanced economies. Takhtamanova (2010), using U.S. data, showed that ERPT declined persistently since the 1980s, attributable to credible monetary policies and structural changes in global value chains. Cicco and Schmidt (2020) critiqued standard econometric models for failing to capture asymmetries between anticipated and unanticipated shocks, advocating DSGE-based approaches for more structural insights.

Empirical studies in developing and emerging economies reveal a distinct pattern: ERPT is typically higher, more volatile, and more sensitive to external shocks than in advanced economies. Campa and Minguez (2006) and Garetto (2009) noted that oligopolistic structures in many developing economies lead to lower pass-through due to pricing power, but volatility and policy shocks can elevate pass-through significantly. The International Monetary Fund (2022) estimated that a 1% depreciation raises global consumer prices by 0.16% over a year, but the effect is 0.3% in emerging markets compared to only 0.08% in advanced economies. Pass-through is particularly high when depreciation is driven by U.S. monetary policy, global commodity shocks, or high domestic inflation.

One aspect that is relatively new and hence received little attention in the literature is the relationship between global value chains (GVCs) and ERPT. GVCs, which imply fragmentation of production across borders, influence how exchange rate changes affect prices at different stages of the production process. When firms are integrated into GVCs, the impact of exchange rate fluctuations on final prices may be reduced, as only a portion of the production process takes place in the country experiencing the exchange rate change. Amiti et al., (2014); De Soyres et al., (2021), highlight that firms more deeply embedded in GVCs tend to absorb exchange rate fluctuations in their profit margins rather than passing them on to prices, leading to a lower ERPT. This highlights the growing need to incorporate GVC-related factors into analyses of ERPT, particularly as global production expands networks.

The BRICS economies illustrate the diversity of ERPT outcomes. Belaisch (2003) and Nogueira Jr. (2007) reported high ERPT during the inflationary 1980s and

1990s, but Correa and Minella (2010) demonstrated that ERPT declined after inflation targeting was adopted in 1999.Russia: Granville and Mallick (2006) found substantial ERPT into domestic prices, reflecting weak monetary anchors and import dependence. Oomes and Kalcheva (2007) observed stronger ERPT during oil price volatility, highlighting the role of external shocks. Cheung & Fujii (2006) documented relatively low ERPT to consumer prices, citing administrative controls and local-currency invoicing. Ito & Sato (2008) reported higher ERPT into producer prices due to deep GVC integration. Zhang & Clovis (2010) found that ERPT is state-dependent, stronger during exchange rate liberalization episodes. Aron, MacDonald, & Muellbauer (2014) observed declining ERPT under credible inflation-targeting regimes. Comparative work underscores the heterogeneity within BRICS. Brazil and Russia historically displayed higher ERPT due to inflationary and commodity-related vulnerabilities, while India, China, and South Africa recorded lower ERPT, aided by stronger monetary anchors and structural features (Rodriguez & Zumaquero, 2019). Chen et al. (2019) highlighted that spillovers from crude oil markets and economic policy uncertainty are time-varying and heterogeneous across BRICS.

Uncertainty has emerged as a pivotal dimension in the empirical literature. Shioji (2012) demonstrated that firms respond differently to anticipated and unanticipated shocks. Takhtamanova (2010) showed that reduced inflation uncertainty in the U.S. contributed to declining ERPT. Forbes et al. (2018) argued that ERPT is muted under domestic demand shocks but amplified under monetary shocks. For China, Wang et al. (2022) found incomplete pass-through of the renminbi but noted that uncertainty amplifies ERPT. Ghosh, Ostry, and Qureshi (2018) confirmed that exchange rate shocks are more inflationary in uncertain environments. Akram (2020) highlighted the destabilizing role of geopolitical instability and oil prices. Olalere et al.

(2024) showed how global tensions and uncertainty disrupt BRICS economies, while Shahrokhi et al. (2017) stressed that geopolitical stability is a prerequisite for sustained growth.

Broadly, uncertainty encompasses macroeconomic volatility, financial crises, wars, disasters, electoral cycles, and abrupt policy shifts (Cižmešija et al., 2017; Zhang et al., 2016; Gulen & Ion, 2016; Gil-Pareja et al., 2019). Empirical evidence consistently shows that emerging economies experience heightened ERPT under uncertainty, while advanced economies with credible institutions buffer these effects more effectively.

The literature on Indian evidence has also evolved over the years. Early studies by Bhattacharya, Patnaik, and Shah (2008) and Mallick and Marques (2006) identified incomplete pass-through due to RBI interventions, government price controls, and protectionist structures. Choudhri and Hakura (2006), Ghosh and Rajan (2007), and Khundrakpam (2007) confirmed weaker pass-through to consumer prices compared to import prices. Pyne and Sinha Roy (2008) showed heterogeneity across industries, with high ERPT for chemicals and negligible effects for machinery. Nath and Samanta (2003) and Patra and Kapur (2012) demonstrated that ERPT rises during inflationary or volatile periods. Patra, Khundrakpam, and George (2018) found that India's adoption of flexible inflation targeting in 2016 helped moderate ERPT. Asymmetries have been documented by Parab (2022) and Ghosh (2021), who showed that appreciations have a stronger dampening effect than depreciations have in raising prices. Long-run ERPT estimates vary: Ghosh and Rajan (2007) reported ~40% for the rupee-dollar rate; Pyne and Sinha Roy (2019) found high ERPT for food and machinery but low for chemicals and heavy manufacturing; Dholakia and Saradhi (2000), Dash and Narasimham (2011), and Yanamandra (2015) even found near-complete or greater-than-complete ERPT when accounting for regime shifts. More recently, Sengupta and Sinha Roy (2023, 2024) highlighted the influence of GVC participation, product variety, and market concentration. Goldberg and Tille (2008), Mishra and Mishra (2020), and Goyal (2023) emphasized the role of invoicing behavior and supply chain positioning in shaping India's ERPT.

Even with a vast literature on Exchange Rate Pass-Through (ERPT), some important gaps exist—especially for emerging economies such as India. Studies on non-linear and asymmetrical nature of ERPT, particularly to global shocks, is also poorly researched. Sector heterogeneity, for example, in the import of chemicals and fuels, has important implications for inflation management but is also poorly researched. With India's integration into global value chains increasing—with the trade-to-GDP ratio increasing from 15% in 1991 to 48% in 2023, and 23% of the CPI basket consisting of imported parts—a re-examination of ERPT is necessary. This is especially so for the Reserve Bank of India's inflation targeting framework.

There is further reference in existing literature to a critical lack of studies on ERPT to export prices, not only internationally but also in India. There is a lack of thorough analyses that examine product-wise ERPT elasticities and their determinants at highly disaggregated levels. Additionally, pricing-to-market behaviour, the impact of domestic production and imported input prices, and asymmetry of ERPT in the event of currency appreciation and depreciation are less researched. The lack of broad application of Dynamic Stochastic General Equilibrium (DSGE) models on ERPT in India—except for Patra, Khundrakpam, and John (2018)—also goes to indicate the gap in the research.

1.5 Objectives and Summarization of Results

This thesis aims to contribute to the literature by addressing these issues in different ways, including

- an investigation into exchange rate pass through to Indian export prices taking into consideration product-wise and destination-wise heterogeneity, and an analysis of the structural factors including participation in Global Value Chains, in determining ERPT heterogeneity.
- an analysis of extent to which exchange rate impacts on import prices, to be followed by inflation expectations reactions to exchange rate movement.
- a study of how various demand and supply side shocks affect ERPT results and the consequent impact on macroeconomic variables in the context of a general equilibrium setup.

This thesis presents a comprehensive investigation into Exchange Rate Pass-Through (ERPT) in India through four interrelated essays, each addressing a different dimension of the phenomenon. The first essay estimates ERPT elasticities for Indian export and import prices over a period of more than four decades (1980- 2021). The findings show ERPT to be incomplete—approximately 23% for exports and 45% for imports—with short-run pass-through being particularly weak. Asymmetric effects emerge, with stronger pass-through during currency appreciation than depreciation, suggesting that Indian firms absorb exchange rate shocks rather than fully transmitting them to prices.

Building on this, the second essay delves into disaggregated product-level and destination-wise ERPT, revealing considerable heterogeneity. Exporters exhibit "pricing-to-market" behavior, particularly in less competitive markets, and greater involvement in Global Value Chains (GVCs) is shown to reduce pass-through by dispersing production and stabilizing prices. Structural factors such as market concentration and product differentiation, as measured by Lerner and Hufbauer indices, also lower ERPT. Asymmetry persists, with depreciation proving to be a less effective policy tool than appreciation.

The third essay examines ERPT's influence on inflation expectations within India's inflation-targeting framework. It finds a that the exchange rate pass through coefficient for crude oil imports prices is 0.81 This means as the exchange rate depreciates by one unit, landed price of crude oil imports rises significantly by 0.83 units. Further the essay shows significant, asymmetric impact of the real effective exchange rate on expectations, alongside strong effects from actual inflation. Other macroeconomic factors—GDP growth, oil prices, money supply, and fiscal trends—also shape expectations to varying degrees. Together, these essays offer crucial insights into India's pricing behavior, macroeconomic stability, and trade competitiveness.

The fourth essay embeds ERPT in a New Keynesian Dynamic Stochastic General Equilibrium (DSGE) framework, illustrating that ERPT is higher for tradable goods than non-tradables, especially under monetary shocks. The impact on CPI lies between the two, and the intensity of shocks influences the degree and persistence of pass-through. The currency of invoicing matters significantly—ERPT is highest under the Dominant Currency Paradigm and lowest under Producer Currency Pricing.

1.6 Data and Method

This collection of essays employs secondary data across a series of chapters to examine export pricing, exchange rate pass-through (ERPT), and inflation dynamics for India. Chapter 2 utilizes 41 annual observations (1980-2021) of time series data to study long-run ERPT and competitiveness of trade. Export and import unit value indices, and world GDP (foreign demand proxy), are from World Development Indicators (WDI). Indian GDP (domestic demand proxy) and Nominal Effective Exchange Rate (NEER) are from RBI's Database on Indian Economy (DBIE). Indian and world GDP growth rates are utilized to smooth the series and minimize volatility.

Chapter 3 uses accurate customs-level export transactions data from the Directorate General of Commercial Intelligence and Statistics (DGCI&S), Ministry of Commerce and Industries, Government of India for the period of 2003-2018. Export goods are coded at the 8-digit Harmonized System (HS) level with corresponding values and quantities to calculate unit prices (in USD) as proxies for India's export prices. Nominal exchange rate (NER) data are used from the Reserve Bank of India's (RBI) Handbook of Statistics on Indian Economy and International Financial Statistics of IMF. Trade openness indicators and other control variables such as destination country GDP are drawn from the World Integrated Trade Solution (WITS). Export import intensity is also measured using data on Net Foreign Exchange Inflow Rate (NFIR), drawn from input-output tables available from the Central Statistical Office (CSO), Government of India. Average costs are obtained by matching HS codes with NIC codes of the Annual Survey of Industries (ASI), and these had to be aggregated to the 4-digit level.

Chapter 4 examines inflation dynamics between Q3 2008 and Q3 2018 with the help of monthly macroeconomic data. CPI-based inflation, inflation expectations (from Inflation Expectations Household Survey), year-over-year change in fiscal balance, real GDP growth, unemployment rates, REER, money supply (M2), and Brent crude oil prices (in INR) are important variables. These indicators were obtained from the RBI and CSO databases, and the Petroleum Planning and Analysis Cell under Ministry of Petroleum and Natural Gas, Government of India. All the indicators were standardized, seasonally adjusted, and interpolated to monthly frequency to maintain the consistency of econometric analysis.

The methodological approaches adopted across Chapters 2 to 5 provide a structured and complementary investigation into exchange rate pass-through (ERPT), combining econometric estimation with structural simulation to capture both partial-equilibrium and general-equilibrium dynamics. Chapters 2 and 4 jointly deploy the Autoregressive Distributed Lag (ARDL) and Nonlinear ARDL (NARDL) models, both well-suited for analyzing relationships involving variables integrated of orders not more than one while distinguishing between short-run and long-run effects. The ARDL framework enables a systematic estimation of symmetric pass-through by quantifying how exchange rate changes translate into import and consumer prices contemporaneously and over time, while the bounds-testing procedure establishes whether a long-run equilibrium relationship exists among the relevant variables. This is particularly important in determining the persistence and completeness of ERPT, as well as the speed of adjustment toward equilibrium. Recognizing, however, that appreciations and depreciations often exert differential effects—due to factors such as downward price rigidity, pricing-to-market behavior, or monetary authority interventions—both chapters also employ the NARDL specification, which decomposes exchange rate movements into positive and negative partial sums to capture asymmetric effects. This allows for the identification of whether depreciations induce stronger or faster pass-through than appreciations, or whether large shocks trigger nonlinear adjustments that linear ARDL models might obscure.

Moving from time-series to cross-sectional dimensions, Chapter 3 employs a fixed effects panel estimation strategy using product-level data, thereby addressing the heterogeneity of ERPT across export destinations and commodities. Aggregate estimates often mask important sectoral differences arising from variations in import intensity, demand elasticity, invoicing practices, and integration into global value chains. The fixed effects framework controls for unobserved heterogeneity across products, isolating within-product variation over time and ensuring more reliable inference on sector-specific ERPT. The fixed effects model enriches the analysis by linking firm- and product-level characteristics to aggregate macroeconomic outcomes, underscoring the importance of disaggregated analysis in formulating trade and monetary policy.

Finally, Chapter 5 develops a Dynamic Stochastic General Equilibrium (DSGE) model to situate ERPT within a broader structural and policy-driven framework. Unlike reduced-form econometric approaches, DSGE models provide a micro-founded, internally consistent representation of households, firms, and policy institutions under nominal and real rigidities, enabling the analysis of how exchange rate shocks propagate through the economy. By simulating both demand-side supply-side shocks, the model captures how exchange rates interact with inflation, output, and external balances. This approach highlights feedback loops, second-round effects, and policy transmission channels that cannot be addressed in single-equation or panel data frameworks. It also facilitates counterfactual exercises, such as examining how ERPT would evolve under alternative monetary rules or varying degrees of openness, thereby linking historical evidence with forward-looking scenarios.

1.7 Chapter Scheme

This thesis is outlined as follows: after this overview chapter, Chapter 2, presenting the first essay, provides an estimation of elasticities of exchange rate pass-through (ERPT) of Indian aggregate export and import prices, recognizing asymmetries in this relationship. In Chapter 3, the second essay, the study estimates ERPT elasticities at a disaggregated level—by product and destination—while identifying structural determinants accounting for heterogeneity in pass-through.

In Chapter 4, the third essay, it estimates the sensitivity of import prices and inflation expectations to exchange rate movements. Chapter 5, the fourth essay, estimates the impact of various demand- and supply-side shocks on ERPT and their general macroeconomic consequences using a Dynamic Stochastic General Equilibrium (DSGE) model. Lastly, Chapter 6 concludes the thesis with a summary of major findings and by stating the policy implications of the findings.

CHAPTER 2

EXCHANGE RATE PASS THROUGH: DOES ASYMMETRY EXIST?

2.1 Introduction

This chapter aims to analyse exchange rate pass through to Indian aggregate import and export price for a period of forty one years (1980-2021). It is observed that the prices of aggregate exports and imports have moved with exchange rate indicating evidence of exchange rate pass through. As has been observed in Chapter 1, the seminal paper by Dornbusch (1987), favour complete pass through, in which prices fully reflected an increase or decrease in an exchange rate. However, partial or incomplete pass has become more popular as a result of advancements in the literature on pass-through. Incomplete pass through happens when the price of tradable items changes at a rate that is not commensurate to changes in the exchange rate. Numerous studies have looked into this issue. For instance, researchers Taylor (2000), Takhtamanova (2010), Marazzi et al. (2005), Otani et al. (2003), and Shioji (2012) discovered that the ERPT was insufficient. Evidence suggests that ERPT is comparatively higher in the developing world (Goldfajn and Werlang (2000), Eun et al. (1999), Webber (1999), Caselli and Roitman (2016)). One of the explanations in the literature regarding incomplete ERPT is explored in terms of asymmetry in ERPT. Asymmetry in ERPT is one of the theories given in the literature for inadequate ERPT. Depreciation had a higher pass-through than appreciation in the countries studied, according to empirical studies including Mann (1986), Goldberg (1995), Pollard and Coughlin (2004), Przystupa and Wrobel (2011), Delatte and Villavicencio (2012), Stoian and Marurasu (2015), Caselli and Roitman (2016), and Forero and Vega (2015).

The explanations offered by these authors range from downward pricing rigidities (Stoian and Marurasu, 2015) to increased profit margin absorption during appreciation regimes (Mann, 1986). On the other hand, research by Rincon and Rodriquez (2016), Campa et al. (2005), Khundrakpam (2007), and Wickermasinghe and Silvapulle (2004) indicate that pass-through is higher during appreciation than in episodes of depreciation. Therefore, the objective of this work is to review the exchange rate pass through phenomenon and calculate the pass through elasticity both in both the short and long haul. The study also aims to explore the asymmetries in the prices of tradable items in reaction to changes in the exchange rate. For this purpose the Auto Regressive Distributive Lag (ARDL) and Non-Linear Autoregressive Distributive Lag (NARDL) frameworks are used as estimation strategy to capture the asymmetric nature of impact of exchange rate fluctuations.

The rest of the chapter is organised as follows. Section 2.2 contains data and the econometric model specifications. The results and discussions are illustrated in section 2.3 and the finding are summarised in Section 2.4.

2.2 Data and Methodology

2.2.1 Data

The analysis at the aggregate level is carried out using annual observations for the period 1980 to 2021.To recapitulate, the information on the unit value indices of exports (EXP) and imports (IMP), as well as the global GDP (used as a substitute for foreign demand), was collected from World Development Indicators (WDI). The RBI Database on Indian Economy (DBIE), provides with the data on Nominal Exchange Rate (NER) and Indian GDP (which is used as a stand-in for domestic demand). The year on year growth rates of the Indian GDP and World GDP over time smooth the series, reducing volatility and the appearance of heteroscedasticity.

To test for the stationarity of the variables in equations (2.1) and (2.2) the Augmented Dickey- Fuller (ADF) test and the Phillip-Perron (PP) test is used. The results obtained as shown in Table 2.1 suggest that neither of the tests can disprove the unit root hypothesis for the variables at levels I (0) and hence are stationary at first difference I (1).

Table 2.1: Stationarity Test

Variables	ADF-test		PP-test	
	Levels	**First Difference**	**Levels**	**First Difference**
EXP	-2.41	-12.63**	-2.76	-11.45**
IMP	-1.04	-7.77**	-1.69	-8.26**
NER	-2.15	-9.61**	-2.01	-10.10**
WLD	-2.98	-6.89**	-3.15	-5.36**
GDP	-3.01	-7.21**	-3.26	-11.26**

Notes: *** 1% level of significance ** 5% level of significance *10% level of significance

2.2.2 The ARDL Model

The Auto Regressive Distributive Lag (ARDL) technique, methodology developed by Pesaran et al. (2001), is used as an estimation strategy examining how exchange rate variations affect export and import prices in India. According to Nkoro et al, (2016), the ARDL model is considered to be the most efficient econometric method in the case where the variables are stationary at I(0) or integrated of order I(1). This model outperforms others in capturing the short- and long-term impacts of independent factors determining price of tradable goods. The ARDL approach, which uses the ordinary least squares (OLS) method to cointegrate variables, may provide short-run and long-run elasticities concurrently for a small sample size (Duasa 2007). ARDL allows the flexibility in the sequence of the variables' integration. According to Frimpong and Oteng (2006), ARDL is acceptable when the model's independent variables are I (0), I (1), or mutually cointegrated, but it is unable to produce findings when I (2) variables are present. The ARDL specifications to estimate the export and import price pass through are as follows:

$$\Delta \mathrm{EXP}_t = \alpha + \sum_{i=0}^{n} \beta_i \Delta \mathrm{EXP}_{t-i} + \sum_{i=0}^{n} \gamma_i \Delta \mathrm{ER}_{t-i} + \sum_{i=0}^{n} \delta_i \Delta \mathrm{WLD}_{t-i} + \theta_1 ER_{t-1} + \theta_2 WLD_{t-1} + \varepsilon_{1t} \tag{2.1}$$

$$\Delta \mathrm{IMP}_t = \mu + \sum_{i=0}^{n} \vartheta_i \Delta \mathrm{IMP}_{t-i} + \sum_{i=0}^{n} \varphi_i \Delta \mathrm{ER}_{t-i} + \sum_{i=0}^{n} \omega_i \Delta \mathrm{GDP}_{t-i} + \rho_1 ER_{t-1} + \rho_2 GDP_{t-1} + \varepsilon_{2t} \tag{2.2}$$

where EXP is the export value index, ER is Nominal Exchange Rate (NER), WLD represents the world growth rate, GDP is the GDP growth rate of India, α *and* μ are the drift parameters, ε_{1t} and ε_{2t} are the disturbance terms. The Akaike information criterion (AIC) is used in the study to calculate the lag length. The study determines the long-run connection between variables before using the error correction model (ECM) to determine the short-run dynamics. The ECM for equations (2.1) and (2.2) is provided in general form by equations (2.3) and (2.4) as follows:

$$\Delta \mathrm{EXP}_t = \alpha + \sum_{i=0}^{n} \beta_i \Delta \mathrm{EXP}_{t-i} + \sum_{i=0}^{n} \gamma_i \Delta \mathrm{ER}_{t-i} + \sum_{i=0}^{n} \delta_i \Delta \mathrm{WLD}_{t-i} + \tau_1 ECM_{t-1} + \varepsilon_{1t} \tag{2.3}$$

$$\Delta \mathrm{IMP}_t = \mu + \sum_{i=0}^{n} \vartheta_i \Delta \mathrm{IMP}_{t-i} + \sum_{i=0}^{n} \varphi_i \Delta \mathrm{ER}_{t-i} + \sum_{i=0}^{n} \omega_i \Delta \mathrm{GDP}_{t-i} + \tau_1 ER_{t-1} + \varepsilon_{2t}$$

(2.4)

where Δ represents the first difference while τ_1 *and* τ_2 is the coefficients of *ECM* showing short-run dynamics. ECM displays the rate at which adjustment takes place towards the long-run equilibrium following a shock.

A conventional ARDL model presupposes that the dependent and explanatory variables have a symmetric relationship, which makes it impossible to discover hidden cointegration. If time series variables' positive and negative components are cointegrated with one another but are not cointegrated in the traditional sense, they are said to have hidden cointegration (Granger & Yoon, 2002). The ARDL estimates do not differentiate the impact of depreciation and appreciation of the currency on tradable price. As an improvement over ARDL, NARDL is resort to.

2.2.3 NARDL Model

We employ the Non Linear Auto Regressive Distributive Lag (NARDL) model established by Shin et al. (2013) as an extension of the approach provided by Pesaran et al. (2001) to account for the asymmetrical link between exchange rate and tradable goods prices. The NARDL provides a likelihood to examine if positive shocks from independent factors have the same impact on dependent variables as negative shocks from those same independent variables. The NARDL is more suited to solving our research challenge since it enables testing of asymmetries in both the short and long runs. NARDL representation of Equations (2.1) and (2.2) are shown in two steps. First, we decompose the exogenous variable ER_t into the positive (POS_t) and negative (NEG_t) partial sum as follows

$$POS_t = \sum_{i=0}^{t} ER^{+} = \sum_{i=0}^{t} \max(\Delta \mathrm{ER}_i, 0) \tag{2.5}$$

$$NEG_t = \sum_{i=0}^{t} ER^{-} = \sum_{i=0}^{t} \min(\Delta \mathrm{ER}_i, 0) \tag{2.6}$$

Second, we substitute the positive and negative partial sum into Equation (2.1) & (2.2) to obtain the NARDL versions in Equations (2.7) and (2.8)

$$\Delta \mathrm{EXP}_t = \alpha + \sum_{i=0}^{n} \beta_i \Delta \mathrm{EXP}_{t-i} + \sum_{i=0}^{n} \gamma_i^{+} \Delta \mathrm{POS}_{t-i} + \sum_{i=0}^{n} \gamma_i^{-} \Delta \mathrm{NEG}_{t-i} + \sum_{i=0}^{n} \delta_i \Delta \mathrm{WLD}_{t-i} + \theta_1 \Delta \mathrm{EXP}_{t-1} + \theta_2 \Delta \mathrm{WLD}_{t-1} + \theta_3^{+} \Delta \mathrm{POS}_{t-1} + \theta_4^{-} \Delta \mathrm{NEG}_{t-1} + u_{1t} \tag{2.7}$$

$$\Delta \mathrm{IMP}_t = \mu + \sum_{i=0}^{n} \vartheta_i \Delta \mathrm{EXP}_{t-i} + \sum_{i=0}^{n} \varphi_i^{+} \Delta \mathrm{POS}_{t-i} + \sum_{i=0}^{n} \varphi_i^{-} \Delta \mathrm{NEG}_{t-i} + \sum_{i=0}^{n} \omega_i \Delta \mathrm{GDP}_{t-i} + \rho_1 \Delta \mathrm{EXP}_{t-1} + \rho_2 \Delta \mathrm{GDP}_{t-1} + \rho_3^{+} \Delta \mathrm{POS}_{t-1} + \rho_4^{-} \Delta \mathrm{NEG}_{t-1} + u_{2t} \tag{2.8}$$

where the superscripts (+) and (−) are the positive and negative partial sums decomposition,

$\frac{-\gamma^{+}}{\beta}, \frac{-\gamma^{-}}{\beta}, \frac{-\varphi^{+}}{\rho}, \frac{-\varphi^{-}}{\rho}$ capture the short-run adjustment in prices to positive and negative shock in the exchange rate while $\frac{-\theta_3^{+}}{\theta_1}, \frac{-\theta_3^{-}}{\theta_1}, \frac{-\theta_3^{+}}{\rho_1}, \frac{-\theta_3^{-}}{\rho_1}$ captures long-run adjustments.

2.3 Results and Discussions

2.3.1 ARDL Model: Symmetric ERPT

Details on the short-run and long-run relationships between the exchange rate and price of tradables are provided by the ARDL estimates. The model fits the data well. The post-estimation diagnostics show that the errors do not show heteroscedasticity or autocorrelation. The Jarque-Berra test results demonstrate that the residuals are normally distributed, and the Ramsey RESET test indicates that the parameters are accurately stated.

The Bound Test's show as Table 2.2, both exports and imports are cointegrated implying existence of equilibrium in the long run.

Table 2.2: Bounds Test for Cointegration

Panel A: Imports				
	F Statistics	**Lower Bound (95%)**	**Upper Bound (95%)**	**Conclusion**
ARDL	8.25	4.87	5.85	Cointegration exists
NARDL	9.26	4.87	5.85	Cointegration exists
Panel B: Exports				
ARDL	7.35	3.38	6.12	Cointegration exists
NARDL	8.65	3.38	6.12	Cointegration exists

Note: Null hypothesis for bounds test is that there is not cointegration.

Exchange rate pass-through to export and import prices as shown in Table 2.3, are found to be incomplete. Although the indications are consistent with the hypothesis (a negative sign indicates that the depreciation of the exchange rate raises import prices and reduces export prices in foreign currency terms), the pass through coefficient is substantially higher in the long run.

Table 2.3: ARDL Model estimates

Dependent Variable	(Exports)	(Imports)
	Long Run	
Intercept	1.97	2.97
ER	−0.79**	0.81**
WLD	3.69**	
GDP		6.33***
	Short Run	
Intercept	0.89	0.73*
L(EXP,1)	1.02**	
L(EXP,2)	1.66	
L(IMP,1)		0.66**
L(IMP,2)		0.71*
ER	−0.23***	0.42***
L(ER,1)	−0.31***	0.39**
L(ER,2)	-0.37	0.36*
WLD	3.79*	
L(WLD,1)	3.28	
L(WLD,2)	2.96	
GDP		5.39*
L(GDP,1)		4.44**
L(GDP,2)		4.12
ECM	-0.65***	-0.63***
	Diagnostic Tests	
Jarque-Bera Test	0.81	0.79
ARCH LM	0.36	0.39
Ljung-Box Q	0.79	0.81
RESET	0.42	0.45

Source: Author's calculations

Notes: ***, **, * represent 1%, 5% and 10% levels of significance respectively.
The lag structure for this model is (2, 2, 2).

While the import and export price pass through coefficient are 0.42 and -0.23 respectively in the short run, the coefficients are substantially higher (0.81 for imports and -0.79 for exports) in the long run. The demand factor, which includes both the national and global gross domestic product, significantly affects the price of tradables. In the short run, the tradable good prices are highly influenced by their own initial lag, demonstrating price persistence. At a 1% level of significance, the exchange rate pass-through amounts to about 23% for export prices and 45% for import prices. Overall, nevertheless, the short-term pass-through of exchange rates in the Indian context is incomplete with export pass-through being lower than import pass-through. The short-run dynamics are stable and the dependent variable returns to the long-run average with the ECM term having a negative and significant. Both the models in Table 2.3 show a fast rate of convergence of tradable prices in the long term (about 65%).

2.3.2 NARDL model- Asymmetric ERPT

NARDL model is used in this section to identify the asymmetric impact of exchange rate changes on prices of tradable commodities. Table 2.4 displays the asymmetric impact of exchange rates on the pricing of tradable products over the long and short terms. It can be shown that a 1% rise in the exchange rate causes a 69% point decrease in export prices. On the other hand, an increase in INR increases export by over 67%. The pass through is, nevertheless, incomplete and has a greater magnitude than the short run. In terms of the short run, it should be remembered that an INR depreciation of 1% lowers export prices in foreign currency by roughly 19%, while an appreciation increases them by about 34%.

Table 2.4: NARDL Model estimates

Dependent Variable	Unit Value Index of Exports	Unit Value Index of Imports
Long Run		
Intercept	2.33	3.76
ER^+	−0.69**	0.65**
ER--	0.67**	--0.68**
WLD	4.67**	
GDP		5.33***
Short Run		
Intercept	1.21	2.53
L(EXP,1)	0.83*	
L(EXP,2)	0.99	
L(IMP,1)		0.73*
L(IMP,2)		0.75**
ER^+	−0.19**	0.12***
$L(ER,1)^+$	−0.21**	0.21
$L(ER,2)^+$	-0.25	0.22
ER--	0.34***	−0.35**
$L(ER,1)^{--}$	0.29	−0.38**
$L(ER,2)^{--}$	0.23	−0.09
WLD	3.31*	
L(WLD,1)	3.37	
L(WLD,2)	1.88	
GDP		4.23**
L(GDP,1)		4.98
L(GDP,2)		5.01
ECM	−0.56***	−0.68***
Diagnostic Tests		
Jarque-Bera Test	0.85	0.89
CUSUM Squared Test	Stable	Stable
B-P Heteroskedasticity	0.21	0.29
RESET	0.44	0.48

Notes: ***, **, * represent 1%, 5% and 10% levels of significance respectively. The lag structure for this model is (2, 2, 2).

The ERPT elasticity for import price pass through is generally low during depreciation and high during periods of appreciation. Overall, the findings indicate that short- term pass-through estimates are higher in magnitude during periods of appreciation than depreciation. A substantial adjustment to the long-run equilibrium is shown by the error-correction term, which shows adjustments of 56% and 68%, respectively in each model. (Mallick & Marques, 2008; Sengupta & Sinha Roy, 2023)

2.4 Summary of Findings

The study looks at how India's export and import prices have changed over the course of forty one years due to symmetric and asymmetric currency rate pass-through. The estimates show that a 1% level of significance, the exchange rate pass-through amounts to about 23% for export prices and 45% for import prices. India's short-term exchange rate pass-through is incomplete, with export pass-through being lower than import pass-through. This suggests that both importers and exporters absorb exchange rate shocks and don't transmit them on as much to pricing.

Considering the non-linearity in specifications, the ERPT elasticity is strong during periods of appreciation and relatively low during depreciation. A significant change from the short run to the long-run equilibrium is indicated by the error-correction term. As exchange rate pass-through to prices is a critical problem to understand price dynamics in an open economy, the results also highlight the necessity to conduct a product level disaggregate analysis for a better understanding of the underlying transmission mechanism

CHAPTER 3[1]

EXCHANGE RATE PASS THROUGH TO EXPORT PRICES: EVIDENCE FOR INDIA AT DISAGGREGATE LEVEL

3.1. Introduction

The endeavour in this chapter is to estimate the product-wise and destination-wise exchange rate pass-through (ERPT) to export prices in India for the period (2003-2018), while explicitly accounting for the microeconomic and structural factors that influence the degree of pass-through. The aggregate analysis presented in Chapter 2, has observed that ERPT elasticity is about 23 percent for aggregate export prices and nearly 45 percent for aggregate import prices. Chapter 2 also highlighted that ERPT in India is incomplete, especially in the short run, consistent with the broader international evidence. However, aggregate estimates risk masking substantial heterogeneity across products and destinations, leading to an incomplete understanding of the pricing behaviour of exporters and the underlying transmission of exchange rate fluctuations to prices of tradables. A more disaggregated analysis is thus warranted.

The importance of moving beyond aggregate measures was already emphasized in the influential work of Campa and Goldberg (2005), who demonstrate that the sensitivity of import prices to exchange rate fluctuations varies considerably depending on the composition of trade flows. Their "compositional-trade hypothesis" suggests that aggregate ERPT measures obscure underlying product-level differences, since the degree of pass-through is strongly influenced by sectoral characteristics, the nature of competition, invoicing practices, and market-specific demand elasticities. For example,

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[1]A earlier version of this chapter is published in the Economic and Political Weekly (16th November 2024).
Link:https://www.epw.in/journal/2024/46/global-value-chains/export-prices-exchange-rate-pass-through-and.html

homogenous goods such as primary commodities may experience close to full pass-through, while differentiated manufactured exports often exhibit lower pass-through due to pricing-to-market strategies and brand effects. Thus, the reliance on aggregate indicators may misrepresent the true dynamics of ERPT.

The literature on Exchange Rate Pass-Through (ERPT) highlights the role of pricing strategies, demand elasticity, and market structures. Krugman (1987) identified pricing-to-market behavior, while Knetter (1993) showed mark-up reductions in depreciated markets, and Athukorala and Menon (1994) questioned consistent reliance on PTM. In India, Mallick and Marques (2008) found destination-specific heterogeneity, and Sengupta and Sinha Roy (2020, 2024) revealed incomplete short-run but stronger long-run pass-through, with appreciations dominating depreciations. Supporting studies—Ghosh and Rajan (2007), Pyne and Sinha Roy (2019), Patra et al. (2018), Dash and Narasimham (2011), Javed Ahmad Bhat et al. (2021), and Parab (2022)—emphasize nonlinearities, asymmetries, and sectoral variations.

Further, prices of items that are traded globally are affected differently by appreciation and depreciation. Studies including Mann (1986), Bussiere (2013), Delatte and Lopez-Villavicencio (2012), Brun-Aguerre et al. (2012), Baharumshah et al. (2017), Amoah and Aziakpono (2018) and Kassi et al. (2019), have also validated the asymmetric impact of exchanges rate changes on prices of tradable goods.

Against this backdrop, the chapter addresses four interrelated issues. First, it seeks to determine whether incomplete pass-through persists at the disaggregate level in Indian exports. By breaking down ERPT estimates across products and destinations, the analysis provides a clearer picture of whether pricing to market exists. Second, the chapter investigates the microeconomic determinants of incomplete pass-through, using disaggregated product-destination-time varying export data. This allows us to examine how factors such as the degree of product differentiation, market concentration, invoicing currency choices, and participation in global value chains shape exporters' pricing behaviour. Third, the chapter explores the possibility of asymmetric pass-through: specifically, whether exchange rate appreciations and depreciations exert different effects on export prices. Such asymmetries are highly relevant in the Indian context, given the prevalence of persistent currency depreciation episodes and the policy emphasis on export competitiveness. Fourth, the chapter explores how participation in fragmented global value chains influence exchange rate pass through to export prices.

Accordingly, the structure of this chapter is as follows. The next section presents a review of the existing literature. Section 3.2 describes the data sources, the disaggregation strategy, and the econometric methodology employed to estimate ERPT at the product-destination level. Section 3.3 presents the empirical results. Section 3.4 concludes the chapter with a summary of the main results.

3.2 Data

The study draws on customs-based transaction-level export data published by Directorate General of Commercial Intelligence and Statistics, Government of India (DGCI&S), Kolkata, covering goods at the 8-digit HS code level, with computed unit prices (export value/quantity) serving as proxies for India's export prices in USD. Nominal exchange rate data (INR vs. partner currency) is sourced from RBI and IMF. Control variables include Trade Openness Index and partner GDP (WITS), average costs (via NIC–HS concordance using ASI), and import intensity of exports. The latter is proxied through Net Foreign Exchange Inflow Rate (NFIR), derived from CSO's input–output tables. Using the diverse literature on ERPT and Industrial organization[2], this study identifies further some factors that underline the variation or heterogeneity in the observed ERPT estimates.

3.2.1 Market Structure

One of the factor is the market structure. According to Dornbusch (1987) ERPT will be higher in markets with higher competition and lower mark-up rates. According to Krugman (1987; Goldberg & Knetter 1997), increased market power combined with imperfect completion tends to reduce the pass through of exchange rates to export prices. Using the following indices, we validate the findings in this chapter.

a. Lerner's Index

The gap between price and marginal costs, presented as a percentage of price, serves as a gauge of market power. When prices are equal to marginal costs in a perfectly competitive environment, market power is zero; however, in an imperfectly competitive environment, the index can take on any value between 0 to the inverse of price elasticity of market demand. We aggregate the trade data at the 2-digit level since it is challenging to match ASI firm-level data with HS 8-digit product-level data.

The Lerner's Index at 2-digit level is calculated as

$$LI = \frac{P_{j,t} - VC_{j,t}}{P_{j,t}}$$

where *j* denotes 2-digit level and *t* denotes time. ASI provides information on the variables Cost like wages and salaries paid to employee (labour cost).

[2] For details see Robinson (1993),Caballero(2017),Ito and Sallee (2018),Koltay et al.(2021),Berger et al.(2023), Herkenhoff (2025)

b. Herfindahl's Index

Trade concentration is measured by Herfindahl indices. A group that has been separated into n categories is given, and the total of the squared shares of each of the n categories with respect to the group yields the Herfindahl index. The indicator thus ranges from 0 (extremely varied) to 1 (very concentrated). When calculating the Herfindahl-intra-industry-product index, the proportion of each 4-digit level product's export value to the total value of 2-digit level product exports for a given nation, time, and 2-digit level exports is taken into consideration. For instance, the shares of the four-digit level products 5001 (silkworm cocoons suited for reeling), 5002 (raw silk), and 5003 (silkworm cocoons) result in the Herfindahl-intra-industry product index for India in 2007 for the two-digit level industry 50 (silk).

$$HHI_{ikt} = \sum_{m=1}^{k} (HSS_4^{ikt})^2$$

where i is the exporter, k the 2-digit level HS product, m the 4-digit level HS product, HSS_4 is the share of 4-digid HS product in 2-digit industry code and t the period.

3.2.2 Product Differentiation:

Consumers can readily shift between varieties, according to Dornbusch (1987), if the exportable item is a near equivalent for the domestic good in the other nation. Therefore, the foreign firm's ability to "price-to-market" will be reduced, leading to a higher ERPT level. On the other hand, if a sector is distinguished by highly differentiating products, then enterprises participating in that area often possess more market power, since they are better able to regulate the amount of pass-through without jeopardising their market shares. Product difference discourages new companies from entering the market and gives current exporting companies more power over prices. In this study, we measure production using the Hufbauer index.

The Hufbauer index is defined as the coefficient of variation of unit values of all exported products within an industry. The simple Hufbauer index calculated for each industry k and in each year t is given as:

$$Hb^{uw} = \frac{\sigma_{kt}}{M_{kt}}$$

where σ_{kt} represents the standard deviation of India's export unit values of all products within 2-digit product level in year t and M_{kt} is the un-weighted mean of the unit values. A high value of this index would imply that there are significant price differences between similar items sold to various nations and between similar products within the same industry, implying higher product differentiation.

The weighted Hufbauer index calculated for each 2digit product code and in each year t is given as:

$$Hb^{w} = \sum w \frac{\sigma_{kt}}{M_{kt}}$$

where w is the ratio of export value of each product at 4-digit level to total exports in at 2-digit level.

3.2.3 Indicator for participation in Global Value Chain

Reliance on imported intermediate goods within global production networks can alter how exchange rate movements impact the production expenses and export pricing of trade partners, thereby influencing the extent of exchange rate transmission to import prices. Capturing a country's involvement in global value chains is not straightforward, but one frequently used indicator is the GVC Participation Index, which represents the proportion of locally generated value in total exports.

It is measured as

$$GVC^{Part} = \left(\frac{FVA + DVX}{Gross\ Export}\right) * 100$$

where FVA and DVX imply Foreign and domestic value added to exports respectively. A larger GVC participation index implies that foreign components make up a substantial part of a nation's export output, reflecting deep integration into international supply chains.

3.3 Methodology

The several factors underlying the determination of export pricing are estimated using the panel data approach. Panel data is employed as export prices at the 8-digit level vary across products, destinations and time. For instance, a car model may be exported to a specific country only during a certain period. Thus, panel structure captures both cross-sectional and temporal heterogeneity in export pricing dynamics. There are several models for panel data analysis depending on the type of cross-sectional heterogeneity. When cross-sectional heterogeneity is accompanied by additional explanatory factors, fixed effect models are found to provide more accurate estimates over random effects. The fixed effect model is preferred over the random effect model because cross-sectional heterogeneity is tied to other explanatory factors[3]. The following base-line linear specification is estimated

$$\Delta\ln(P_{idt}) = \psi_t + \mu_{id} + \beta_1 \Delta lne_{dt} + \lambda lnGDP_{dt} + \varepsilon_{idt} \tag{3.1}$$

with $\Delta\ln(P_{idt}) = \Delta\ln\left(\frac{export\ value_{idt}}{export\ quantity_{idt}}\right)$ being the first difference of the free-on-board (fob) unit value at the product-destination level employed as a proxy for export price changes (in USD). It is calculated as the division of the exported value by export

[3] For details of panel data models see Manuel (2003), Wooldridge (2010),Cheng (2014, Greene (2018), Baltagi (2021)

quantity (units or weights in kg), at HS 8-digit product level i; to destination d[4] at time t: Unit prices are calculated for every transaction at the 8-digit level and then averaged at the HS 6-digit level to make it compatible as per international practices before taking the natural log (ln) value of it. Then, the first difference of $\ln(P_{idt})$ is calculated to arrive at the dependent variable of the regression equation 3.1. Δlne_{dt} is the change in the natural log of nominal exchange rate in year t between India and the export destination d, measured as INR over the destination currency (an increase denotes a depreciation of the INR).The β_1 coefficient is the desired regression coefficient as it captures the exchange rate pass through to export price and is expected to be negative in sign.

Time (t) and product-destination (μ_{id}) fixed effects are included in the baseline specification (3.1), so that the effect of exchange rate movements on export prices is identified from within destination-product variation over time. In this specification we control for demand-driven price adjustments by adding the changes in log nominal GDP in destination d at time t ($lnGDP_{dt}$) and ε_{idt} is the disturbance term.

Apart from exchange rate there are other factors including average cost, import intensity of exports and trade openness, that that can affect export prices. These explanatory variables are chosen based on the evidence available in the literature on export price pass through (Kravis and Lipsey, 1974; Baldwin, 1988; Citrin, 1989; Fienberg, 1991; Athukorala and Menon, 1994; Gagnon and Knetter, 1995; Hansen, 1999; Bussiere, 2004; Gust at al., 2006; Mallick and Marques, 2008a, 2008b, 2010).The equation 3.1 is modified to control for other determining factors.

[4] Top 25 destinations of India's exports account for approximately 75% of India's total export volume.

$$\Delta \ln(P_{idt}) = \psi_t + \mu_{id} + \beta_1 \Delta lne_{dt} + \beta_2 \, lnAC_{jt} + \beta_3 lnNFIR_{it} + \beta_4 lnTOI_{jt} + \varepsilon_{idt} \quad (3.2)$$

In this specification the average cost (AC) for a product i over time t is obtained from the Annual Survey of Industry database after being matched with HS codes. The β_2 coefficient captures the cost pass through to export prices. TOI is calculated for the sector j to which a product i belongs according to HS classification.

For this exercise, export goods that make up to 80% of total exports from India are considered. The export share of each of item at 2-digit HS categorization in the export basket is shown in Table A3.1 (see Appendix to Chapter 3).

First, we capture the variation in ERPT across 2 digit HS codes by keeping the destination country differences fixed. For each 2 digit code (k), the following specification is estimated:

$$\Delta \ln(P_{idt}) = \psi_t + \mu_d + \beta_1 \Delta lne_{dt} + \beta_2 \, lnAC_{j\in k,t} + \beta_3 lnNFIR_{j\in k,t} + \beta_4 lnTOI_{j\in k,t} + \varepsilon_{idt} \quad (3.3)$$

Equation 3.3 is estimated by pooling observations of HS 8 digit codes, across destinations and for all years within a 2-digit HS code (k).Hence by assumption β is same across all destination countries and over time.

Further, ERPT elasticities are estimated for each destination country, keeping product variations constant. For each destination country *d,* we estimate the following equation.

$$\Delta \ln(P_{idt}) = \psi_t + \mu_i + \beta_1 \Delta lne_{dt} + \beta_2 \, lnAC_{jt} + \beta_3 lnNFIR_{it} + \beta_4 lnTOI_{jt} + \varepsilon_{idt} \quad (3.4)$$

Equation 3.4 is estimated for a given destination country by pooling observations of all HS 8- digit codes across all 2 digit codes and years. In this study the 2-digit HS codes serve as a proxy for the respective industry level of aggregation for each of associated disaggregate product level information. Here we assume that for a given destination country, there are no variations in pass through across products and over time.

In this chapter, the following empirical specification is used to examine the extent of asymmetricity in exchange rate pass through.

$$\Delta\ln(P_{idt}) = \psi_t + \mu_{id} + \beta_1\, \Delta lne_{dt} + \beta_2\, lnAC_{jt} + \beta_4 lnNFIR_{it} + \beta_6 lnTOI_{jt} + \Theta_1(AP\Delta lne_{dt}) + \lambda \ln GDP_{dt} + \varepsilon_{idt} \quad (3.5)$$

An appreciation dummy (AP) is introduced in equation 3.5 to distinguish between episodes of appreciation and depreciations of nominal exchange rates. AP is defined as

$$AP = \begin{cases} 1 & if \quad \Delta lne_{dt} < 0 \\ 0 & otherwise \end{cases}$$

In order to analyse the factors that explain within product and cross-country differences in pass through estimates, the fitted values of the ERPT elasticities ($\beta_{1'idt}$)estimated using equation (3.1) are regressed on the Lerner's Index, Herfindahl's Index and Hafbauer's Index. Since all the pass through estimates are negative we transform the dependent variable using a modulus operator.

The regression specification used here in the panel data framework are

$$\left|\widehat{\beta_{1'\imath dt}}\right| = \psi_t + \mu_k + \delta_d + \gamma_1\, lnLI_{kt} + \gamma_2\, lnHHI_{kt} + \gamma_3 lnHb_{kt}^{UW} + \gamma_4 lnHb_{kt}^{W} + \gamma_5\, lnGVC_{kt}^{Part} + \gamma_6\, Fgn_{DD} + \varepsilon_{idt} \quad (3.6)$$

where ψ_t, μ_k, δ_d are time, cross section and destination fixed effects.

To check for robustness of the results we also modify equation 3.6 is modified with respect to the choice of dependent variable. We include the estimated coefficient of asymmetric pass through from equation (3.4) and regressed for the same set of control variables as used in equation 3.6.

$$\left|\widehat{\theta_{1\imath dt}}\right| = \psi_t + \mu_k + \delta_d + \gamma_1\, lnLI_{kt} + \gamma_2\, lnHHI_{kt} + \gamma_3 lnHb_{kt}^{UW} + \gamma_4 lnHb_{kt}^{W} + \gamma_5\, lnGVC_{kt}^{Part} + \gamma_6\, Fgn_{DD} + \varepsilon_{idt} \quad (3.7)$$

3.4 Results

3.4.1 ERPT to Export Prices

The ERPT coefficients estimated using equation 3.3 are reported in Table 3.1. The export price elasticity estimates for the all the products included in the sample, are inelastic either at 1% or 5% level of significance. For example, a 10% depreciation of exchange rate leads to a 6.5% statistically significant decline in dollar denominated export price for mineral products. This suggests that exchange rate pass through to export prices is incomplete.

Table 3.1: Export Price Pass Through Elasticities

HS Code	Description	ERPT Coefficient
	Animal and Animal product	
2	Meat and Edible Meat Offal.	-0.41 (1.23)
3	Fish and Crustaceans, Other Aquatic Invertebrates.	-0.21 (2.49)
	Vegetable Products	
10	Cereals.	-1.56 (2.49)
	Mineral Products	
27	Mineral Fuels, Mineral Oils and Products of Their Distillation; Bituminous Substances; Mineral Waxes.	-0.65 (0.12) ***
	Chemicals And Allied Industries	
29	Organic Chemicals	-0.23 (0.46)***
30	Pharmaceutical Products	-0.009 (0.01) ***

32	Tanning or Dyeing Extracts; Tannins Dyes, Pigments and Other Colouring Matter; Paint and varnishes; Putty and Other Mastics;	-0.36 (0.12) **
38	Miscellaneous Chemical Products.	-0.56 (4.12)
Plastics/Rubbers		
39	Plastic And Articles thereof	-0.93(0.32)
Textiles		
52	Cotton	-0.83(0.06)***
61	Articles of Apparel and Clothing Accessories, Knitted or Crocheted.	-0.79(0.05)**
62	Articles of Apparel and Clothing Accessories, Not Knitted or Crocheted.	-0.73(0.11)**
63	Other Made Up Textile Articles; Sets; Worn Clothing And Worn Textile Articles; Rags	-0.81(0.23)**
Metals		
71	Natural or Cultured Pearls, Precious or Semiprecious Stones, Pre Metals, Clad with Pre Metal and Etc.	-0.63(0.76) **
72	Iron And Steel	-0.73(0.02)***
73	Articles Of Iron Or Steel	-0.68(0.06)***
76	Aluminum and Articles Thereof.	-0.71(0.31)**
Machinery/Electrical		
84	Nuclear Reactors, Boilers, Machinery And Mechanical Appliances	-1.23 (3.23)
85	Electrical Machinery And Equipment And Parts Thereof; Sound Recorders And Reproducers, Television Image	-0.91(1.96)*
Transport		
87	Vehicles Other Than Railway Or Tramway Rolling Stock	-0.04(0.007)**
89	Ships, Boats and Floating Structures.	-0.11(0.009)**

Source: Authors calculation based on equation 3.3.
Note: Robust standard errors in parentheses; ***, **, * represents statistical significance at 1% 5% 10% respectively. All the controls are included.

However, the pass through coefficients are found to vary across product groups at 2-digit level. The estimated results reveal that the pass through to export price are insignificant for agricultural commodities, animal products, and plastic goods. Pharmaceutical items (HS 30), with high technological intensity, are estimated to have the lowest pass through coefficient. Metals and textiles items, which are examples of low technology products, have large pass through coefficients. The results are in tune to Campa and Goldberg (2005) and thus reflect that with rise in technological intensity, pass through to export prices becomes less as the firms have large mark-ups to absorb the exchange rate shocks. Table 3.2 further reports that ERPT coefficients estimated using equation (3.4). 22 of the 25 nations in our study exhibit a notable differences in country-by-country elasticities export price pass-through

Table 3.2: Export Price Pass Through across Destination Countries

Rank	Country / Region	Export Share	ERPT Coefficient
1	U S A	16.79	-0.03(0.01)***
2	China People's Republic	5.35	-0.09(0.05)***
3	U A E	9.14	-0.59(0.21)**
4	Saudi Arab	1.85	-0.36(0.41)**
5	Hong Kong	3.55	-0.69(0.54)**
6	Singapore	3.22	-0.76(1.12)**
7	Bangladesh	2.55	-1.23(5.31)
8	Germany	2.65	-0.04(0.01)***
9	Korea Republic	1.44	-0.26(2.33)*
10	Indonesia	1.40	-0.68(0.76)**
11	Sri Lanka	0.31	-0.42(0.11)**
12	Japan	1.49	-0.01(0.01)***
13	Malaysia	1.94	-0.43(0.89)**
14	Belgium	1.91	-0.52(2.14)
15	Brazil	1.27	-0.89(3.89)
16	U K	2.72	-0.07(0.01)***
17	Spain	1.31	-0.19(0.07)***
18	Turkey	1.42	-1.12(3.54)*
19	Vietnam	1.71	-1.16(3.68)*
20	Netherland	2.76	-0.61(0.69)**
21	South Africa	1.23	-0.71(0.98)**
22	France	1.68	-0.21(0.05)**
23	Thailand	1.34	-0.63(0.19)**
24	Italy	1.61	-0.23(0.56)*
25	Nepal	2.2	-1.16(2.46)*
	Total of Top 25 countries	72.84	

Note: Author's Calculations; Robust standard errors in parentheses; ***, **, * represents statistical significance at 1% 5% 10% respectively. All the controls are included

Export prices in majority of the industrialized nations in our sample, including the United States, Germany, Japan, the United Kingdom, France and China tend to have incomplete pass through, whereas the corresponding elasticities in developing market economies, such as Sri Lanka, Indonesia, Thailand, and the United Arab Emirates, show higher levels of pass through. In particular higher values ERPT coefficients (more than 1) can be observed for Turkey and Vietnam. This is an indication that exports from India face more competition in developing market economies than exports to developed nations and that they tend to pass through exchange rate changes at a higher percentage rate to remain competitive. Hence, the results obtained reiterate the findings of Mallick and Marques (2008a,2008b, 2012) where Indian exporter rely on Pricing to Market strategy for selling the Indian goods in different destination countries.

3.4.2 Asymmetric Exchange Rate Pass through

ERPT to tradable prices is often found to be asymmetric when currency appreciates or depreciates. (Mann, 1986; Bussiere, 2013; Delatte & Lopez-Villavicencio, 2012; among others) Inelastic demand markets experience high pass-through during source-country appreciations but low pass-through during depreciations, as exporters absorb fluctuations without significant market share gains. Conversely, in elastic demand markets, exporters transmit depreciations more strongly to gain or maintain market share, while appreciations show low pass-through. Thus, exchange rate effects are rarely symmetric unless elastic and inelastic goods balance out.

The estimated coefficient of equation (3.5) are reported in Table A3.2 (see Appendix to Chapter 3). From the reported estimates, pass through is found to be asymmetric. More specifically, it can be observed that export prices are more sensitive to appreciation than depreciation of nominal currency. A 1% appreciation of the Indian rupee raises the export price (in dollar) of natural minerals 42 times more than proportionately than a similar fall in export prices (in dollar) due to 1% depreciation of INR. This suggests that an Indian exporter does not pass on the depreciation of the local currency and absorbs it in their mark-ups resulting in incomplete pass through to export prices.A comparison across product categories shows the presence of asymmetry for most of the product groups in our sample except for agricultural products like animal and vegetable products. The magnitude of the asymmetric impact of exchange rate fluctuations is highest for Mineral Products[5] , followed by Chemicals and Textiles items and is least for metals and transports.

3.5.3 Factors affecting ERPT

The results obtained in the previous section indicate that ERPT into India's export prices is largely incomplete and there are wide variations in the pass through estimates across different destinations over time.

The estimated results of equation (3.6) and equation (3.7) are presented in Table 3.3. We find that variables capturing the extent of market concentration Herfindahl index and the price-cost margin known as (Lerner's Index) are negative and significant. This result, as expected, suggests that pass-through will be lower in markets that are more concentrated. Higher is the concentration, greater is the market power and greater is the ability of the firms to absorb exchange rate shocks. Eventually the pass through to the export prices become incomplete. This result is in conformility with Goldberg et.al. (2016).

Table 3.3: Role of Market structure and Product Differentiation

Dep.Var	Est. Coefficient ($\lvert\widehat{\beta_{1\prime idt}}\rvert$)					Est. Coefficient ($\lvert\widehat{\theta_{1\prime idt}}\rvert$)				
	1	2	3	4	5	6	7	8	9	10
LI	-0.56				-0.43***	-0.51				-0.37***
	(1.12)				(0.83)	(2.21)				(0.53)
HHI		-0.32***			-0.27***		-0.42***			-0.21***
		(0.21)			(0.23)		(0.26)			(0.27)
HB^{UW}	-0.26***	-0.34***	-0.31***			-0.25**	-0.43***	-0.13***		
	(0.06)	(0.07)	(0.05)			(0.12)	(0.05)	(0.05)		
HB^{W}				-0.43**	-0.47**				-0.49**	-0.47**
				(0.12)	(0.17)				(0.12)	(0.17)
GVC^{part}			-0.27**		-0.24**			-0.25**		-0.29**
			(0.09)		(-0.08)			(0.08)		(0.07)
Fgn_DD	2.36**	2.95**	2.85**	3.01**	3.23***	1.81**	2.95**	1.99**	3.19**	3.43***
	(1.01)	(1.31)	(1.29)	(1.21)	(1.11)	(1.12)	(1.38)	(1.25)	(1.25)	(2.01)
Prod FE	No	No	No	No	YES	No	No	No	No	YES
Dest FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Constant	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-Sq	0.47	0.47	0.48	0.49	0.51	0.51	0.51	0.48	0.59	0.61
N	26294	26294	26294	26294	26294	26294	26294	26294	26294	26294

Source: Author's calculations

Note: Columns represent different econometric specifications; Robust standard errors in parentheses; ***, **, * represents statistical significance at 1% 5% 10% respectively.

Turning to the role of product differentiation, it is found that the simple Hufbauer index constructed using Indian export data is negative and significant. This suggests that a sector of the economy with a high degree of product differentiation also undergoes shifts in the standards of the goods produced and engages in pricing-to-market. Such strategies result in a lower pass through. This outcome is in line with Dornbusch's (1987) hypothesis that pass-through rates will be lower in sectors with very distinct product lines. Further, firms engaged in GVCs often have pricing power and may absorb exchange rate changes to maintain stable prices across markets, leading to lower and more delayed ERPT. Further, when exporters rely more on imported intermediate inputs, currency fluctuations affect their production costs in local currency. Consequently, their export prices (in foreign currency) become less sensitive to exchange rate shifts (Georgiadis et al., 2019)

Additionally, in alternative specifications this outcome is unaffected by other weighted Hufbauer's Index.Even with asymmetry, the results are still robust. The market power and product features have a greater impact on the pass through coefficients during episodes of appreciation than during episodes of depreciation. As a result, appreciation works better than depreciation as a method to boost export prices. The foreign demand also plays a strong positive role in determining the pass through coefficient.

3.5. Summary of Findings

This chapter focuses on estimating the product-wise and destination-wise exchange rate pass-through (ERPT) to export prices in India, while explicitly accounting for the microeconomic factors that influence the degree of pass-through. The results obtained show that exchange rate pass-through (ERPT) is incomplete across all product categories and varies significantly by partner country. Among the 25 nations studied, industrialized countries like the USA, China, Germany, Japan, the UK, and France exhibit partial pass-through, while emerging markets such as Bangladesh, Sri Lanka, and Indonesia have higher levels. Indian exporters, in particular, adopt a "pricing-to-market" strategy, adjusting mark-ups in response to weak competition. This behaviour suggests that pass-through is smaller in more concentrated markets on account of participation in Global Value Chains (GVCs). GVCs play a crucial role in lowering ERPT by fragmenting production across multiple countries, which disperses costs, encourages price stability, and reduces sensitivity to exchange rate movements. In GVCs, intermediate goods cross borders several times, diminishing the direct impact of exchange rate changes on the export price of final merchandise, especially in less competitive and concentrated markets.

The study also finds that market concentration and product differentiation, as reflected in negative coefficients of Lerner and Hufbauer Indices, further reduce pass-through. Firms with greater market power and more differentiated products can be better resilient to exchange rate shocks, leading to less price adjustment. The analysis reveals an asymmetric pass-through, where prices do not adjust uniformly to currency appreciation and depreciation.

Appendix to Chapter 3

Table A3.1: India's Major Export Items

HS Code	Description	Export Value	Export Share
Animal And Animal Product			
2	Meat And Edible Meat Offal.	26,03,392.48	1.13
3	Fish And Crustaceans, Molluscs And Other Aquatic Invertebrates.	43,83,218.83	1.90
Vegetable Products			
10	Cereals.	56,82,855.00	2.46
Mineral Products			
27	Mineral Fuels, Mineral Oils And Products Of Their Distillation; Bituminous Substances; Mineral Waxes.	3,35,47,439.80	14.54
Chemicals And Allied Industries			
29	Organic Chemicals	1,27,56,673.67	5.53
30	Pharmaceutical Products	1,03,23,992.70	4.47
32	Tanning Or Dyeing Extracts; Tannins And Their Derivatives. Dyes, Pigments And Other Colouring Matter; Paints; Putty And Other Mastics; Inks.	23,12,403.45	1.00
38	Miscellaneous Chemical Products.	32,39,659.32	1.40
Plastics/Rubber			
39	Plastic And Articles Thereof.	56,07,897.32	2.43
Textiles			
52	Cotton.	55,02,070.31	2.38
61	Articles Of Apparel And Clothing Accessories, Knitted Or Crocheted.	54,69,178.09	2.37
62	Articles Of Apparel And Clothing Accessories, Not Knitted Or Crocheted.	58,13,591.85	2.52
63	Other Made Up Textile Articles; Sets; Worn Clothing And Worn Textile Articles; Rags	36,76,823.96	1.59
Metals			
71	Natural Or Cultured Pearls, Precious Or Semiprecious Stones, Pre-Metals, Clad With Pre-Metal And Articles Thereof; Imitations Jewellery; Coin.	2,82,79,365.85	12.25
72	Iron And Steel	68,07,482.60	2.95
73	Articles Of Iron Or Steel	50,98,296.95	2.21
76	Aluminium And Articles Thereof.	39,87,562.54	1.73
Machinery/Electrical			
84	Nuclear Reactors, Boilers, Machinery And Mechanical Appliances; Parts Thereof.	1,46,65,227.99	6.35
85	Electrical Machinery And Equipment And Parts Thereof; Sound Recorders And Reproducers, Television Image And Sound Recorders And Reproducers, And Parts.	89,19,233.08	3.86

Transport			
87	Vehicles Other Than Railway Or Tramway Rolling Stock, And Parts And Accessories Thereof.	1,26,53,335.85	5.48
89	Ships, Boats And Floating Structures.	39,25,894.45	1.70
Total			**80.28**

Source: Directorate General of Commercial Intelligence and Services (DGCI&S), Government of India

Table A3.2: Asymmetric Export Price Pass through Elasticities

HS Code	Description	ERPT Coefficient
	Animal And Animal Product	
2	Meat And Edible Meat Offal.	0.45(1.76)
3	Fish And Crustaceans, Molluscs And Other Aquatic Invertebrates.	0.48(2.12)
	Vegetable Products	
10	Cereals.	1.62(2.29)
	Mineral Products	
27	Mineral Fuels, Mineral Oils And Products Of Their Distillation; Bituminous Substances; Mineral Waxes.	0.42(0.13) ***
	Chemicals And Allied Industries	
29	Organic Chemicals	0.21(0.06)***
30	Pharmaceutical Products	0.12(0.02)***
32	Tanning Or Dyeing Extracts; Tannins And Their Deri. Dyes, Pigments And Other Colouring Matter; Paints; Putty And Other Mastics; Inks.	0.36(0.12)**
38	Miscellaneous Chemical Products.	0.46(2.14)
	Plastics/ Rubber	
39	Plastic And Articles Thereof.	0.95(1.15)
	Textiles	
52	Cotton.	0.26(0.07)***
61	Articles Of Apparel And Clothing Accessories, Knitted Or Crocheted.	0.28(0.06)**
62	Articles Of Apparel And Clothing Accessories, Not Knitted Or Crocheted.	0.15(0.06)**
63	Other Made Up Textile Articles; Sets; Worn Clothing And Worn Textile Articles	0.31(0.16)**
	Metals	
71	Natural Or Cultured Pearls, Precious Or Semiprecious Stones, Pre Metals, Clad With Pre Metal And Etc.	0.11(0.06) **
72	Iron And Steel	0.16(0.03)***
73	Articles Of Iron Or Steel	0.19(0.05)***
76	Aluminum And Articles Thereof.	0.14(0.08)**

Machinery/Electrical		
84	Nuclear Reactors, Boilers, Machinery And Mechanical Appliances; Parts Thereof.	0.45(2.32)
85	Electrical Machinery And Equipment And Parts Thereof; Sound Recorders And Reproducers, Television Image And Sound Recorders And Reproducers, Parts.	0.46(1.28) *
Transport		
87	Vehicles Other Than Railway Or Tramway Rolling Stock, And Parts And Accessories Thereof.	0.04(0.03) **
89	Ships, Boats And Floating Structures.	0.11(0.06)**

Source: Authors Calculation Based On Equation 3.5.

Note: Robust Standard Errors In Parentheses; ***, **, * Represents Statistical Significance at 1% 5% 10% Respectively. All Controls Included.

CHAPTER 4

THE NEXUS BETWEEN EXCHANGE RATE PASS THROUGH AND INFLATION: THE ROLE OF EXPECTATIONS

4.1. Introduction

This chapter investigates into the relationship between exchange rate pass through and inflation in India for the period of 2008-2018. Changes in the value of the Indian rupee against foreign currencies often manifest, directly by influencing trade balances, inflation, and economic stability (Bhanumurthy et al, 2012; Balakrishnan & Parameshwaran, 2022 and 2025). In specific, in the Indian context, currency depreciation reduces the purchasing power of households and businesses, often triggering inflation through exchange rate pass-through. ERPT in this context refers to the degree to which exchange rate changes influence domestic prices of goods and services. The studies on ERPT on India such as Patra and Kapur (2012) and Bhattacharya, Patnaik, and Shah (2008), show that ERPT in India is incomplete but significant, varying across sectors and time periods on account of structural and policy factors. Balakrishnan & Parameswaran (2025) show that food-price inflation is best suited to understanding the Indian inflation experience.

India's adoption of inflation targeting (I.T.) in 2016 marked a pivotal shift in its monetary policy framework. The Reserve Bank of India (RBI) set a formal inflation target with the primary goal of achieving price stability. This adoption aligns with global trends, as studies like Minella et al. (2003) on Brazil demonstrate that I.T. can reduce ERPT by anchoring inflation expectations during currency depreciation. For India, studies such as Bhanumurthy, Bose, and Sinha (2018) and Patra, Khundrakpam, and George (2020) provide evidence that I.T. has strengthened monetary policy credibility and moderated inflation expectations. Furthermore, Schmidt-Hebbel and

Werner (2002) and Mishkin and Savastano (2001) emphasize that I.T. frameworks reduce ERPT by stabilizing expectations, even if they do not eliminate it entirely.

India's inflation-targeting regime emphasizes accountability, transparency, and flexibility, making it well-suited to managing inflation expectations. Research by Nasir, Balsalobre-Lorente, and Huynh (2020) highlights these strengths, while Williams (2014) underscores the importance of anchored inflation expectations in I.T.'s success. However, implementing I.T. in India has not been without challenges. Patra, Khundrakpam, and Kavediya (2017) identify factors like fiscal dominance, supply-side constraints, and commodity price volatility to complicate the effectiveness of I.T. Furthermore, following Frankel (2012), the resilience of I.T. during financial crises can be questioned. Inflation Targeting (I.T.), first adopted by New Zealand in the 1990s, spread globally, supported by Artis & Kontolemis (1998), Bernanke et al. (2001), Bernanke (2003), Balima, Combes & Minea (2017), Lanzafame (2016), Lee (2011), and Minella et al. (2003).

Inflation targeting in India potentially moderates ERPT by anchoring inflation expectations, as shown by Anand and Kumar (2018) and Mishra and Mishra (2020).

Inflation in India is influenced by various factors beyond exchange rates, including aggregate demand, labor market dynamics, supply shocks (e.g., oil price fluctuations; See Figure 4.1), fiscal policy, money supply, and past inflation trends. The exchange rate (measured in rupees per unit of us dollars), especially with a one-month lag, is statistically significant and can, along with fuel prices, account for as much as 80% of the core, and 70% of the manufacturing, inflation(Mandal et.al, 2012; Bhattacharya et al.,2008; Rakshit, 2011). Notably, inflation expectations themselves are shaped by these determinants, reflecting a complex and dynamic relationship. This interaction, emphasized the works by Friedman (1968); Phelps (1967); Marfatia (2018);

Mandal et.al (2012); Nasir et al. (2020); Bhattacharya (2025) and Balakrishnan & Pareameswaran (2025), highlights the critical role of expectations in inflation dynamics. Indian studies, such as Bhattacharya et al. (2008), further support this view, showing that inflation expectations are influenced by both global and domestic factor, including monetary policy credibility.

Within the inflation targeting framework, a significant question arises: how do inflation expectations in India respond to exchange rate shocks and ERPT? Empirical evidence (Bernanke et al., 2001; Obstfeld, 2014; Roger, 2010) shows I.T. stabilizes inflation and expectations, though post-GFC critiques (Williams, 2014; Haldane, 2015; Nasir, 2017) highlight ZLB and muted inflation. Determinants of expectations include past inflation and shocks (Friedman, 1968; Phelps, 1967; Gali & Gertler, 1999; Canova et al., 2007; Boschia & Girardi, 2007; Norkute, 2015; Lagoa, 2017; Mehra & Herrington, 2008; Ueda, 2010; Fuhrer, 2011).

Fiscal policy (Sargent & Wallace, 1981, 1986; Catao & Terrones, 2005; Fischer et al., 2002; Lin & Chu, 2013; Minea & Tapsoba, 2014; Cerisola & Gelos, 2009; Corbo et al., 2001; Yigit, 2010) and money supply (Friedman, 1970; Lu et al., 2017; Su et al., 2016; Hung & Thompson, 2016) also shape expectations.

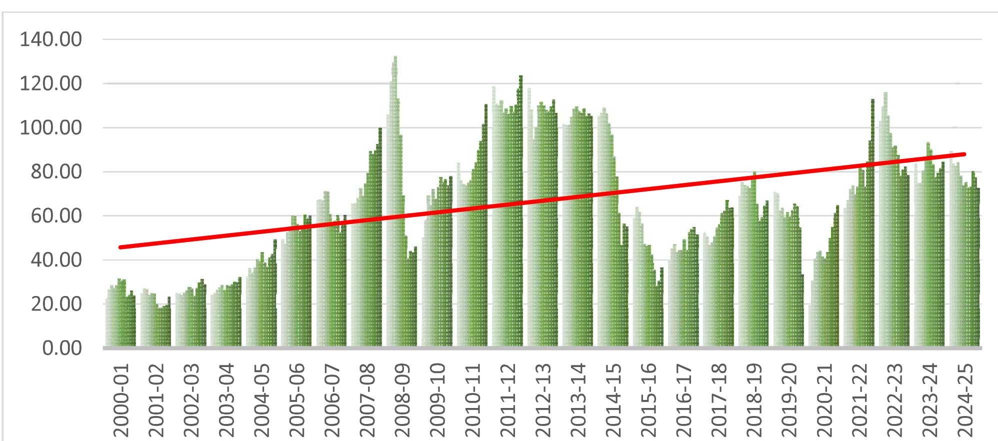
Addressing this question requires empirical investigation using a sound analytical framework. To explore this issue, a Nonlinear Autoregressive Distributed Lag (N-ARDL) model was applied to Indian data spanning for the period of 2008Q3 to 2018Q1. This model captures both short-term and long-term effects of various determinants, including exchange rate shocks, inflation, oil prices, money supply, unemployment, output growth, and fiscal policy health, on inflation expectations. The results reveal that ERPT significantly affects inflation expectations in India, which are also influenced by actual inflation and adaptive expectations. Additionally, factors such as output growth, labour market conditions, money supply, and oil price shocks exert varying impacts on inflation expectations in the short and long term.

This chapter contributes to the growing discourse on ERPT and Inflation Targeting by emphasizing the importance of anchoring inflation expectations in the Indian context. The chapter is structured as follows: Section 4.2 discusses some stylised facts. Section 4.3 briefs the data used and delineates the Nonlinear-ARDL methodology, Section 4.4 discusses the empirical findings, and Section 4.5 provides summary of main findings of the chapter.

4.2. Stylised facts

As observed in chapter 1, the relationship between exchange rate dynamics and inflation presents challenges for central banks striving to meet their inflation targets (Fraga et al., 2003). Some studies, such as those by Eichengreen (2002) and Mishkin & Savastano (2001), have argued that the adoption of I.T. led to a decline in ERPT in many emerging markets. However, this claim is not universally supported, as more recent studies (e.g., Forbes, 2016; Forbes et al., 2015; Nasir et al., 2020) suggest that ERPT has, in fact, increased in inflation targeting countries, challenging earlier views.

Figure 4.1: Trends in Crude Oil Prices



Source: Petroleum Planning and Analysis Cell, Government of India

A key channel through which exchange rate fluctuations influence import prices is through the price of crude oil. For validation, we run an N-ARDL regression and we estimate the pass through coefficient.

Table 4.1: Estimates for ERPT to Crude Oil Prices

Variables	Long Run	Short Run
Oil Price$_{(t-1)}$		0.34** (0.22)
GDP$_{(t)}$	1.23 (1.29)	0.03* (0.79)
NER$_{(t)}^{+}$	0.86** (0.07)	0.81** (0.05)
NER$_{(t)}^{-}$	-0.62* (0.55)	-0.71** (0.42)
Unemployment$_{(t-1)}$	2.52 (5.33)	1.23 (1.89)
Fiscal	2.12 (3.04)	1.39 (3.23)
Constant	3.55** (1.43)	4.01** (1.89)

Source: Authors Calculation

The pass-through coefficient for crude oil imports is estimated at 0.81 in the short run and marginally higher at 0.86 in the long run. This reflects a relatively strong pass-through, indicating that importers transfer a substantial share of exchange rate fluctuations to domestic prices, thereby exerting significant pressure on inflation.

4.3. Data and Methodology

4.3.1 Data

This study examines the dynamics of inflation in India using a comprehensive dataset covering the period from the third quarter of 2008 to the third quarter of 2018. The analysis incorporates key economic variables, including inflation expectations, actual inflation, fiscal health, output growth, labor market conditions, the real effective exchange rate (REER), money supply, and oil prices, which serve as a proxy for supply-side shocks. Data on inflation expectations were drawn from the Inflation Expectations Household Survey (IEHS) of Reserve Bank of India, which capturescapturing one-year projections from market participants. Inflation is measured using seasonally adjusted year-on-year percentage changes in the Consumer Price Index (CPI), the official benchmark for inflation targeting. Real GDP growth rates, reflecting economic performance, and unemployment levels, indicating labour market slack, are sourced from official statistics published by the Central Statistical Office. Fiscal health is measured using year-on-year changes in the budget deficit or surplus, sourced from the Reserve Bank of India's Handbook of Statistics on the Indian Economy. REER and money supply (M2), indicative of exchange rate competitiveness and liquidity conditions, respectively, are also obtained from the Reserve Bank of India. Oil prices, represented by Brent crude in USD, are sourced from the Petroleum Planning and Analysis Cell, converted to Indian rupee terms to assess cost-push inflation. The data are adjusted to monthly frequencies using linear interpolation, standardized, and seasonally adjusted to ensure time consistency, enabling an in-depth exploration of the interdependencies between inflation and factors underlying its behaviour.

4.3.2 Model

The relationship is initially modelled using an open economy framework consistent with the New Keynesian Phillips Curve (NKPC)[6]:

$$\pi_t = \beta_1 \pi_{t-i} + \beta_2 E(\pi_{t+i}) + \beta_3 (REER)_{t-i} + \beta_4 OG_{t-i} + \beta_5 UR_{t-i} + \beta_6 FS_{t-i} + \beta_7 Oil_{t-i} + \beta_8 MS_{t-i} + e_t \quad (4.1)$$

[6] The NKPC takes into account forward looking expectations unlike augmented Philips Curve which is based on adaptive expectations. The specification is in contrast with Balakrishnan and Parameswaran (2025), who finds it is appropriate to use the augmented Phliips Curve equation in estimating the factors determining inflation in India.

where inflation (π_t) is determined by its past values i.e. an element of persistence (π_{t-i}), its expectations ($E\pi_t$), real exchange rate (REER), GDP growth (OG), labour market outlook which can be gauged by unemployment rate (UR), fiscal policy health (FS), Oil price shocks (Oil) shocks and dynamics of the Money Supply (MS). Considering the fact these factors are theoretically perceived and often empirical proved to be the determinants of inflation, the expectations of inflation are also influenced by these factors and their dynamics. Hence,

$$E(\pi)_t = \beta_1\pi_{t-i} + \beta_2E(\pi_{t+i}) + \beta_3(REER)_{t-i} + \beta_4OG_{t-i} + \beta_5UR_{t-i} + \beta_6FS_{t-i} + \beta_7Oil_{t-i} + \beta_8MS_{t-i} + e_t \quad (4.2)$$

The Nonlinear Autoregressive Distributed Lag (N-ARDL) model is applied to explore the interplay between inflation expectations and key economic factors, including the real exchange rate, output growth, labour market dynamics, supply-side shocks (e.g., oil prices), money supply, and fiscal health of the economy. The N-ARDL framework is particularly useful because it captures both asymmetries and nonlinearities in the relationship between inflation expectations, exchange rate movements, and other determinants, making it ideal for analyzing inflation dynamics in an open economy. This approach is based on the foundational work of Pesaran and Shin (1999), Pesaran, Shin, and Smith (2001), and later refined by Shin, Yu, and Greenwood-Nimmo (2011).

The long-term relationship between inflation, inflation expectations, and their determinants is expressed as:

$$\pi_t = \mu_0 + \mu_1E(\pi_t) + \mu_2(REER)_t^+ + \mu_3(REER)_t^- + \mu_4OG_t + \mu_5UR_t + \mu_6FS_t + \mu_7Oil_t + \mu_8MS_t + e_t \quad (4.3)$$

$$E(\pi_t) = \mu_0 + \mu_1(\pi_t) + \mu_2(RER)_t^+ + \mu_3(RER)_t^- + \mu_4 OG_t + \mu_5 UR_t + \mu_6 FS_t + \mu_7 Oil_t + \mu_8 MS_t + e_t \quad (4.4)$$

Where π_t is inflation and $E(\pi_t)$ are inflation expectations and their determinants are as specified in equation (4.1) and (4.2), and $\mu = (\mu_0 - \mu_8)$ is a co-integrating vector of long-run parameters. In Equation (4.3) and (4.4) the $REER_t^+$ and $REER_t^-$ are partial sums of positive and negative changes in the real exchange rate, it can be specified as,

$$REER_t^+ = \sum_{i=0}^{t} \Delta REER_i^+ = \sum_{i=0}^{t} \max(\Delta REER_i, 0) \quad (4.5)$$

$$REER_t^- = \sum_{i=0}^{t} \Delta REER_i^- = \sum_{i=0}^{t} \min(\Delta REER_i, 0) \quad (4.6)$$

In light of formulation presented above [Equations (4.3) and (4.4)], the relationship between the real exchange rate (REER) shocks and inflation expectations $E(\pi_t)$ is expected to be negative (μ_2).However, μ_3 accounts for the relationship between REER and inflation expectations while there are reductions in REER or depreciation. As exchange rate and inflation, as well as inflation expectations, are expected to show the opposite direction of movement, estimates of μ_3 can be expected to yield negative signs. It can also be posited that the depreciation in the exchange rate will lead to a higher increase in the inflation expectations than the increase in the exchange rate which may lead to a decrease in the inflation expectations. Thus, a negative shock (depreciation) could have a larger effect as compared to a positive (appreciation) shocks i.e. $\mu_3 > \mu_2$. This implies downward price or exchange rate pass-through rigidity which could be manifested in the inflation expectations. Hence, an asymmetric exchange rate pass-through can be expected in the long run. Equations (4.3) and (4.4) can be framed into a Nonlinear Autoregressive Distributed Lag Model (NARDL) setting as follows:

$$\Delta\pi_t = \alpha_1 + \beta_1(\pi_{t-i}) + \beta_2(REER)^{+}_{t-i} + \beta_3(REER)^{-}_{t-i} + \beta_4 E(\pi_{t-i}) + \beta_5 OG_{t-i} + \beta_6 UR_{t-i} + FS_{t-i} + \beta_8 Oil_{t-i} + \beta_9 MS_{t-i} + \sum_{i=1}^{p}\phi_i\,\Delta\pi_{t-i} + \sum_{i=1}^{q}(\theta_t^{+}\Delta REER^{+}_{t-i} + \theta_t^{-}\Delta REER^{-}_{t-i}) + \sum_{i=0}^{s}\gamma_i\Delta OG_{t\dot{-}\iota} + \sum_{i=0}^{v}\delta_i\Delta UR_{t\dot{-}\iota} + \sum_{i=0}^{w}\Omega_i\Delta FS_{t\dot{-}\iota} + \sum_{i=0}^{x}\xi_i\Delta\, E\pi_{t\dot{-}\iota} + \sum_{i=0}^{z}\tau_i\Delta\, Oil_{t\dot{-}I} + \sum_{i=0}^{m}\psi_i\Delta\, MS_{t\dot{-}\iota} + e_t \quad (4.7)$$

$$\Delta E\pi_t = \alpha_2 + \beta_1(\pi_{t-i}) + \beta_2(REER)^{+}_{t-i} + \beta_3(REER)^{-}_{t-i} + \beta_4 E(\pi_{t-i}) + \beta_5 OG_{t-i} + \beta_6 UR_{t-i} + \beta_7 FS_{t-i} + \beta_8 Oil_{t-i} + \beta_9 MS_{t-i} + \sum_{i=1}^{p}\phi_i\,\Delta\pi_{t-i} + \sum_{i=1}^{q}(\theta_t^{+}\Delta REER^{+}_{t-i} + \theta_t^{-}\Delta REER^{-}_{t-i}) + \sum_{i=0}^{s}\gamma_i\Delta OG_{t\dot{-}\iota} + \sum_{i=0}^{v}\delta_i\Delta UR_{t\dot{-}\iota} + \sum_{i=0}^{w}\Omega_i\Delta FS_{t\dot{-}\iota} + \sum_{i=0}^{x}\xi_i\Delta\, E\pi_{t\dot{-}\iota} + \sum_{i=0}^{z}\tau_i\Delta\, Oil_{t\dot{-}I} + \sum_{i=0}^{m}\psi_i\Delta\, MS_{t\dot{-}\iota} + e_t \quad (4.8)$$

where all the variables are defined earlier in the chapter and p,q,s,v,w,x,z,m are lag orders. $\alpha_I = -\frac{\beta_2}{\beta_1 -}$ and $\alpha_2 = -\frac{\beta_3}{\beta_1 -}$ are long run coefficients of association between REER dynamics and inflation (Equation 4.7)) and inflation expectations (Equation (4.8)). In Equation (4.7), the $\sum_{i=1}^{q}\theta_t^{+}$captures the short-run impacts of REER appreciation on inflation, while $\sum_{i=1}^{q}\theta_t^{-}$ captures short-run impacts of depreciation on inflation. On the other hand, in Equation (4.8), $\sum_{i=1}^{q}\theta_t^{+}$captures the short-run impacts of REER appreciation on expected inflation, while $\sum_{i=1}^{q}\theta_t^{-}$ captures short-run impacts of depreciation on inflation expectation. Concomitantly, we account for the asymmetries between real exchange rate (pass-through) and inflation expectations in both short and long-run relationship.The summary statistics of the variables are provided in Table 4.2.The descriptive statistics indicate moderate variability in inflation and its expectations, relative stability in monetary and labour market indicators, but substantial volatility in oil prices.

Table 4.2: Summary Statistics

Variables	Observations	Mean	Standard Deviation	Min	Max
Inflation Expectation	41	6.23	1.98	2.34	10.58
Inflation	41	7.58	2.97	3.32	11.98
GDP(OG)	41	6.67	1.61	3.08	8.49
REER	41	90.23	2.63	83.07	103.20
Unemployment	41	7.61	1.69	7.01	9.23
Money Supply	41	76.97	1.84	74.09	79.07
Oil Price	41	79.50	2.24	21.20	122.30
Fiscal Health	41	5.07	3.21	4.65	5.72

Source: Author's Calculations

Unit root tests are conducted to determine the order of integration for each variable. The validity of this framework relies on the data series being either stationary at the level (I (0)) or at the first difference (I (1)). If any variable is found to be integrated at the second order (I (2)), it renders the computation of F-statistics for cointegration testing invalid (Ibrahim, 2015). To ensure no variable exceeds I (1) integration order, the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are utilized for unit root testing.

Table 4.3: Unit Root Test

Variables	Augmented Dickey Fuller		Phillips Perron	
	Levels	First Difference	Levels	First Difference
Inflation Expectation	-4.41	-21.56***	-4.62	-22.86***
Inflation	-3.16	-18.26***	-3.32*	-18.96***
GDP(OG)	-2.29	-5.48***	-2.45	-6.12***
REER	-2.89	-15.62***	-3.01	-16.21***
Unemployment(UR)	-7.89*	-7.89*	-7.59**	-7.59**
Money Supply (MS)	-2.56**	-2.56**	-3.35**	-3.35**
Oil Price (Oil)	-3.32*	-12.35**	-3.61	-12.76**
Fiscal (Surplus/Deficit) (FS)	-5.35*	-5.35*	-5.71**	-5.71**

Source: Authors Calculation; Note: (*), (**), (***) reflected statistically significant of the corresponding coefficients at 10%, 5% and 1% level. Standard errors of the corresponding coefficients are reflected in square brackets.

Even though the ARDL approach does not strictly require variables to be classified as I (0) or I (1) (Pesaran et al., 2001), it is crucial to ensure that none of the variables are integrated at I (2), as the F-test used in the bounds testing framework is valid only for variables that are I (0) or I (1) (Ouattara, 2004). The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were employed to determine the order of integration. The results, summarized in Table 4.3, show that three variables—unemployment rate, money supply, and fiscal health are stationary at levels i.e. (I (0)), while the remaining variables attain stationarity after first differencing. This assure that all variables are suitable for the bounds testing approach.

Once the stationarity conditions are confirmed, the N-ARDL model as represented in equations (4.7) and (4.8) is estimated. Following the estimation, the bounds testing approach is employed to evaluate the existence of cointegration, as outlined by Pesaran et al. (2001) and Shin et al. (2011). Finally, asymmetric cumulative dynamic multipliers are derived to assess the impact of a 1% change in the real effective exchange rate (REER) on the dependent variables.

$$m_h^+ = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{REER_{t-1}^+},$$

$$m_h^- = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{REER_{t-1}^-} \quad , h=0,1,2,\ldots..$$

Noticeably as. $h \rightarrow \infty$, $m_h^+ \rightarrow \alpha_I$ and $m_h^- \rightarrow \alpha_2$

4.4 The Results

4.4.1 Cointegration: Bound Test Results

The results of the bounds test for nonlinear cointegration, presented in Table 4.4, reveal that the calculated F-statistics exceed the upper bound critical value at the

90% confidence level. This result provides strong evidence of a long-run equilibrium relationship between inflation expectations and their determinants, as specified in Equation (4.8). The significance of this relationship suggests that inflation expectations are not only influenced by short-term variations in the factors determining inflation expectations but also by their long-term trends. These results on cointegration lead one to investigate into the measures of the relationships during periods of appreciation and depreciation.

Table 4.4: Bound Test for Cointegration

Dependent Variable	F-Statistics	Lower Bound (90%)	Upper Bound (90%)	Conclusion
Inflation Expectation	4.29	2.85	3.85	Co-integration exists

Source: Authors Calculation

4.4.2 Asymmetricity and non-linearity in relationships: NARDL Estimates

The findings from the Nonlinear Autoregressive Distributed Lag (N-ARDL) model are presented in Table 4., providing empirical evidence on the asymmetries and nonlinearities in the relationship between inflation expectations, exchange rate (REER), and other determinants of inflation expectations in both the short and the long runs. The short-run results reveal a significant negative effect of past inflation expectations on current inflation expectations, indicating a corrective mechanism and an element of adaptive expectations.

Table 4.5: Estimation Results

Variables	Long Run	Short Run
Inflation Expectation$_{(t-1)}$		-0.12*** (-4.22)
Inflation$_{(t)}$	1.65** (3.62)	0.05*** (2.21)
GDP$_{(t)}$	1.23 (1.29)	0.03* (0.79)

REER$_{(t)}^{+}$	-4.11** (-6.23)	-0.31*** (-2.65)
REER$_{(t)}^{-}$	-4.39* (-5.89)	-0.28** (-2.35)
Money Supply$_{(t)}$	-0.86* (-1.12)	-0.01** (-1.21)
Oil Price$_{(t)}$	1.98** (3.34)	1.31** (5.22)
Unemployment$_{(t-1)}$	1.52 (1.19)	0.71* (0.89)
Fiscal	-2.11 (-2.04)	-1.35 (-1.32)
Δ Unemployment $_{(t)}$		-0.01* (-0.12)
Δ Inflation Expectation$_{(t-1)}$		-0.19** (-1.56)
Constant	2.55 (1.43)	1.11 (0.89)

Source: Author's Calculations
Note: (*), (**), (***) reflected statistically significant of the corresponding coefficients at 10%, 5% and 1% level. Standard errors of the corresponding coefficients are reflected in square brackets.

The results in Table 4.5 further show both during episodes of appreciation and depreciation, shows a significant negative impact, with the positive REER shocks (REER+) having a more substantial effect than the negative shocks (REER-), with the latter still has a weaker negative influence. The results also show a positive and significant effect of inflation on inflation expectations, suggesting that an increase in inflation leads to higher expectations of future inflation. This result shows the presence of hysteresis and highlights the importance of price stability in anchoring inflation expectations, with price instability exacerbating future inflation expectations and price instability.

Further, oil price shocks, GDP growth, and unemployment have a positive impact on inflation expectations in the short run. The unemployment impact, though counterintuitive, might stem from perceptions that high unemployment signals higher future inflation and perceive higher costs. Fiscal health (surplus/deficit) shows a negative effect on inflation expectations, indicating that fiscal consolidation tends to lower expectations. Similarly, money supply has a negative impact.

In the long run, the positive exchange rate shocks (REER+) significantly reduce inflation expectations at a 5% level of significance, while negative exchange rate shocks (REER-) have a negative but insignificant effect. This suggests an asymmetric effect of exchange rate pass- to inflation expectations. In the long run, current inflation, GDP, oil prices, and unemployment rate have positive effects on inflation expectations, while money supply and fiscal health, a deficit, reduce expected inflation. Notably, inflation itself emerges as the most significant factor influencing inflation expectations.

Table 4.6: Diagnostic Checks

Diagnostic Tests	Coefficients
Error correction term	-0.089*** (6.39)
R^2	0.94
F test	632.26***
JB-Normality test	152.38**
BG-LM test	3.11
DW test	1.99
BPG test	68.65***
White test	189.98***
Ramsey -RESET test	0.06

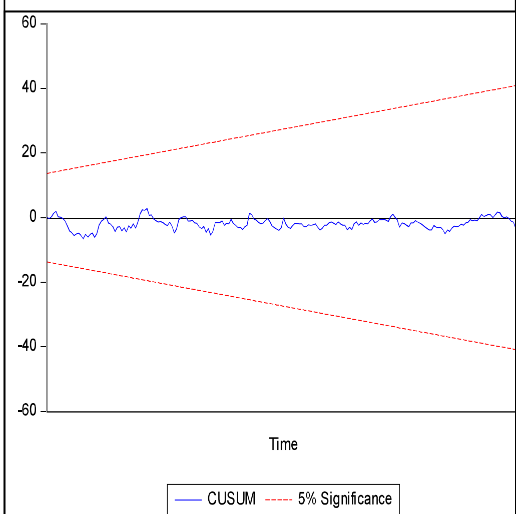
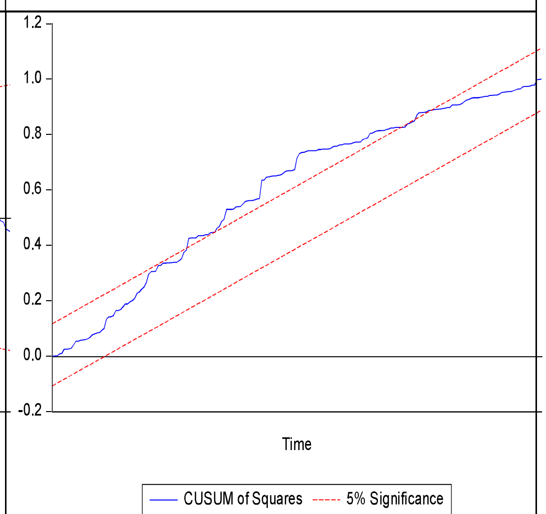
Note: (*), (**), (***) reflected statistically significant of the corresponding coefficients at 10%, 5% and 1% level. Standard errors of the corresponding coefficients are reflected in square brackets.

To assess the robustness of the model and estimates, a diagnostic test was performed. The adjusted R-squared value as in Table 4.6 indicates that the explanatory variables account for 94% of the variation in inflation expectations. The Error Correction term is negative (-0.089) and statistically significant at 1% level, suggesting the stability of the model and the speed of adjustment to long-term equilibrium. The F-statistic rejects the null hypothesis that all coefficients are zero, and the Breusch-Godfrey (BG) LM test, along with the Durbin-Watson test, indicate no serial correlation in the residuals at the 1% significance level, confirming the suitability of the model for forecasting. However, the Jarque-Bera (JB) test rejects the null hypothesis of normality for residuals at 1% significance level. The Breusch-Pagan-Godfrey (BPG) and White tests for heteroscedasticity reject the null hypothesis of no heteroscedasticity, although this does not affect the unbiasedness of the results. The Ramsey-RESET test for misspecification fails to reject the null hypothesis that the model is correctly specified, confirming that the model is well-specified.

4.4.3 Stability Checks

To ensure the stability of the model estimated, the following parameter stability test is conducted. The results of the CUSUM test are presented in Figure 4.2

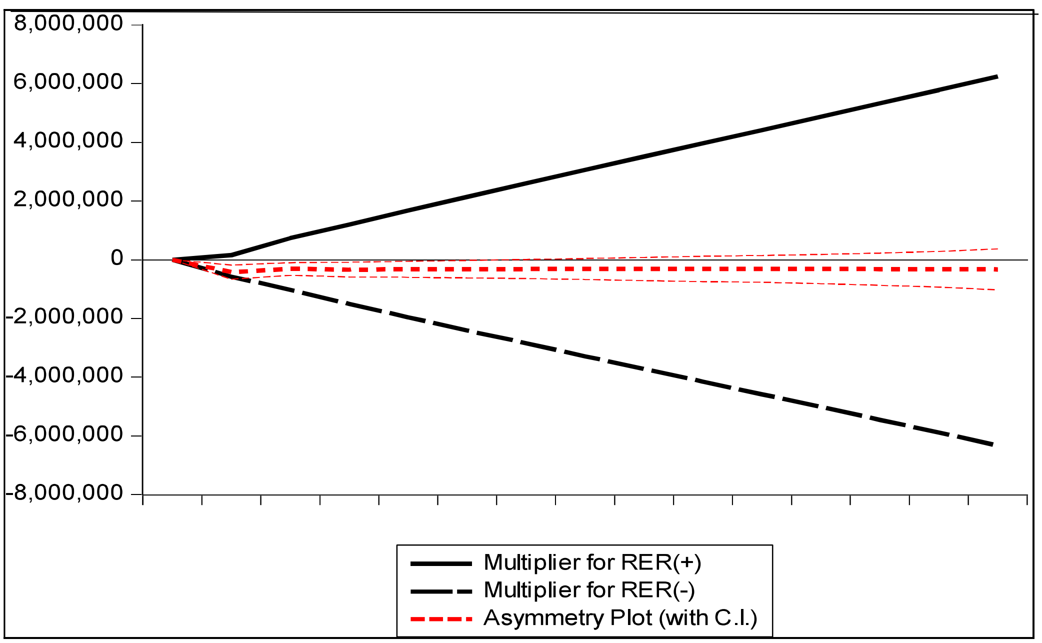
Figure 4.2: Parameter stability test for inflation expectations

Panel A	Panel B
	

Panel A indicate that the parameters have remained stable throughout the entire period. Meanwhile, the CUSUM of Squares test in Figure 4.2, Panel B reveal that where the parameters crossed the 5% significance level, but they remained close to the bound within the 10% level and eventually reverted to the 5% level, suggesting a general confidence level of 90%. Additionally, we performed a cumulative multiplier analysis to assess the impact of the real effective exchange rate on inflation expectations.

The cumulative multiplier results, presented in Figure 4.3, provide a comprehensive view of the influence of REER on Indian inflation expectations. A 1% appreciation of the Indian Rupee, or a positive shock to the REER, leads to a negative response in inflation expectations, which persists over several months. Conversely, a 1% negative shock to the REER, or depreciation of the Indian Rupee, results in an increase in inflation expectations over the following months. Overall, the exchange rate pass-through to inflation expectations is clearly evident.

Figure 4.3: NARDL Multiplier of the REER and inflation expectations



4.5 Summary of Findings

The relationship between Exchange Rate Pass-Through and its implications for various aspects of the macroeconomy and price stability has been a longstanding and much-debated issue. Inflation Targeting has introduced new dimensions to this debate, with arguments on both sides. Some argue that the extent ERPT has diminished on account of I.T., while others believe that the reverse is true. One often overlooked aspect of this debate is whether inflation expectations serve as a channel for ERPT. Given that inflation expectations are considered a key determinant of inflation, it seems intuitive to explore how ERPT influences these expectations. This study aimed to address this gap by analyzing the impact of ERPT and other determinants of inflation on inflation expectations in the Indian context.

Our findings indicate that inflation expectations in India, a small open economy within an inflation-targeting framework, are significantly influenced by ERPT. We also find evidence of an asymmetric and non-linear impact of REER on inflation expectations. Inflation itself is found to have a highly significant effect on future inflation expectations, suggesting that periods of price stability can help anchor inflation expectations. Other determinants, including GDP growth, unemployment, oil price shocks, money supply, and fiscal discipline, also showed a considerable impact on inflation expectations, though the significance and magnitude of these effects vary between the short and the long runs.

Chapter 5

Exchange Rate Pass-Through, Monetary Policy, and Currency Invoicing: An Analysis within a DSGE Framework for India

5.1 Introduction

This chapter integrates three key components – Exchange Rate Pass-Through, monetary policy, and considerations regarding the currency of invoice – into a medium-scale New Keynesian Dynamic Stochastic General Equilibrium (DSGE) framework. The primary objective is to gain a deeper understanding of how exchange rates changes impact domestic prices, overall economic performance, and the effectiveness of monetary policy. The ERPT process unfolds in two stages: initially, shifts in the nominal exchange rate (NER) cause price fluctuations in tradable goods, which subsequently drive inflation rates to change.

Earlier chapters, which are empirical, reveal that exchange rate pass-through in India is incomplete and exhibits asymmetry. The extent of pass-through varies across markets, with relatively higher transmission observed in more concentrated sectors characterized by imperfect competition, where firms possess greater pricing power. Such markets tend to adjust prices more strongly to exchange rate fluctuations compared to competitive markets. Moreover, the analysis shows that pass-through coefficients are typically higher in the long run than in the short run, suggesting that while immediate adjustment is partial, exchange rate changes are more substantially incorporated into export, import and domestic prices over time.

However, as observed in the earlier chapter 1, the empirical approaches have certain limitations (Cicco and Schmidt, 2020). They assume symmetric effects of monetary policy shocks on the NER and prices and lack the capability to distinguish between the impacts of current and anticipated monetary policies on Exchange Rate

Pass-Through. To overcome the shortcomings of these methods, recent studies have shifted their focus on structural modelling within the framework of a Dynamic Stochastic General Equilibrium (DSGE) model. This framework amalgamates the dynamics of economic variables – encompassing aspects such as output, inflation, and interest rates – with the inherent uncertainty and shocks that shape economies over time. DSGE models offer an all-encompassing depiction of the behaviour of economic agents, including households, firms, and policymakers. This allows for the exploration of various policy scenarios and external shocks. Understanding the intricate interplay among monetary policy, the movements of exchange rates and exchange rate pass through, within the flexibility of DSGE framework, helps in devising effective policy strategies, particularly in an increasingly integrated global economic landscape.

This chapter commences by specifying a simple DSGE model, calibrated to Indian data. This model captures the micro behaviour of households and firms in a small open economy with nominal rigidities, making it susceptible to policy-induced or other external shocks. Further, the study also analyses the ERPT in context to alternative monetary policy paths. The study then introduces distinct pricing strategies—Local Currency Pricing (LCP), Producer Currency Pricing (PCP), and Dominant Currency Pricing (DCP)—to explore varying degrees of ERPT under alternative pricing approaches. Further, the study highlights the changes in the degree of ERPT under different monetary policy stances.

The rest of the chapter is organized as follows: Section 5.2 outlines the baseline DSGE model, while Section 5.3 discusses the results and their interpretations related to CERPT. Section 5.4 highlights the role of different monetary policy paths that influence CERPT Section 5.5 presents the model describing currency-specific invoicing and its outcomes. Finally, Section 5.6 summarises the major findings of the chapter.

5.2 The Model

This section presents a medium scale DSGE model, based on Schmitt-Grohé and Uribe (2017).This model makes its departure from the Schmitt-Grohe model by incorporating certain elements of the external sector.[7] The model incorporates four major shocks to observe the impulse response functions and analyse the Conditional Exchange Rate Pass Through (CERPT)[8]. In specific, this model has a tradable sector, *T*, and a non-tradable sector, *N*. The central bank follows an inflation targeting regime and sets the interest rate using a Taylor rule in the baseline and then with other alternatives to evaluate the effects of different policies. The price stickiness in New Keynesian framework has been incorporated using Calvo pricing rule which helps in finding out transmission channel of exchange-rate movements to domestic prices.

5.2.1 Households

The representative household consumes a basket of tradable and non-tradable goods, works to earn wages W and intends to maximize the present discounted value of life time utility,

[7] The model hence includes the framework of the currency of invoicing of tradable goods suitable in Indian context.

[8] Conditional exchange rate pass-through (ERPT) refers to the responsiveness of domestic prices to changes in the nominal exchange rate (NER) under specific conditions, shocks, or policy paths. For instance, conditional ERPT might investigate how a change in monetary policy stance, such as an interest rate adjustment, affects the pass-through of exchange rate fluctuations to consumer prices. It could also explore how different pricing strategies, such as currency of invoice choices or producer pricing behaviors, interact with exchange rate movements and impact the magnitude of ERPT.

$$Max\ E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \frac{C_t^{1-\sigma}}{1-\sigma} - \eta \frac{L_t^{1+\varphi}}{1+\varphi} \right\} \tag{5.1}$$

where C_t is consumption and L_t are hours worked, β is the discount factor, σ is the risk aversion parameter, φ is the inverse of the Frisch elasticity[9] of labour supply and η is a scale parameter. The household is assumed to maximize its utility subject to the budget constraint, which is as:

$$P_t C_t + e_t B_t^* + B_t = L_t W_t + e_t R_{t-1}^* B_{t-1}^* + R_{t-1} B_{t-1} + \pi_t \tag{5.2}$$

Here P_t is the price of final consumption, e_t is the nominal exchange rate, B^* and B_t are holdings of foreign and domestic bonds respectively (with R^* and R being the return on bonds), W is the wage rate, and Π adds exogenous profits from all firms.

The consumption good C_t is a composite of tradable consumption good, C^T, and non-tradable consumption good, C^N, expressed in the form of Constant Elasticity of Substitution function.

$$C_t = \left[\gamma^{\frac{1}{\theta}} (C_t^N)^{\frac{\theta-1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}} (C_t^T)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{1-\theta}} \tag{5.3}$$

where γ is the share of nontradables in the total consumption and θ is the constant elasticity of substitution between tradable and non-tradable goods.

Additionally, non-tradable consumption is expressed as a Dixit-Stiglitz aggregate of non-tradable differentiated varieties, C^N (j) with ε being the constant elasticity of substitution across the varieties of goods.

[9] The Frisch elasticity measures labor supply responsiveness to wage changes, holding marginal utility of wealth constant.

$$C_t^N = \left[\int_0^1 \left(C_t^n(j)\right)^{\frac{\varepsilon-1}{\varepsilon}} di \right]^{\frac{\varepsilon}{\varepsilon-1}} \tag{5.4}$$

The representative household exhibits an expenditure minimizing behaviour and we derive the Consumer Price Index P[10] as a combination of prices of tradable and non-tradable consumption good.

$$P_t = \left[(1-\gamma)(P_t^T)^{1-\theta} + \gamma(P_t^N)^{1-\theta}\right]^{\frac{1}{1-\theta}} \tag{5.5}$$

5.2.2 Firms

5.2.2.1 Production Technology

The tradable *sec*tor is assumed to have a homogenous stochastic endowment of the tradable good, Y^T, with existence of Purchasing Power Parity (PPP) holding good and expressed as

$$P^T = eP^{T,*} \tag{5.6}$$

where $P^{T,*}$ is the price of the trade good in the foreign country.

On the contrary, in the non-tradable sector, each firm produces goods which are differentiated across varieties $j \in [0, 1]$ and is produced using labour as the only factor of production.The firms adopt a production technology,

[10] The Composite Price is derived using the expenditure minimising behaviour of households.

$$Y_t^i(j) = L_t^{\alpha_N}(j) \qquad \forall j \in [0,1]\ \alpha_N \tag{5.7}$$

$$= (0,1]$$

where $Y_t^i(j)$ is the quantity of output produced by firm i, $L_t(j)$ are labour hours hired for production of j varieties and $\alpha_N \in (0, 1]$ is the labour share parameter. Each firm j faces a downward sloping demand given by:

$$Y_t^N(j) = \left[\frac{P_t^N(j)}{P_t^N}\right]^{\varepsilon} Y_t^N \tag{5.8}$$

where $P^N(j)$ is the price of variety j and Y^N is the aggregate production of the non-tradable sector.

5.2.2.2 Pricing Strategy

It is assumed in this model that the firms resort to *Calvo* Pricing technique. In any given period, only a fraction of firms is allowed to adjust their prices. The rest of the firms continue with their existing prices. At any given time, the firms either choose prices optimally with probability *(1-s)* or update according to past inflation data π_{t-1}, and the inflation target, $\bar{\pi}$:

$$\bar{\pi}_t = \pi_{t-1}^{\rho} \bar{\pi}^{(1-\rho)} \tag{5.9}$$

The optimisation problem solved by the firms when choosing prices is to maximise profit function (*V)*,

Max V=

$$E_t \sum_{\tau=0}^{\infty} (\beta s)^{\tau} \Lambda_{t,t+\tau} \left[\frac{\left(P_t^N(i)\right)^{1-\varepsilon}}{(P_{t+\tau}^N)^{-\varepsilon_j}}\right] Y_{t+\Lambda}^N - P_t^N(i)^{\frac{-\varepsilon}{1-\alpha_N}} W_{t+\tau} \left(\frac{y_{t+\tau}^N}{(P_{t+\tau}^N)^{-\varepsilon}}\right)^{\frac{1}{1-\alpha_N}}$$

$$\prod_{S=1}^{\tau} [(\pi_{t+s-1})^{-\rho} \bar{\pi}^{1-p}]^{-\frac{\varepsilon}{1-\alpha_N}} \tag{5.10}$$

where Λ is the stochastic discount factor. Defining $p_t^{N,*}$ as the real optimal price of the non- tradable good, chosen by the firms, the First Order Condition (FOC) equation can be recursively expressed in the form,

$$U_t^N = \frac{\epsilon - 1}{\epsilon}(p_t^{N,*})^{1-\varepsilon}C_t^N + \beta s E_t\left(\frac{p_t^{N,*}}{p_{t+1}^{N,*}}.\frac{\pi_{t-1}^{\rho}\overline{\pi}^{(1-\rho)}}{\pi_{t+1}^N}\right)^{1-\varepsilon}\frac{\lambda_{t+1}}{\lambda_t}\frac{\pi_{t+1}^N}{\pi_{t+1}}U_{t+1}^N \tag{5.11}$$

$$U_t^N = \frac{1}{\alpha}(p_t^{N,*})^{\frac{-\varepsilon}{\alpha}}\frac{w_t}{p_t^{N,}}(C_t^N)^{\frac{1}{\alpha_N}} + \beta s E_t\left(\frac{p_t^{N,*}}{p_{t+1}^{N,*}}.\frac{\pi_{t-1}^{\rho}\overline{\pi}^{(1-\rho)}}{\pi_{t+1}^N}\right)^{\frac{1-\varepsilon}{\alpha}}\frac{\lambda_{t+1}}{\lambda_t}\frac{\pi_{t+1}^N}{\pi_{t+1}}U_{t+1}^N \tag{5.12}$$

5.2.3 The Monetary Policy

The Central Bank adopts a Taylor rule where the interest rate is determined by the divergence between actual and targeted inflation rates, actual and potential GDP and some exogenous monetary policy shock (e_t^m) . This is expressed as:

$$\left(\frac{R_t}{\overline{R}}\right) = \left(\frac{\pi_t}{\overline{\pi}}\right)^{\alpha_\pi}\left(\frac{GDP_t}{\overline{GDP}}\right)^{\alpha_y}\exp(e_t^m) \tag{5.13}$$

Here the values of the variables without the time subscripts are the steady state values of interest rateR_t, actual inflation π_t and actual gross domestic product GDP_t respectively andα_π, α_y are non-negative constants. The specific impact of each factor on the interest rate is determined by coefficients that reflect the Central Bank's policy objectives and the prevailing economic scenario. The Taylor Rule dictates that when inflation and growth targets exceed expectations, the policy rate is increased. Conversely, if these targets fall short, the policy rate is decreased.

5.2.4 *The external sector*

The price of the tradable goods P_t^{T*} , the external interest rate R_t^* and the foreign inflation rate π_t^* are determined abroad and are assumed to be exogenous to the system. We close this model with an interest parity condition.

$$R_t^* = R_t^w + \phi_B \left[\exp \left(\bar{b} - \frac{B_t^*}{P_t^{T*}} \right) - 1 \right] \tag{5.14}$$

where R_t^w is the exogenous world interest rate and ϕ_B and $\bar{b}$ are parameters. Hence the foreign interest rate is determined by the world interest rate and the country premium obtained due to deviation from the UIP[11] condition.

5.2.5 The Shocks and Calibration

In this model, we incorporate four significant disturbances:

a) uncertain tradable endowment Y^T shock,

b) shock to monetary policy represented as e_t^m

c) shock to global interest rate R_t^w

d) shock to foreign inflation π_t^* .

Each of these shocks denoted as 'sk' is governed by an autoregressive process of order one (AR (I)) with the $u_t^{sk} \sim iid\ (0, \sigma_{sk})$.

$$log\left(\frac{sk_t}{sk}\right) = \rho_{sk} log\left(\frac{sk_{t-1}}{sk}\right) + u_t^{sk} \tag{5.15}$$

[11] It states that the difference in interest rates between two countries should be equal to the expected change in the exchange rate between their currencies

For the simulation purpose we calibrate the parameters of the model to represent the Indian context. The exact descriptions of the parameters and their calibrated values have been summarized in Table 1.

Table 5.1 Description of Calibration Parameters

Parameters	Values	Description	Source
β	0.9823	Discount Factor	Levine et.al. (2012)
σ	1.99	Risk Aversion	Levine et.al. (2012)
φ	3	Inverse of Frisch Elasticity	Anand and Prasad(2010)
θ	1.5	Elasticity of substitution between C^T and C^N	Batini (2010)
γ	0.46	Share of C^N in Consumption	Basu and Das (2015)
α_N	0.34	Labour share in non-traded sector	Economic survey (2017)
ϵ	0.97	Elasticity of substitution between non tradables varieties	Goldar(2014)
s	0.75	Calvo probability	Patra and Kapur (2012)
ρ	0	Index to past inflation	Patra and Kapur (2012)
α_π	1.1	Taylor rule coeff of π	Patra and Kapur (2012)
α_y	0.4	Taylor rule coeff of GDP	Patra and Kapur (2012)
φ_B	0.233	Debt elastic interest rate	Schmitt-Grohe and Uribe(2017)
$\overline{\pi}$	0.04	Inflation target	RBI
P^T	1	Relative price of tradables	Normalisation
L	0.56	Hours worked	0.56
S^{TB}	0.42	Measure of openness(Trade/GDP)	Patra and Kapur (2012)

5.3. The Results

The initial sub-part focuses on how individual shocks influence main endogenous variables in the model. The subsequent subpart examines how each of the four shocks impacts the dynamics of conditional exchange rate pass-through.

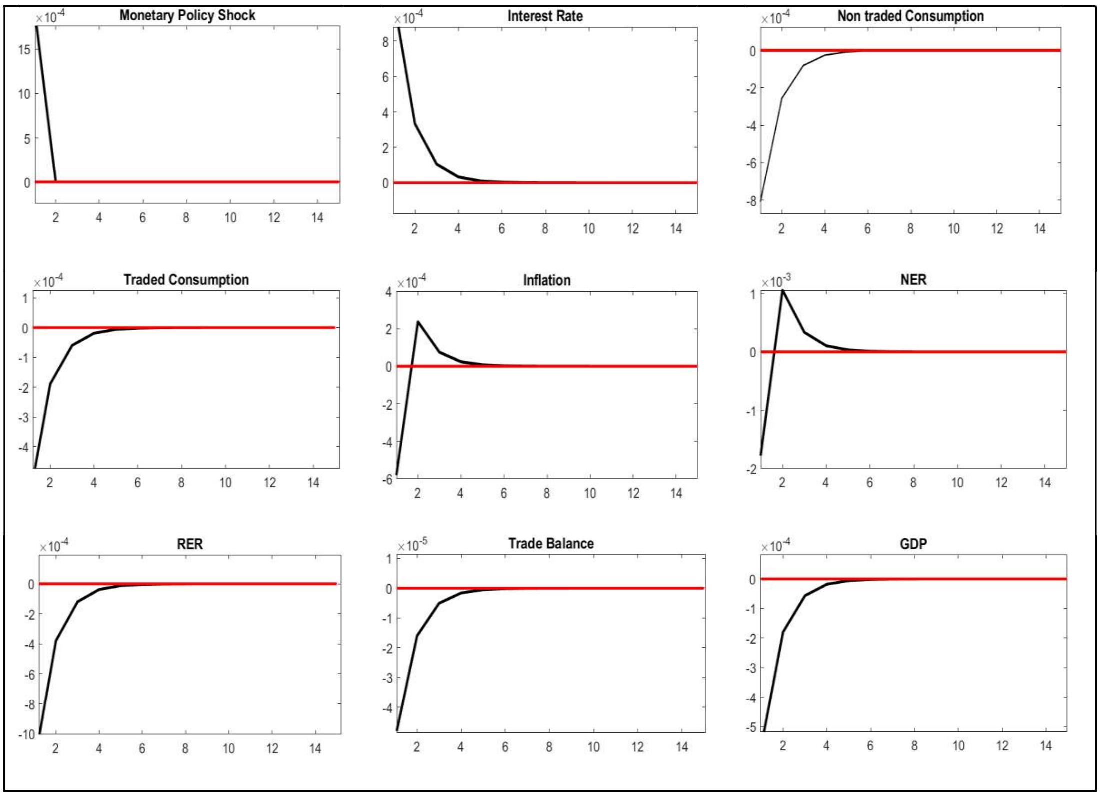
5.3.1 Impulse Response Analysis

5.3.1.1 Impact of Monetary Policy Shock

An upward shift in the Taylor rule results in a decrease in the nominal interest rate, prompting a shift towards current consumption preference. From in Figure 5.1

showing the impulse responses, it can be seen that the demand for both tradable and non-tradable goods increases, consequently driving up the general price level and giving rise to g inflationary tendencies. As a result of nominal and real depreciation, the trade balance experiences improvement, ultimately contributing to a potential increase in GDP.

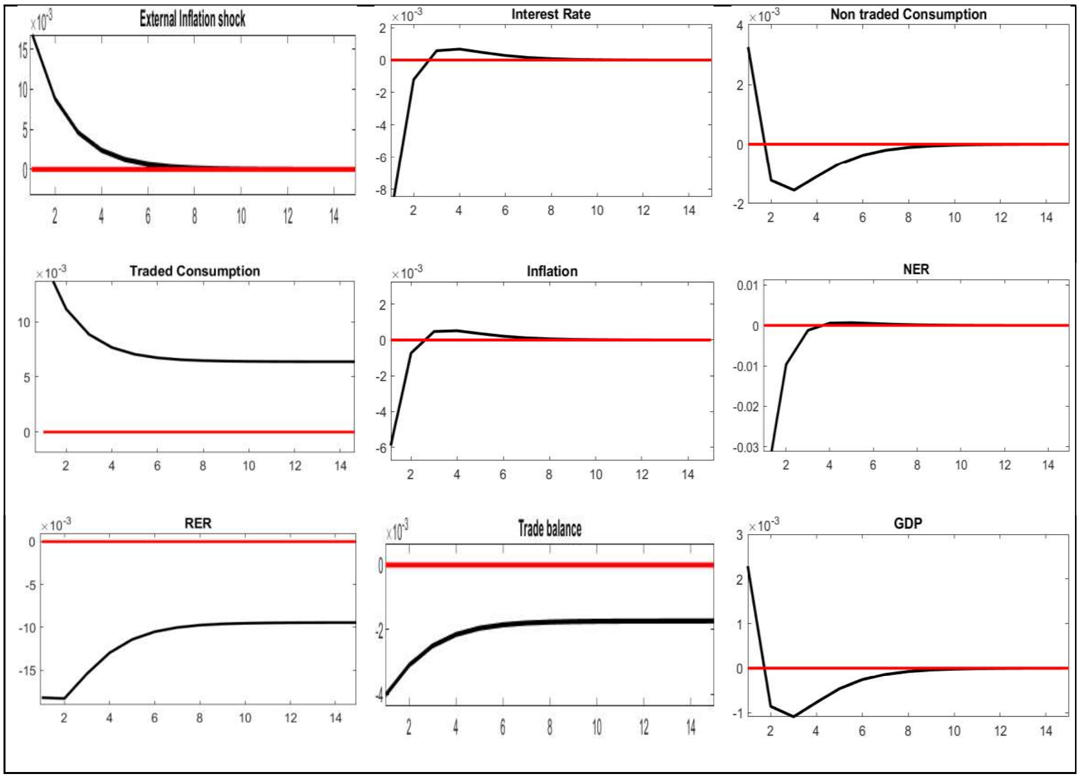
Figure 5.1: Monetary Policy Shocks: Impulse Response



5.3.1.2 Impact of Foreign Inflation shock

A positive external inflation rate shock generates a favorable impact on income. As in this model,it is assumed that foreign bonds are denominated in US dollars. The decline in foreign inflation magnifies the value of debt payments when assessed in real terms. This, in turn, reduces aggregate demand within the economy, resulting in a reduction in the desire for both tradable and non-tradable goods,thereby leading to a decline in GDP (See Figure 5.2) , an escalation in unemployment and reduction of inflation.

Figure 5.2: External Inflation Shocks: Impulse Responses

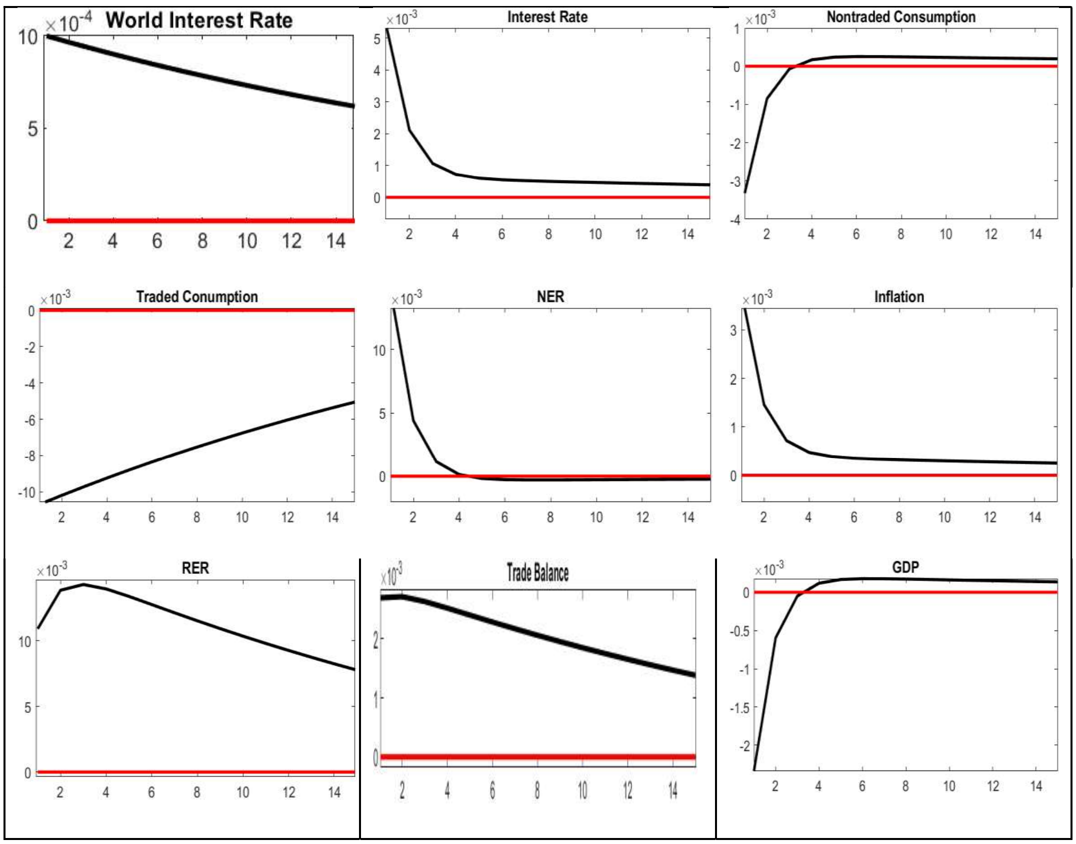


For restoring equilibrium in the non-tradable sector, the absolute price of non-tradable goods experiences a increase. This triggers both nominal and real depreciations in exchange rates, contributing to a increase in inflation. Further, this shock also raises the domestic prices of tradable goods, thereby partially or fully offsetting the impacts of observed decline in inflation earlier.

5.3.1.3 Impact of World Interest Rate Shock

The impact of a rise in the world interest rate shifts the intertemporal consumption in favour of the future leading to increased savings in the present period. This leads to an excess supply of labour and emergence of unemployment emerges. The relative price of non-tradable goods decreases leading to depreciation of the real exchange rates. As prices are sticky in the new Keynesian framework, the nominal exchange rate also depreciates. However, since a negative income effect is created due to rise in world interest rate, a reduction in demand in the non-traded sector emerges. Hence the equilibrium impact on consumption is ambiguous.

Figure 5.3: World Interest Rate Shocks: Impulse Response



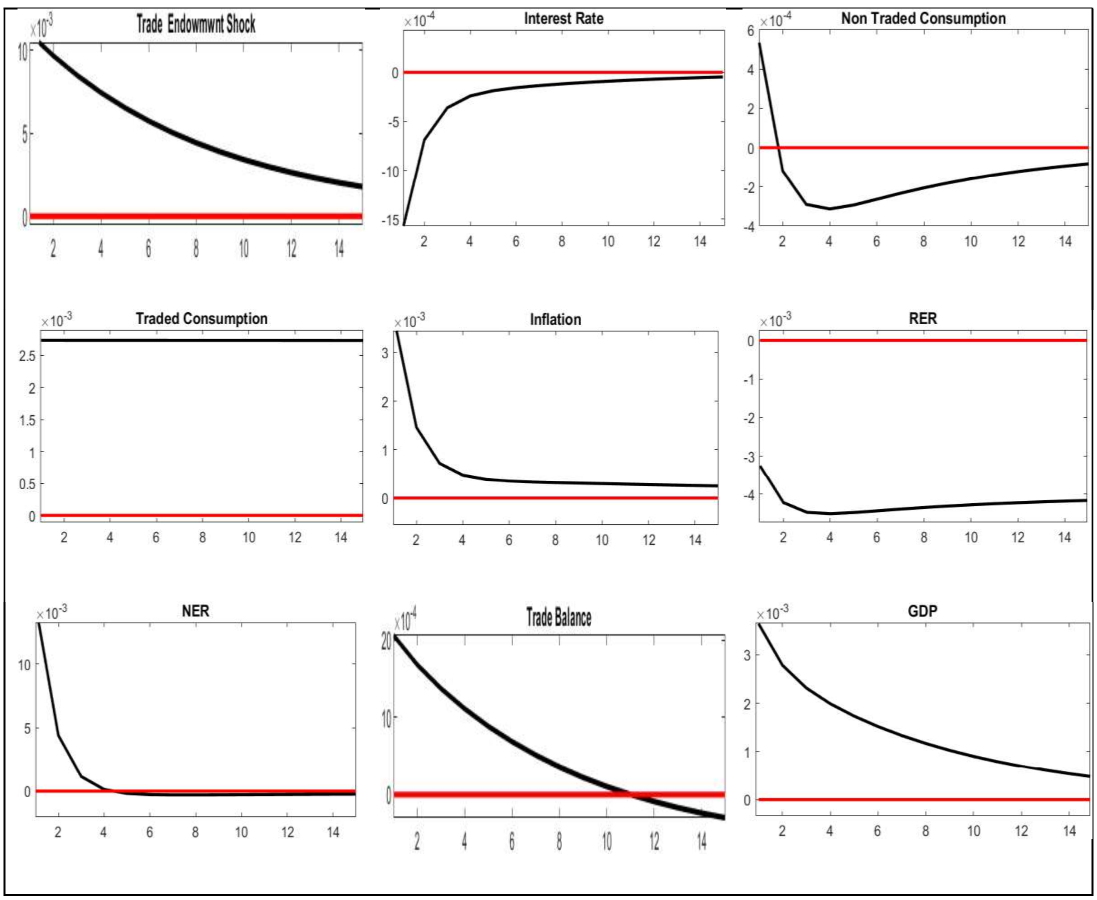
5.3.1.4 Impact of trade endowment shock:

A shock to the trade endowment[12] produces an adverse income effect. This effect works to decrease the aggregate demand, subsequently leading to a reduction in the present-period consumption of both tradable and non-tradable goods. Consequently,

[12] Decline in the resources available to produce the goods for export

this brings about a decline in the absolute price of both traded and non-traded goods, thereby contributing to a further reduction in the relative price when assessed in real terms. As a result, the real exchange rate appreciates. Simultaneously, the nominal exchange rate experiences an appreciation, which results in making imports comparatively less expensive. Hence, this appreciation adversely affects the trade balance, leading to a deterioration in GDP and stimulating tendencies towards inflation.

Figure 5.4: Impulse Response Function to trade endowment shock



On the whole, the four shocks demonstrate that an upward Taylor rule shift lowers nominal interest rates, boosting demand and inflation while improving trade balance and GDP. A positive foreign inflation shock reduces real debt burden, dampening demand, GDP, and inflation, though exchange rate depreciation later raises prices.

Rising world interest rates shift consumption to the future, causing unemployment, depreciation, and ambiguous consumption effects. Trade endowment shocks reduce demand, appreciate exchange rates, worsen trade balance, depress GDP, and trigger inflationary pressures

5.3.2. Conditional Exchange Rate Pass-through (CERPT)

In this section, we delve into the calculation of Conditional Exchange Rate Pass-Through (CERPT) based on the Impulse Response Functions (IRFs) derived from the previous subsection.

Figure 5.5: Conditional ERPTs

Trade Endowment Shock

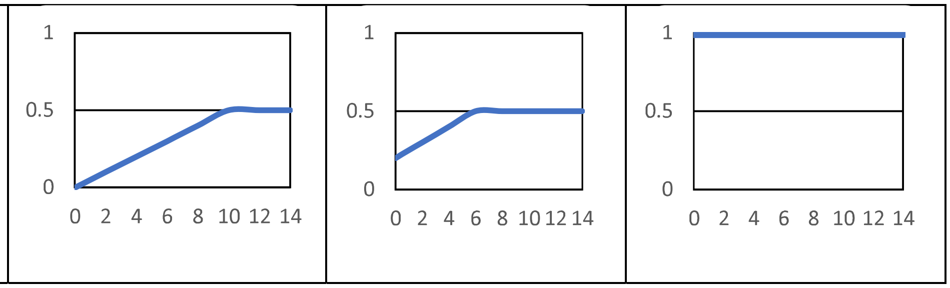


Figure 5.5 illustrates how the CERPTs distinctly vary across the four shocks within the economy. To begin with, it is evident that the CERPTs for tradable goods consistently surpass those for non-tradable goods, primarily because the former are not restricted by price rigidities. Furthermore, the CERPTs for tradable prices are notably high, signifying a nearly complete Exchange Rate Pass-Through (ERPT). On the contrary, this is not the case for the foreign inflation shock, which doesn't necessitate a complete ERPT for any domestic price at any time horizon.

The CERPT for tradable goods following a foreign inflation shock begins around 0.55 in the initial period and gradually declines. This trajectory emerges due to the fact that external inflation experiences a more significant decrease compared to nominal depreciation, and tradable inflation stems from the interaction of these two factors. The response of non-tradable goods is also more pronounced in the face of shocks to the world interest rate, tradable endowment, and monetary policy, compared to a foreign-inflation shock. While in the long run, these CERPTs have to converge to unity. In the short term, near unity ERPT is achieved only in response to the monetary shock. In contrast, reacting to changes in the foreign interest rate and tradable endowment, ERPT gradually increases over time, whereas the response remains less dynamic for a foreign inflation shock. Nonetheless, the pass-through effect remains incomplete to prices of non-tradable goods.

As anticipated, the CERPT for the Consumer Price Index (CPI) falls between those for tradable and non-tradable goods. The most substantial CERPT is witnessed in response to the monetary shock, followed by the tradable endowment and foreign interest rate shocks. Conversely, the smallest CERPT results from a foreign inflation shock. Beyond differences in magnitude, the temporal evolution also varies. It is pertinent to comprehend the comparative significance of each shock in elucidating fluctuations in NER. As presented in Table A5.2 (see appendix), fluctuations in foreign inflation and the foreign interest rate take precedence as the primary drivers of NER fluctuations.

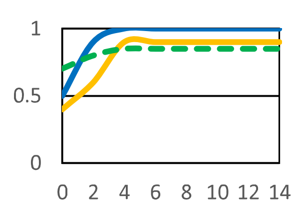
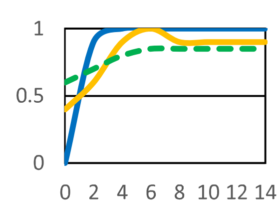
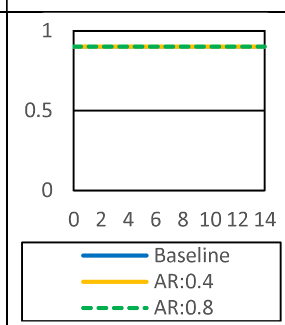
5.4. Monetary Policy

The manner in which a central bank makes choices on interest rates, targeting inflation, employing communication strategies, and implementing unconventional policies can collectively mould the process through which alterations in exchange rates affect domestic prices. The central bank's selection to raise or lower interest rates can wield a substantial influence on Exchange Rate Pass-Through (ERPT). An escalation in interest rates could draw foreign investment, prompting an increase in the value of the domestic currency (Grenville, 2023). In instances where a central bank effectively establishes stability in inflation and firmly anchors inflation expectations, it could potentially alleviate the transmission of exchange rate fluctuations into changes in domestic prices (Mendonca and Tiberto, 2017). Gali (2020) suggests that offering transparent information regarding forward shifts in interest rates and the economic landscape holds the potential to shape the anticipations of investors, consequently affecting exchange rates. Proficient forward guidance could potentially modify how exchange rate adjustments are transmitted into changes in prices. Similarly, the central bank's involvement in quantitative easing, for example, has the potential to prompt a devaluation of the currency, potentially heightening the pass-through impact on domestic prices. In this sub-section, the importance of monetary policy is explored in determining the extent of CERPT.

5.4.1 The Intensity of shocks

Additionally, CERPTs in response to a monetary policy shock under scenarios of different intensity of shocks are explored. In the baseline scenario, it is assumed that the shocks are independent and identically distributed (i.i.d.), and then this subsection consider autocorrelated shocks with coefficients of 0.4 and 0.8. The impulse responses focus solely on the CERPTs following the monetary shock, as the other shocks remain unaffected by this shock. It can be observed from Figure 5.6 that the Exchange Rate Pass-Through (ERPT) for non-tradable goods and the overall Consumer Price Index (CPI) demonstrate significant changes with more persistent shocks. In contrast, the ERPT for tradable goods remains unchanged.

Figure 5.6: Conditional ERPTs: Intensity of monetary policy shocks

	Composite Price	Non Traded Price	Traded Good Price
Monetary policy Shock			

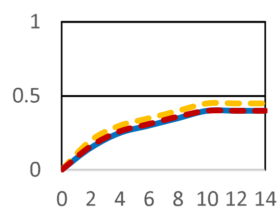
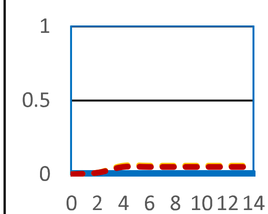
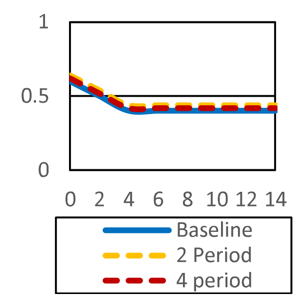
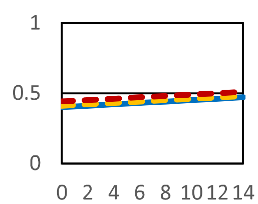
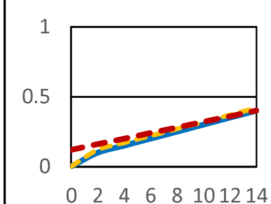
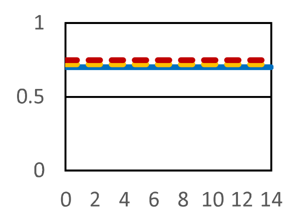
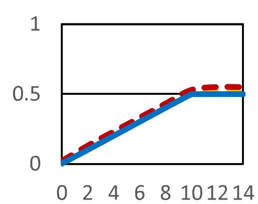
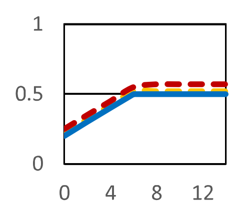
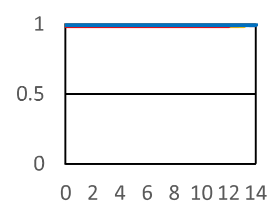
Upon closer observation, as the autocorrelation coefficient increases, the CERPTs exhibit amplified fluctuations in the short term and converge toward one over a long period of time. This phenomenon can be explained by two primary factors. First, a higher autocorrelation translates to more pronounced shifts in the entire impulse response curve, causing non tradable consumption and inflation to experience more substantial increases. Although this also leads to a more considerable depreciation, the impact is comparatively small than the additional effect on inflation, which shows an initial magnified CERPT. Second, greater persistence in policy adjustments extends the time it takes for the depreciation rate to return to its steady-state value, thereby contributing to a prolonged and more enduring CERPT pattern.

5.4.2 Administration of Interest Rates

This analysis involves a comparison of CERPTs under different policy scenarios. It juxtaposes the baseline approach, where the interest rate is consistently set according to the Taylor rule, with alternative strategies wherein the central bank, upon the impact of the shock, opts to maintain a fixed interest rate for a specific number of periods before reverting to the Taylor rule. Specifically, two durations of fixed rates are examined: 2 and 4 periods. This simulation mirrors a plausible real-world situation wherein the central bank refrains from immediate response to an observed depreciation, potentially on account of an assumption of low pass-through.

Initially, the ramifications of these alternative policy paths on Exchange Rate Pass-Through (ERPT) are not apparent, as the decision to fix the interest rate (which can be seen as a comparatively more accommodative policy than the baseline) leads to simultaneous increments in both inflation and the Nominal Exchange Rate (NER). As a result, the effect on the ratio that is computed in the ERPT remains uncertain. Figure 5.7 displays the diverse effects of these alternative policy paths, contingent on the nature of the shock. In the context of a changes in foreign inflation, if the interest rate is held steady for 2 periods, CERPTs tend to be higher compared to scenarios where the interest rate adheres to the Taylor rule. Conversely, when the interest rate is maintained for 4 periods, CERPTs turn out to be lower in comparison to the other two cases. Conversely, when a global interest rate shock is considered, the impact of different policy paths appears more substantial and displays a consistent trend.

Figure 5.7: Conditional ERPTs after fixing interest rates

Shocks	Composite Price	Non Traded Price	Traded Good Price
External Inflation			
World Interest			
Trade Endowment			

For instance, focusing on the composite price the outcome of a 10% depreciation triggered by changes in foreign inflation from 1.4% to 1.6% and 1.2% when the rate is fixed for 2 and 4 periods, respectively. Similarly, if the depreciation stems from a global interest rate shock, the projected shift would alter from 3.4% to 3.8% and 4.2% under the same fixed-rate durations.

In essence, the analysis underscores the intricate interplay between policy choices, shocks, and their subsequent impacts on ERPTs. The outcomes demonstrate nuanced dynamics that emerge in response to divergent policy paths within a complex economic context.

5.5. Currency Specific Invoicing

One of the explanations for the phenomenon of incomplete Exchange Rate Pass-Through (ERPT) is linked to the currency in which tradable goods are invoiced. When the currency of invoice matches the domestic currency (for instance, a US company invoicing exports in US dollars), fluctuations in exchange rates have a direct impact on the prices of imported goods. If the domestic currency appreciates, the cost of imports in local currency terms decreases, leading to reduced prices for imported products. Conversely, when the domestic currency depreciates, the cost of imports in local currency terms rises, which could potentially result in higher prices for imported goods. In this scenario, ERPT tends to be higher because exchange rate changes directly translate into adjustments in import prices.

However, if the currency of invoice differs from the domestic currency (for example, a US company invoicing its exports in euros), changes in exchange rates might not be immediately passed on to import prices. Importers could absorb some of the exchange rate fluctuations in order to maintain stable local prices. This practice can lead to a lower degree of ERPT, as the complete impact of exchange rate fluctuations isn't immediately mirrored in import price changes.

The currency of invoice hence plays a pivotal role in determining the extent of ERPT. When the currency of invoice aligns with the domestic currency, ERPT is typically more pronounced. Conversely, when the currencies differ, ERPT might be weaker due to market dynamics and pricing strategies.

Given the existing evidence that suggests tradables are invoiced in a handful of major currencies (as indicated by Friberg, 1998; Coresetti et al., 2001;Devereux et al., 2004; Bacchetta & van Wincoop, 2005; Engel, 2006; Gopinath, Itskhoki & Rigobon, 2010; Amiti, Itskhoki & Konings, 2018; Gopinath et al., 2020; Bahaj & Reis, 2020; Egorov & Mukhin, 2023), this study also aims to investigate the Dominant Currency Paradigm (DCP) compared to Local Currency Pricing (LCP) and Producer Currency Pricing strategies (PCP) in relation to Indian tradable goods.

In the original baseline model, there is no choice of currency for invoicing tradable goods. We have assumed perfect competition and also adhere to the presumption that the law of one price holds. Following the approach of Cicco and Schmidt (2020), we modify the baseline model as outlined below:

5.5.1 Model

Let the exportable bundle $C_t^{T,F}$, invoiced in foreign currency, demanded at time t be denoted as,

$$C_t^{T,F} = \left(\frac{P_t^{T,F,F}}{P_t^{T,*}}\right)^{-\varsigma*} C^{row} \tag{5.16}$$

where $P_t^{T,F,F}$ is price of the exported good, which is invoiced in foreign currency and is being purchased in the foreign country at time and C^{row} is the consumption level in rest of the world. $P_t^{T,*}$ denotes the international price of the good.

Equation 5.16 illustrates that the demand for exports is inversely correlated with the dollar-denominated price of the export relative to the global price of the standardized good. In a similar manner, the demand for total imports in domestic currency is formulated as a function of the price of the goods, which are invoiced in domestic currency and are sold in the home country.

$$C_t^{T,H} = (1-\gamma)\left(\frac{P_t^{T,H,H}}{P_t}\right)^{-\varsigma*} C_t \tag{5.17}$$

Every consumption combination $C_t^{T,d}$ for d = {H, F} is differentiated across varieties and then combined using Dixit-Stiglitz aggregation methods,

$$C_t^{T,d} = \left[\int_0^1 \left(C_t^{T,d}(j)\right)^{\frac{\epsilon_d - 1}{\varepsilon_d}} dj\right]^{\frac{\varepsilon_d}{\epsilon_d - 1}} \tag{5.18}$$

leading to,

$$C_t^{T,d}(j) = \left(\frac{P_t^{T,d,c}(j)}{P_t^{T,d,c}}\right)^{-\varepsilon_d} C_t^{T,d} \tag{5.19}$$

Moreover, it is posited that there exists a continuum of monopolists distributed in [0.1], who function under linear technology and acquire a uniform tradable commodity. These monopolists have the option to either utilize their trade endowment or resort to importing as a means of financing. Both groups of monopolists produce differentiated goods and implement Calvo-style pricing strategies in order to determine the pricing of their commodities. Subsequently, these goods are procured by two separate monopolistically competitive aggregators operating within the tradable sector. One of these aggregators caters to the domestic market, while the other engages in foreign sales. Various iterations of pricing strategies can emerge based on the advantageous selection of currency by these monopolists.

Let ${P_t^T}^{d,c}$ be the price of the tradable in time t be solid at a destination d in the currency of the country c (where both d and c can be Home, H or foreign, F.). Each of the monopolistically competitive firm chooses ${P_t^T}^{d,c}$ to maximize the following Lagrangian

$$E_t \sum_{\tau=0}^{\infty} (\beta s_d)^{\tau} \Lambda_{t,t+\tau}^{c} \, {P_t^T}^{d,c} \, C_{t+\tau}^{T,d} \left[\frac{\left({P_t^T}^{d,c}(i) \right)^{1-\varepsilon_d}}{\left({P_{t+\tau}^T}^{d,c} \right)^{1-\varepsilon_d}} \right] \left[\prod_{S=1}^{\tau} \left(\pi_{t+s}^{d,c} \right) \right]^{1-\varepsilon_d}$$

$$- \left[\prod_{S=1}^{\tau} \left(\pi_{t+s}^{d,c} \right) \right]^{1-\varepsilon_d} \frac{MC_{t+\tau}^{c}}{{P_{t+\tau}^T}^{d,c}} \qquad (5.20)$$

where $\Lambda_{t,t+\tau}^{c}$ is the stochastic discount factor for currency c such that $\Lambda_{t,t+\tau}^{H} \frac{e_{t+\tau}}{e_t} = \Lambda_{t,t+\tau}^{F}$ and $MC_t^H = e_t P_t^{T*}$ and $MC_t^F = P_t^{T*}$ being the marginal cost in the domestic and foreign currency respectively.

As can be seen from the Lagrangian in equation 5.20, all the firms choose to set the price at $\bar{P}_t^{T,d,c}$ in time t. The optimality conditions can be recursively expressed as,

$$O_t^{T,d,c} = \left(\frac{\bar{P}_t^{T,d,c}}{P_t^{T,d,c}} \right)^{1-\varepsilon_d} \left(\frac{\varepsilon_d - 1}{\varepsilon_d} \right) C_t^{T,d}$$

$$+ \beta s E_t \left\{ \Lambda_{t,t+1}^{c} \left(\frac{\bar{P}_t^{T,d,c}}{\bar{P}_{t+1}^{T,d,c}} \right)^{1-\varepsilon_d} \left(\pi_{t+1}^{d,c} \right)^{1-\varepsilon_d} \pi_{t+1}^{T,d,c} O_{t+1}^{T,d,c} \right\} \qquad (5.21)$$

$$O_t^{T,d,c} = \left(\frac{\bar{P}_t^{T,d,c}}{P_t^{T,d,c}}\right)^{-\varepsilon_d}\left(\frac{MC_t^c}{P_t^{T,d,c}}\right)C_t^{T,d} + \beta s_d E_t\left\{\Lambda_{t,t+1}^c\left(\frac{\bar{P}_t^{T,d,c}}{\bar{P}_{t+1}^{T,d,c}}\right)^{-\varepsilon_d}\left(\pi_{t+1}^{d,c}\right)^{-\varepsilon_d}\pi_{t+1}^{T,d,c}O_{t+1}^{T,d,c}\right\} \tag{5.22}$$

In real terms

$$O_t^{T,d,c} = \left(\bar{p}_t^{T,d,c}\right)^{1-\varepsilon_d}\left(\frac{\varepsilon_d - 1}{\varepsilon_d}\right)C_t^{T,d} + \beta s_d E_t\left\{\Lambda_{t,t+1}^c\left(\frac{\bar{p}_t^{T,d,c}}{\bar{p}_{t+1}^{T,d,c}}.\frac{1}{\pi_{t+1}^{T,d,c}}\right)^{1-\varepsilon_d}\left(\pi_{t+1}^{d,c}\right)^{1-\varepsilon_d}\pi_{t+1}^{T,d,c}O_{t+1}^{T,d,c}\right\} \tag{5.23}$$

$$O_t^{T,d,c} = \left(\bar{p}_t^{T,d,c}\right)^{-\varepsilon_d}\left(\frac{MC_t^c}{P_t^{T,d,c}}\right)C_t^{T,d} + \beta s_d E_t\left\{\Lambda_{t,t+1}^c\left(\frac{\bar{p}_t^{T,d,c}}{\bar{p}_{t+1}^{T,d,c}}.\frac{1}{\pi_{t+1}^{T,d,c}}\right)^{-\varepsilon_d}\left(\pi_{t+1}^{d,c}\right)^{-\varepsilon_d}\pi_{t+1}^{T,d,c}O_{t+1}^{T,d,c}\right\} \tag{5.24}$$

The different alternative pricing strategies in this context can be:

- Local Currency Pricing (LCP) holds when we choose the sticky prices ${P_t^T}^{F,F}$ and ${P_t^T}^{H,H}$ while ${P_t^T}^{F,H} = e_t {P_t^T}^{F,F}$ and ${P_t^T}^{H,F} = \frac{{P_t^T}^{H,H}}{e_t}$
- Producer Currency Pricing (PCP) holds when we choose the sticky prices ${P_t^T}^{F,H}$ and ${P_t^T}^{H,H}$ while ${P_t^T}^{F,F} = \frac{{P_t^T}^{F,H}}{e_t}$ and ${P_t^T}^{H,F} = \frac{{P_t^T}^{H,H}}{e_t}$
- Dominant Currency Pricing (DCP) Holds when we choose the sticky prices ${P_t^T}^{F,F}$ and ${P_t^T}^{H,F}$ while ${P_t^T}^{F,H} = e_t {P_t^T}^{F,F}$ and ${P_t^T}^{H,H} = e_t {P_t^T}^{H,F}$

The relationship between real price of the tradable good $\bar{p}_t^{T,d,c}$ and the inflation level $\pi_t^{T,d,c}$ can be summarized using

$$(1-\theta_d)\left(\bar{p}_t^{T,d,c}\right)^{1-\varepsilon_d} + \theta_d\left(\frac{\pi_t^{d,c}}{\pi_t^{T,d,c}}\right) = 1 \tag{5.25}$$

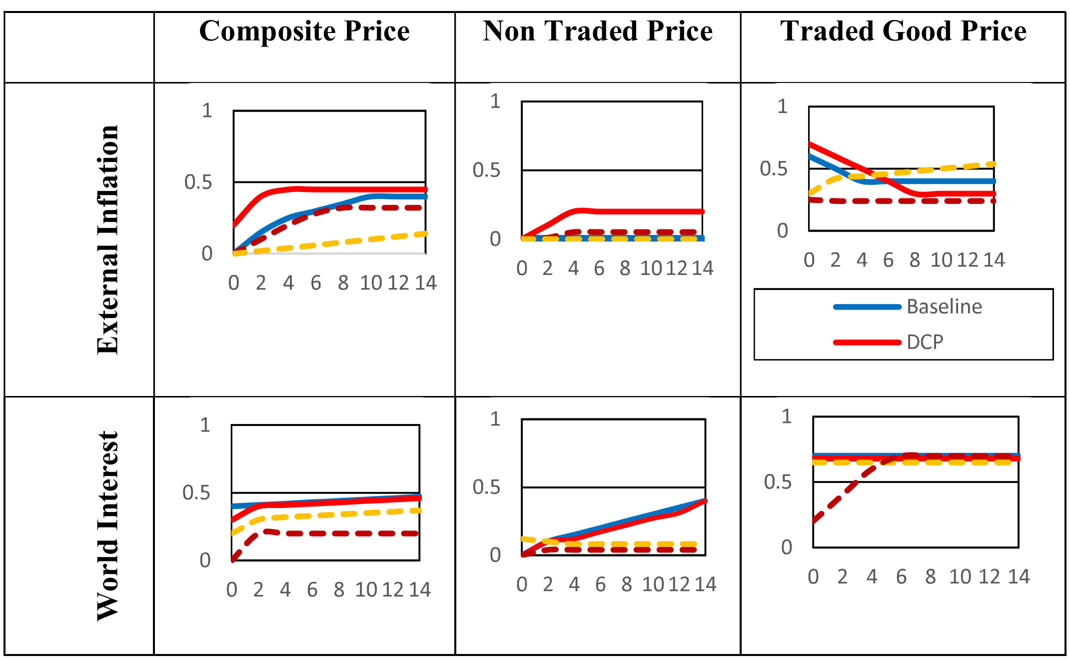
Given that sum of demand factors of production for all the monopolist should sum to the amount of tradable endowment and total imports

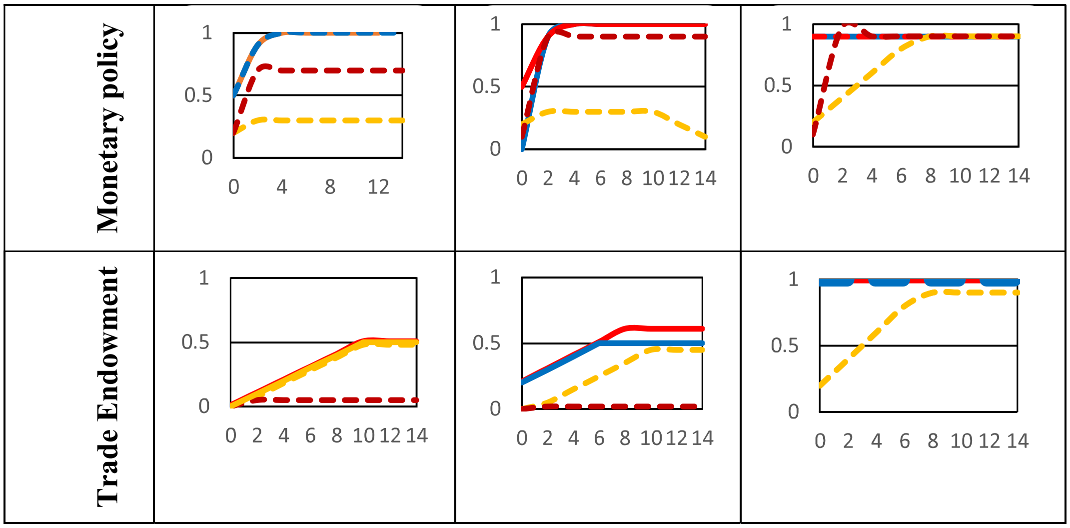
$$\int_0^1 \left[\left(\frac{P_t^{T,H,c}(j)}{P_t^{T,H,c}}\right)^{-\varepsilon_H} C_t^{T,H} + \left(\frac{P_t^{T,F,c}(j)}{P_t^{T,F,c}}\right)^{-\varepsilon_F} C_t^{T,F}\right] dj = Y_t^T + M_t \tag{5.26}$$

5.5.2 The Impulse Response Analysis

From the IRF's generated for the modified model it can be said that when the monopolist resort to PCP, ERPT is lower for non tradables than that for tradables. This impact is similar under the influence of all the four shocks used in the model.

Figure 5.8: Conditional ERPTs for different currency specific invoicing





The dynamics within these scenarios rely on how the domestic terms of trade develop over time. In the baseline and DCP (Scenario 1), the relationship between certain economic indicators remains unaffected by changes in the Nominal Exchange Rate (NER). In the case of LCP (Scenario 2), when there's a nominal depreciation of the currency, the terms of trade improve due to a relatively rigid denominator while the numerator is more responsive. Conversely, in the PCP scenario (Scenario 3), the opposite effect occurs.

Figure 5.8 illustrates the Conditional Exchange Rate Pass Through (CERPTs) for the four alternative models. Notably, the baseline and DCP models have nearly indistinguishable CERPTs when subjected to an external interest rate shock. Discrepancies arise post-shock in external inflation due to the DCP model's characteristic of elastic exports in response to changes in the Price Threshold (PT)*. The LCP alternative presents smaller CERPTs for tradable goods, primarily because their local currency prices remain inflexible. For nontradable goods, a nominal depreciation enhances the domestic terms of trade, leading to reduced demand contraction and a lesser impact on Domestic Price Level (PN).

Under PCP, CERPTs for tradables are also diminished compared to the baseline. However, the depreciation-induced decline in the domestic terms of trade leads to a decrease in consumption and inflation for non-tradable goods, resulting in lower CERPTs. Importantly, regardless of how tradable goods are priced, CERPTs exhibit substantial differences. Some of these differences are even more pronounced in certain scenarios.

To summarize, although exchange rate pass-through is incomplete in most cases, it closely resembles the baseline in the DCP scenario, followed by the PCP scenario, and is least similar under the LCP scenario. Interestingly, the pass-through under the PCP scenario is lower than under the LCP scenario, particularly when influenced by a monetary policy shock.

5.6. Summary of Findings

This chapter integrates the concepts of Exchange Rate Pass-Through (ERPT), monetary policy, and considerations related to the currency of invoicing within the framework of a New Keynesian Dynamic Stochastic General Equilibrium (DSGE) model. When subjected to monetary policy or world interest shocks, inflation increases, leading to subsequent nominal and real depreciation that enhance trade balance and increase potential GDP growth. Conversely, positive external inflation or trade endowment shocks result in lowered GDP growth, deflation, and heightened unemployment. The conditional ERPT consistently shows that ERPT for tradable goods exceeds that for non-tradable goods due to fewer constraints on prices for the former category. Specifically, CERPT for tradable goods indicates almost complete ERPT for monetary shocks, but incomplete ERPT for foreign inflation shocks.

The CERPT for the Consumer Price Index (CPI) falls between tradable and non-tradable goods, with monetary shocks having the highest impact and foreign inflation shocks having the lowest impact. In terms of the intensity of monetary policy shocks, persistent shocks induce significant changes in ERPT for non-tradable goods and the CPI, while ERPT for tradable goods remains constant. Increasing autocorrelation coefficients amplify short-term CERPT fluctuations and extend the convergence of ERPT to one. Regarding the administration of interest rates for specific periods, uncertain effects on ERPT are observed, with shorter fixed-rate periods increasing CERPT and longer periods reducing it.

Additionally, the study examines the influence of Currency-Specific Invoicing, highlighting how the currency choice for invoicing tradable goods affects ERPT. ERPT is generally incomplete, and it closely resembles the baseline in the Dominant Currency Paradigm (DCP) scenario, followed by the Producer Currency Pricing (PCP) scenario, and differs most from the Local Currency Pricing (LCP) scenario. Interestingly, the pass-through under the PCP scenario is lower than under the LCP scenario, particularly when influenced by a monetary policy shock.

Table A5.1: The first order conditions of the baseline model

$C_t^{-\sigma} = \lambda_t$	(EQ.1)
$\eta(L_t)^{\varphi} = \lambda_t w_t$	(EQ.2)
$\lambda_t = \beta E_t\left[\frac{\lambda_{t+1} R_t{}^{*} \pi_t^{e}}{\pi_{t+1}}\right]$	(EQ.3)
$\lambda_t = \beta E_t\left[\frac{\lambda_{t+1} R_t}{\pi_{t+1}}\right]$	(EQ.4)
$C_t^N = \gamma(p_t^N)^{-\theta} C_t$	(EQ.5)
$C_t^T = (1-\gamma)(rer_t)^{-\theta} C_t$	(EQ.6)
$(1-\gamma)(rer_t)^{1-\theta} + \gamma(p_t^N)^{-\theta} = 1$	(EQ.7)
$U_t^N = \frac{\epsilon - 1}{\epsilon}(p_t^{N,*})^{1-\varepsilon} C_t^N + \beta s E_t \left(\frac{p_t^{N,*}}{p_{t+1}^{N,*}} . \frac{\pi_{t-1}^{\rho} \bar{\pi}^{(1-\rho)}}{\pi_{t+1}^N}\right)^{1-\varepsilon} \frac{\lambda_{t+1}}{\lambda_t} \frac{\pi_{t+1}^N}{\pi_{t+1}} U_{t+1}^N$	(EQ.8)
$U_t^N = \frac{1}{\alpha}(p_t^{N,*})^{\frac{-\varepsilon}{\alpha}} \frac{w_t}{p_t^{N,}} (C_t^N)^{\frac{1}{\alpha}} + \beta s E_t \left(\frac{p_t^{N,*}}{p_{t+1}^{N,*}} . \frac{\pi_{t-1}^{\rho} \bar{\pi}^{(1-\rho)}}{\pi_{t+1}^N}\right)^{\frac{1-\varepsilon}{\alpha}} \frac{\lambda_{t+1}}{\lambda_t} \frac{\pi_{t+1}^N}{\pi_{t+1}} U_{t+1}^N$	(EQ.9)
$\pi_t^N = \frac{p_t^N}{p_{t-1}^N} \pi_t$	(EQ.10)
$\pi_t^T = \frac{rer_t}{rer_{t-1}} \pi_t$	(EQ.11)
$(1-s)(p_t^{N,*})^{1-\varepsilon} + s[\pi_{t-1}^{\rho} \bar{\pi}^{(1-\rho)}]^{1-\varepsilon} \left(\frac{1}{\pi_t^N}\right) = 1$	(EQ.12)
$\left(\frac{R_t}{\bar{R}}\right) = \left(\frac{\pi_t}{\bar{\pi}}\right)^{\alpha\pi} \left(\frac{GDP_t}{\overline{GDP}}\right)^{\alpha_y} \exp(e_t^m)$	(EQ.13)
$\frac{rer_t}{rer_{t-1}} = \frac{\pi_t^e \pi_t^*}{\pi_t}$	(EQ.14)
$R_t^* = R_t^w + \phi_B\left[e^{\hat{b} - b_t^*} - 1\right]$	(EQ.15)
$C_t^N = \Delta_t^{-\alpha} L_t^{\alpha}$	(EQ.16)

$$(1-s)(p_t^{N,*})^{\frac{-\varepsilon}{\alpha}} + s[\frac{\pi_{t-1}^{\rho}\bar{\pi}^{(1-\rho)}}{\pi_t^N}]^{\frac{-\varepsilon}{\alpha}}\Delta_{t-1} = 1$$	(EQ.17)
$$TB_t = rer_t(Y^T - C_t^T)$$	(EQ.18)
$$rer_t.b_t^* = TB_t + \frac{rer_t}{\pi_t^*}R_{t-1}^*b_{t-1}^*$$	(EQ.19)
$$GDP_t = C_t + Y^T - C_t^T$$	(EQ.20)
$$p_t^Y.GDP_t = C_t + TB_t$$	(EQ.21)

Table A5.2: The Variance Decomposition

Variables	Foreign inflation shock	Monetary policy shock	World interest shock	Trade endowment shock
NER	87.33	0.21	11.26	1.19
Inflation	66.65	0.59	28.25	4.51
Interest Rate	68.21	0.88	28.39	2.52
Non traded Consumption	52.97	2.36	41.84	2.84
Non traded price	63.43	0	24.97	11.59
Traded consumption	63.43	0	24.98	11.59
Traded price	70.61	0.48	26.14	2.77
RER	63.43	0	24.97	11.59
GDP	13.87	0.62	10.96	74.55
Trade Balance	63.43	0	24.98	11.59
Shocks				
Trade endowment shock	0	0	0	100
Foreign inflation shock	100	0	0	0
Monetary policy shock	0	100	0	0
World interest shock	0	0	100	0

Table A5.3: Theoretical moments of select endogenous variables

VARIABLE	MEAN	STD. DEV.	VARIANCE
NER	0.0074	0.0460	0.0021
Inflation	0.0074	0.0082	0.0001
Interest rate	0.0385	0.0119	0.0001
Non traded consumption	-0.5199	0.0056	0
Non traded price	0	0.2857	0.0816
Traded consumption	-1.5658	0.5495	0.3019
Traded good price	0.0074	0.0302	0.0009
RER	0	0.8132	0.6613
GDP	-0.1675	0.0076	0.0001
Trade Balance	0.0423	0.1492	0.0223
Foreign inflation shock	0	0.0199	0.0004
Monetary policy shock	0	0.0020	0
World interest shock	0.0311	0.0039	0
Trade endowment shock	-1.3815	0.0230	0.0005

CHAPTER 6

CONCLUSION

6.1 Summary of major Findings:

This study is a collection of essays on represents an in-depth and multi-dimensional exploration of Exchange Rate Pass-Through (ERPT) in the Indian context, utilizing empirical, theoretical, and policy-oriented approaches to examine the nature, extent, determinants, and implications of ERPT across multiple domains. Spanning a four-decade period, this research captures the evolution of India's external sector behaviour amidst globalization, trade growth diversification, and deepening of participation in Global Value Chains (GVCs), inflation targeting. The global empirical evidence confirms that ERPT is lower and declining in advanced economies with strong monetary anchors, but higher and more volatile in emerging markets. Indian studies, though fewer in number, similarly show incomplete pass-through, but they suffer from limitations such as focus only on imports, reliance on aggregate data, and lack of exploration of asymmetry, heterogeneity, and inflation expectations. These gaps define the contribution of the present study, which integrates disaggregated customs-level data, surveys on inflation expectations, and a New Keynesian DSGE framework into a unified analysis of ERPT in India.

The objectives of the thesis are fourfold. First, it aims to measure the magnitude and dynamics of ERPT into India's import and export prices, distinguishing between short-run and long-run effects while testing for asymmetry between appreciation and depreciation. Second, it seeks to analyse heterogeneity in ERPT across products, partner countries, and sectors, with attention to pricing-to-market behaviour, invoicing practices, and GVC integration. Third, it explores the link between ERPT and inflation expectations in the context of India's inflation-targeting framework, identifying nonlinear and asymmetric patterns in how households form expectations in response to exchange rate shocks. Fourth, it embeds ERPT into a New Keynesian DSGE model to study structural transmission mechanisms and policy-relevant dynamics.

The findings, drawn from advanced econometric modelling such as the Autoregressive Distributed Lag (ARDL) approach and a New Keynesian Dynamic Stochastic General Equilibrium (DSGE) framework, provide a granular and policy-relevant understanding of how currency movements affect domestic prices, trade competitiveness, inflation expectations, and macroeconomic stability. The study relies on diverse data sources and methods tailored to each objective. Aggregate time-series data are analysed through Auto Regressive Distributed Lag (ARDL) models, Non Linear Auto Regressive Distributed Lag (N-ARDL) and Error Correction Models (ECM) to capture short-run and long-run ERPT into import and export prices. Highly disaggregated product-level and partner-level customs data form the basis for static three dimensional panel regressions that identify heterogeneity and pricing-to-market strategies. Household survey data on inflation expectations are used to assess the impact of ERPT on expectation formation, while a structural New Keynesian DSGE model calibrated to Indian data provides insight into the dynamic interplay between exchange rate shocks, inflation, and policy

At the core of this study is the empirical finding that India exhibits a low and incomplete pass-through of exchange rate changes to both export and import prices, with significant differences in magnitude and adjustment dynamics. Specifically, the exchange rate pass-through to export prices is approximately 23%, while it is about 45% for import prices which are significant at a 1% level. These figures indicate that while currency depreciation theoretically improves trade balances by making exports cheaper and imports costlier, the actual impact is muted. A key reason is that both exporters and importers absorb exchange rate shocks instead of fully transmitting them to end consumers, indicating a strategic price-setting behaviour in response to global competition, contractual rigidities, and cost absorption.Importantly, the short-run ERPT is weaker than the long-run, implying that firms gradually adjust to currency changes, perhaps on account of contractual commitments or market expectations. The error correction mechanism highlights a significant shift from short-term disequilibrium to long-run equilibrium, reinforcing the time-dependent nature of ERPT in India. This dynamics has critical implications for policy responses aimed at immediate trade correction or inflation control via exchange rate adjustments.

The study also reveals a distinct asymmetry in ERPT, with pass-through effects being stronger during currency appreciation than during depreciation. This is crucial because policymakers often consider depreciation as a tool to stimulate exports and correct current account deficits. However, if depreciation does not lead to proportionate changes in prices, then the intended effects on trade competitiveness may not materialize. Instead, firms might reduce their markups or absorb costs to retain market share, leading to limited gains in export volumes and trade balances.

Furthermore, exchange rate pass-through is highly heterogeneous across countries and product categories, a point that emerges prominently in essay 3. Among the 25 countries studied, emerging economies like Bangladesh, Sri Lanka, and Indonesia display relatively higher ERPT compared to industrialized nations such as the United States, Germany, Japan, and China. This divergence is rooted in differences in market structure, macroeconomic stability, monetary credibility, and the depth of integration into GVCs.Indian exporters are found to adopt a "pricing-to-market" strategy, adjusting their export prices based on the demand elasticity, competition intensity, and local market conditions of the destination country. This means that exporters use pricing discretion to protect market share rather than passively respond to currency changes, which again contributes to incomplete ERPT. In highly concentrated and competitive markets, Indian firms are likely to maintain their prices by compressing margins, especially when facing weak competition or operating in segments with differentiated products. This behaviour aligns with the negative signs of the Lerner and Hufbauer indices noted in the analysis, reflecting how market power and product differentiation insulate prices from currency shocks.

One of the most significant findings is the role of Global Value Chains (GVCs) in moderating ERPT. As Indian firms increasingly integrate into GVCs, particularly in sectors such as textiles, electronics, and pharmaceuticals, the production process becomes more fragmented across borders. Intermediate goods cross borders multiple times, with value addition occurring in several countries before the final product reaches the market. This dilutes the direct impact of exchange rate movements on the final export price because cost changes get dispersed throughout the value chain. Moreover, GVC integration promotes price stability and leads to greater use of foreign currency invoicing, particularly in dominant currencies like the USD or EUR, which further weakens the transmission of exchange rate changes.

Essay 4 contributes a intriguing dimension by linking ERPT to inflation expectations, a variable increasingly central to the conduct of inflation-targeting regimes. In the Indian context, inflation expectations are found to be strongly influenced by ERPT, alongside other macroeconomic determinants such as oil prices, money supply, GDP growth, fiscal stance, and unemployment. The econometric analysis reveals a non-linear and an asymmetric relationship between the Real Effective Exchange Rate (REER) and inflation expectations, with real depreciation exerting an upward, albeit smaller impact on inflation expectations than the downward impact of appreciation.

This has profound implications for monetary policy credibility and transmission. In an inflation-targeting regime, the central bank's effectiveness hinges on the anchoring of expectations. If ERPT distorts this anchoring through asymmetric responses, it complicates policy signalling and forecasting. Furthermore, the study shows that past inflation significantly affects future expectations, suggesting that price stability is essential to maintain low and stable expectations. The interaction between ERPT and inflation expectations thus forms a feedback loop that policymakers must manage delicately.

Essay 5 deepens the analysis by embedding ERPT within a New Keynesian DSGE model. This approach introduces monetary policy shocks, world interest rate changes, trade endowment shocks, and inflation shocks into a theoretically consistent structure, offering insights into how ERPT interacts with broader macroeconomic variables. The findings based on impulse response functions reveal that ERPT is stronger for tradable goods than non-tradable goods, owing to the relative price rigidity of the latter. Tradable goods are more exposed to global competition and market forces, making them more susceptible to currency fluctuations.

Moreover, monetary policy shocks lead to near-complete ERPT for tradable goods, while ERPT in response to foreign inflation shocks remains incomplete. This underscores the role of domestic monetary policy as a more effective transmission mechanism for exchange rate effects compared to external shocks. Interestingly, the Consumer Price Index (CPI) shows an intermediate level of ERPT, reflecting the composite nature of the index that includes both tradable and non-tradable goods. This layered structure of ERPT has crucial implications for inflation targeting and central bank communication strategies.

The study also explores the effect of currency invoicing practices on ERPT, comparing the Dominant Currency Paradigm (DCP), Producer Currency Pricing (PCP), and Local Currency Pricing (LCP). The findings suggest that ERPT is most aligned with the DCP scenario, followed by PCP, and least with LCP. Contrary to conventional theory, the PCP model exhibits lower pass-through than LCP under monetary shocks, highlighting that invoicing in producer currency does not always amplify ERPT, especially when firms engage in long-term contracts or operate in GVCs where intermediate pricing is pre-determined. These nuanced results suggest that currency choice in invoicing can shape the extent of ERPT to a large extent, and thus has implications for trade policy, exchange rate regimes, and monetary autonomy.

From a broader perspective, this research demonstrates that ERPT is not a purely mechanical or symmetric transmission of exchange rate changes into prices. Rather, it is shaped by firm-level pricing strategies, industry characteristics, macroeconomic institutions, and the global economic integration. The pass-through is conditional—varying across time, sectors, and contexts. For emerging market economy like India, which is increasingly exposed to global trade and capital flows while pursuing domestic macroeconomic goals such as inflation targeting, employment generation, and export promotion, understanding the contours of ERPT is of strategic importance.

This study also contributes to a growing body of evidence that developing economies, especially emerging market economies including India, face structural challenges in managing ERPT. These include underdeveloped financial markets, low trade invoicing in domestic currency, and limited monetary autonomy on account of external debt and capital account pressures. In such contexts, policy trade-offs become sharper: for example, between exchange rate stability and inflation control, or between export competitiveness and imported inflation. Recognizing these trade-offs, the findings point to the importance of policy coordination—between the central bank, fiscal authorities, and trade policymakers—to navigate the complexities of ERPT effectively.

6.2 Implications for Policy

The findings of this study on Exchange Rate Pass-Through (ERPT) in India yield several important implications for policy. These prescriptions are organized around three broad axes: exchange rate management and trade policy, monetary policy and inflation targeting, and structural and institutional reforms aimed at enhancing ERPT effectiveness and price stability in a globalized setting.

1. Exchange Rate and Trade Policy Recalibration

Given the asymmetric and incomplete ERPT, especially the muted impact of depreciation on export prices, policymakers must recalibrate the strategic use of exchange rate devaluation as a tool for export promotion. Exchange rate interventions should be aligned with the recognition that depreciation may not significantly improve export volumes due to pricing-to-market behaviour, limited invoicing in domestic currency, and GVC integration. As such:

- Depreciation can not be used in isolation. It must be supported by supply-side policies that enhance price competitiveness, such as improving logistics, easing input tariffs, and subsidizing technology adoption.
- Export diversification—geographically and across products—can mitigate the impact of asymmetric ERPT and shield Indian exporters from demand and price shocks in specific markets.

- The government and RBI should encourage greater invoicing of trade in Indian Rupees, especially in transactions with neighbouring or strategically aligned countries. Expanding rupee-based settlements can amplify ERPT and enhance monetary policy autonomy.

2. Monetary Policy and Inflation Targeting Framework

In the context of inflation targeting (IT), the study finds that ERPT plays a critical role in shaping inflation expectations—an essential anchor of IT regimes. This interaction necessitates a more nuanced approach:

- The RBI needs to integrate ERPT diagnostics and REER movements more explicitly into its inflation modelling and forward guidance, especially in light of asymmetric effects during currency appreciation and depreciation.
- Greater transparency in exchange rate interventions and their intended macroeconomic objectives can reduce policy uncertainty and anchor expectations.
- The communication strategy of the RBI has to clearly delineate the sources of inflation—whether from external shocks, currency volatility, or domestic supply constraints—so as to manage public expectations more effectively.

3. Structural and Institutional Reforms

Structural features such as market concentration, invoicing practices, and GVC participation are central to the ERPT process. To strengthen ERPT transmission and its alignment with macroeconomic goals:

- Support for MSMEs and mid-sized exporters is vital to reduce market concentration and increase price responsiveness. Access to hedging tools and currency risk management should be enhanced through financial literacy programs and simplified derivative instruments.

- Promotion of local content and backward integration in production can reduce dependence on imported intermediates and thus mitigate the inflationary effects of depreciation.
- Given the lower ERPT for non-tradable goods, urban reforms and deregulation of key services (housing, utilities, logistics) can improve pass-through and reduce the persistence of inflation in non-tradables.
- Labour market flexibility and contract reform can ensure that firms respond more efficiently to external shocks, thereby improving long-run macroeconomic adjustment.

In conclusion, managing ERPT is not solely a currency or monetary policy issue. It intersects with structural competitiveness, trade strategy, invoicing systems, and expectations management. A whole-of-government approach, anchored in macroprudential foresight, is essential for India to enhance the effectiveness of exchange rate adjustments and sustain growth especially in an uncertain global environment.

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