Exchange Rate Pass-Through: A Comparative Analysis of VAR and Input-Output Model Approaches

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June 06, 2023

1. Introduction

Understanding the relationship between exchange rates and various sectors of the economy is a pressing research question in the era of globalization. Variations in exchange rates impact the competitiveness of goods in international markets and the cost of imported inputs. These factors, in turn, influence different sectors of an economy in multifaceted ways. Hence, a comprehensive analysis of exchange rate sensitivities of sectors becomes indispensable for both policy makers and economists. As Choudhri and Hakura (2006) point out, a low ERPT makes it easier for policymakers to implement independent monetary policy, ensuring an effective inflation target.

The investigation into the dynamics of exchange rates has been a prominent field of study for years. Interest in pass-through began in the 1960s and early 1970s, when open-economy monetary models assumed absolute (and sometimes relative) purchasing power parity, and became the macroeconomic cousin of the single-good price law. A natural question that arose from these models was, “Do purchasing power parity or pricing laws apply to the data?” Numerous tests were carried out on different products and countries. There was little evidence to support this assumption.

Empirical studies indicate that changes in nominal exchange rates are not fully reflected in commodity prices. In fact, consumer prices appear to be largely insensitive to changes in nominal exchange rates. A consequence of this finding is that the “spending shift effect” due to changes in exchange rates can be very small. In other words, changes in the nominal exchange rate may not result in significant substitution between domestically produced goods and foreign-produced goods, as the relative prices of these commodities for final consumers will remain almost unchanged. A consequence of this finding is that the "spending shift effect" due to changes in exchange rates can be very small. In other words, changes in the nominal exchange rate may not result in significant substitution between domestically produced goods and foreign-produced goods, as the relative prices of these commodities for final consumers will remain almost unchanged. As we delve into our analysis, it is essential to acknowledge various factors that can contribute to incomplete pass-through, deviating from the assumption of a one-price law. Market pricing, local currency pricing, cross-border production, the process of international globalization, and the role of non-traded domestic inputs in the distribution chains of tradeable commodities are among the factors that can explain imperfect pass-through.

Various methodologies and models have been deployed to show the size and the magnitude of the exchange rate pass through. Traditional Vector Auto Regression (VAR) approaches, for instance, have been a cornerstone in understanding the multifarious impacts of exchange rate movements. This framework allows for fundamental dynamic interrelationships between prices and other variables of interest at various stages of distribution. Additionally, it allows to track the dynamic reaction of prices to external shocks. In the basic VAR model, the identification is done by Cholesky decomposition.

However, while the VAR approach offers useful insights, it also comes with its own set of limitations. One such limitation is that the VAR approach often assumes that the relationships between variables are linear and that these relationships remain constant over time. This assumption, however, might not hold in real-world scenarios, particularly in emerging economies and developing countries where economic structures can change rapidly. Additionally, VAR models typically consider aggregate data, which can mask considerable sectoral heterogeneities. Given these shortcomings of traditional VAR approaches, there is a growing impetus to employ alternative methodologies that offer a more nuanced understanding of the relationship between exchange rates and different sectors.

In light of these factors, it becomes evident that the limitations of VAR models in capturing the intricacies of exchange rate pass-through have prompted the exploration of alternative methodologies. This paper adopts an Input-Output (IO) model to offer a more nuanced understanding of the relationship between exchange rates and various sectors. The IO model provides a detailed depiction of the interdependencies among different industries within an economy, capturing the flow of goods and services among sectors. This sector-specific approach offers deeper insights into the sensitivities of different sectors to exchange rate movements, addressing a key limitation of the VAR approach. By adopting an IO model, researchers can disentangle the intricate web of interactions among sectors and gain a more granular understanding of how exchange rate fluctuations affect specific sectors.

The goal of this paper, therefore, is to move beyond the aggregate analysis provided by traditional VAR models and instead focus on a sector-specific approach utilizing the IO model. By doing so, we aim to enhance our understanding of the complex relationship between exchange rates and sectors and provide more accurate and detailed insights for policymakers and economists. Recognizing the pivotal role that exchange rates play in shaping the economic trajectory of countries, we believe that understanding the sector-specific sensitivities to exchange rate fluctuations can help policymakers formulate strategies to mitigate exchange rate risks and maintain economic stability.

To achieve our objective, we conduct a comprehensive analysis of several sectors across multiple countries, which includes fragile countries like Turkey, South Africe, India, Indonesia, Brazil, and developed countries like USA, UK, Japan, Germany and France. The selected sectors encompass a wide array of industries, such as Agriculture, Mining, Computer, Electronics, Chemical products, Pharmaceuticals, and more. Our ambition is to quantify the extent to which a percentage increase in the exchange rate impacts consumer prices in these sectors. By focusing on a diverse set of countries and sectors, we aim to provide a comprehensive and robust understanding of the economic implications of exchange rate variations.

The subsequent sections of this paper are organized as follows: Section 2 reviews the existing literature on exchange rate pass-through (ERPT) and the methodologies employed in previous studies. This review provides a theoretical and empirical foundation for our research.

Section 3 describes the data used in the analysis and provides an overview of the selected countries and sectors. Section 4 and 5 presents the two approaches used in our analysis – the IO model and VAR models, and outlines their implementation. Section 6 discusses the results obtained from both models and compares the estimates derived from the two methodologies. Finally, Section 7 concludes the paper and offers insights for future research directions.

2. Literature

There are many studies that analyse the reasons for incomplete exchange rate pass through. One of the motivations for deviating from the one-price law is market pricing, as suggested by Krugman (1987) and Dornbusch (1987). To achieve imperfect pass-through in this framework, we usually assume an oligopoly market where firms can adjust their premiums to exchange rate shocks. In particular, pass-through is incomplete when the firm's premium declines as the price of the goods it sells rises.

Another framework is local currency pricing. Imagine that an export company fixes the price of its goods, which may or may not be fixed in the currency of the destination country. Most popular works in this approach are Devereux and Engel (2001) and Bacchetta and van Wincoop (2003). These papers endogenize firms' choice of accounting currency. The indicate that countries with less relative exchange rate volatility and stable monetary policies are more likely to choose their own currencies to settle transactions, and thus less likely to pass on import prices.

Another reason for incomplete pass-through is cross-border production. When production takes place in many countries and in multiple stages, the cost of producing the final product is multi-currency. This could explain the imperfect pass-through unless all these currencies collectively appreciate against the destination currency. For example, Aksoy and Riyanto (2000) and Hegji (2003) develop theoretical models in which increased use of cross-border production within the same firm may have led to reduced pass-through.

Gust, Leduc, and Vigfusson (2005) suggest that the process of international globalization itself may lead to reduced infections. In their model, lower trade costs increase the relative premium of exporting firms, which in turn reduces the sensitivity of prices to exchange rates and reduces pass-through. Burstein et al. (2003) instead underline the role of (non-traded) domestic inputs in the distribution chains of tradeable commodities. Burstein et al. (2005) emphasize the importance of the possible problem due to mismeasurement of CPI.

The most widely employed approach for assessing exchange rate pass-through is the VAR model introduced by McCarthy (1999). This model encompasses various key variables, including the nominal exchange rate, industrial production, import prices, oil prices, producer prices, and consumer prices. Gagnon and Ihrig (2004) argued that VAR models might be unsuitable for economies that have experienced significant macroeconomic instability, which could potentially disrupt the stability of relationships estimated within VAR models. Moreover, Towbin and Weber (2013) highlighted that VAR models might fail to adequately capture structural breaks and non-linearities that are characteristic of certain economies, thus leading to biased or inconsistent estimates of pass-through rates.

Various studies in the empirical literature have conducted analyses on different countries and time periods. McCarthy (1999) examined OECD countries using a recursive VAR framework and found that the impact of exchange rates on consumer prices is modest, with pass-through being correlated to the level of economic openness.

Ca'zorzi et al. (2007) focused on 12 emerging markets in Asia, Latin America, and Central and Eastern Europe to investigate exchange rate pass-through to prices. Their findings challenge the conventional belief that emerging countries always have higher pass-through compared to developed nations.

Ihrig et al. (2006) studied G-7 countries from the late 1970s and 1980s, revealing a decline in the responsiveness of consumer prices to exchange rate movements across almost all countries. The average pass-through in G-7 countries decreased from approximately 0.13 to zero.

Hahn (2003) specifically examined the Euro Area and observed that pass-through is most significant and rapid for non-oil import price shocks, followed by exchange rate shocks and oil price shocks. The size and speed of pass-through diminish along the distribution chain, and external shocks explain a substantial portion of the variance in price indices.

Jasova et al. (2016) investigated the dynamic impact of large exchange rate movements on CPI inflation after the global financial crisis across a wide range of economies. They analyzed more than 20 years of pass-through development for these economies and found that pass-through has been consistently low and stable in advanced economies while declining in emerging economies.

Taylor (2000) has notably proposed a hypothesis that asserts a positive relationship between price responsiveness and exchange rate fluctuations, which depends on inflation. According to this hypothesis, persistent inflation leads to a perception of less transitory exchange rate movements, prompting firms to make adjustments in prices. Additionally, the degree of a country's openness influences the transmission of exchange rate movements into CPI changes via import prices, a view supported by Ca'zorzi et al. (2007) and Devereux & Yetman (2002).

From a theoretical standpoint, another factor determining exchange rate pass-through is the level of trade openness in a country. McCarthy (1999) and Goldfajn and Werlang (2000) emphasize that higher levels of openness correspond to increased transmission of exchange rate movements into CPI changes through import prices.

In response to these limitations, an emerging body of literature is exploring alternative approaches to the VAR methodology. These include the use of detailed micro-level data (Gopinath and Itskhoki, 2010), non-linear models (Bussière, 2013), and models that integrate additional variables such as measures of economic slack or global commodity prices (Bruno and Shin, 2015).

The use of Input-Output (IO) models to estimate ERPT represents a relatively novel advancement in the literature. This approach emphasizes the direct and indirect impacts of exchange rate shifts on sectoral equilibrium prices, accounting for the production interdependencies and the utilization of imported goods and services in the production process. A crucial advantage of the IO approach is that it encapsulates the structure of the economy, thereby providing a more nuanced understanding of ERPT.

Despite the potential advantages of the IO model, its use in ERPT research is still limited. This paper seeks to address this gap, contributing to the ERPT literature by applying and contrasting the IO model with the traditional VAR methodology.

3. The Data

To assess the impact of exchange rate fluctuations on different sectors of the economy, we harness two main sources of data: the Input-Output (IO) tables from the Organization for Economic Cooperation and Development (OECD) and the Merchandise Trade Price Index (MTPI) from the United Nations COMTRADE database.

The IO tables provide a comprehensive snapshot of the sales and purchase relationships between different sectors of an economy. These tables capture both the interdependencies of various industries and the role that imported goods and services play in each industry's production process. For our analysis, we use the latest available IO tables from the OECD, which are for the year 2018.

To account for changes in the prices of imports, we use the MTPI from the UN COMTRADE database. This database provides information about trade values and quantities, which we use to compute the import prices for different sectors. The MTPI covers approximately 170 countries from 2011 to 2020 and provides indices for both exports and imports, broken down by 30 different products.

For the purposes of our analysis, we define unit values as the ratio of trade value to quantity. We then compute unit value indices at the HS 6-digit level by dividing these unit values by the unit values of the previous year. These unit value indices are subsequently aggregated across countries and commodities using the Laspeyres formula, which takes the form of a weighted average.

Given that our goal is to understand how changes in the exchange rate affect domestic prices, our analysis focuses on changes in the Laspeyres Price Index expressed in national currency and benchmarked to the aggregate implicit trade prices using national statistics.

For the VAR model, the analysis covers the period from January 2011 to December 2018 for five fragile countries and five developed economies. The crude oil price, which is an average of monthly prices in nominal US dollars of Brent, Dubai, and WTI, is obtained from World Bank Commodity Price Data. We use nominal effective exchange rates from the IFS database to capture the fluctuations in exchange rates. The industrial production data come from the OECD database. Producer and consumer price indices were obtained by IFS, except that the producer price index of Indonesia comes from Indonesia Bank due to lack of availability of the data. As the import price index, we used the commodity import price index from IMF Access to Macroeconomic &Financial Data. This index is gathered by weighting commodities by the ratio of imports to total commodity imports. Finally, the interest rate is the monetary policy-related interest rate from IFS.

4. The IO Model

The model is a cost-push IO price model used to calculate the pass-through effect. Assume an economy with n producing sectors and two basic inputs, namely labor (L) and capital (K, representing all other factors of production). Labor is paid wages and salaries (W) and capital earns the operational surplus (V).

$$p_j = \sum_{i=1}^{n} a_{ij} \cdot p_i + e \cdot \sum_{i=1}^{n} m_{ij} \cdot p_i^* + v_j \quad \text{for} \quad j = 1, \ldots, n$$

Where:

p_j is the price of the output j,

q_j is the quantity of output j,

q_{ij} is the domestic intermediate use of output i by sector j,

a_{ij} is the direct domestic input coefficient, given by $a_{ij} = \dfrac{p_i \cdot q_{ij}}{p_j \cdot q_j}$,

e is the nominal exchange rate (number of domestic currency per foreign currency),

p_i^* is the import price of output i in foreign currency,

p_i^f is the import price of output i in domestic currency, given by $p_i^f = e \cdot p_i^*$,

m_{ij} is the direct imported input coefficient, given by $m_{ij} = \dfrac{p_i \cdot M_{ij}}{p_j \cdot q_j}$,

M_{ij} is the imported intermediate use of output i by sector j,

w_j is the unit labor cost, given by $w_j = \dfrac{W_j}{p_j \cdot q_j}$ for sector j,

v_j is the unit operational surplus (capital costs), given by $v_j = \dfrac{V_j}{p_j \cdot q_j}$ for sector j,

W_j is the total labor costs for sector j,

V_j is the total operational surplus (capital costs) for sector j.

This equilibrium price system can be expressed in matrix form as:

$$\mathbf{p} = \mathbf{A}^T\mathbf{p} + \mathbf{M}^T\mathbf{p}^f + \mathbf{w} + \mathbf{v}. \tag{1}$$

$\mathbf{p}$ is the vector of the commodity prices,

$\mathbf{p}^f$ is the vector of import prices in domestic currency, where $\mathbf{p}^f = e\mathbf{p}^*$,

$\mathbf{p}^*$ is the vector of import prices in foreign currency,

$\mathbf{e}$ is the scalar nominal exchange rate,

$\mathbf{v}$ is the vector of unit operational surplus (unit capital costs),

$\mathbf{w}$ is the vector of unit labor costs,

$\mathbf{A}^T$ is the transpose of the direct domestic input coefficients matrix $\mathbf{A}$,

$\mathbf{M}^T$ is the transpose of the direct imported input coefficients matrix $\mathbf{M}$.

Solving the model:

$$\mathbf{p} = (\mathbf{I} - \mathbf{A}^T)^{-1}(\mathbf{M}^T\mathbf{p}^f + \mathbf{w} + \mathbf{v})$$

Taking total differentials:

$$\Delta\mathbf{p} = (\mathbf{I} - \mathbf{A}^T)(\mathbf{M}^T\Delta\mathbf{p}^f + \Delta\mathbf{w} + \Delta\mathbf{v})$$

Assuming that all the domestic and direct imported input coefficients, basic input costs are constant, the effect of a small change in the exchange rate on prices can be shown to be:

$$\Delta\mathbf{p} = (\mathbf{I} - \mathbf{A}^T)^{-1}(\mathbf{M}^T\mathbf{p}^*d\mathbf{e})$$

Dividing both sides gives the effect of the exchange rate on sectoral equilibrium prices as:

$$\frac{\partial \mathbf{p}}{\partial \mathbf{e}} = (\mathbf{I} - \mathbf{A}^T)^{-1}(\mathbf{M}^T \mathbf{p}^*)$$

where $\mathbf{i}$ is the unit column vector. In this model, comparative-static partial derivatives measure the effects on sectoral equilibrium prices of a small change in the nominal exchange rate.

After calculating the changes in the sectoral equilibrium prices, the change in the general price level, π, can be calculated as a weighted average of sectoral price changes.

$$\pi = \sum_{i=1}^{n} \alpha_i \left(\frac{\partial p_i}{\partial e} \right)$$

where α_i is the share of commodity i in the aggregate consumption expenditures.

5. VAR Models

We applied the three most popular VAR models in the literature to observe and compare the exchange rate pass-through effect across countries. Our purpose in using three different models is to observe possible different results since the identification of the VAR model and the ordering may affect the relationship between the variables.

The first model, shown by equations (1)-(6), is based on McCarthy (1999) and Hahn (2003). In consideration of the variables relevant to our analysis and their unit properties, the first model incorporates the following variables: Δoil_t is the first difference of the log of oil price, Δprod_t is the first difference of the log of industrial production, Δexc_t is the first difference of the exchange rate, π_t^{IPI} and π_t^{CPI} are inflation rates for import price and consumer price indices. Finally, $\Delta \text{interest}_t$ is the first difference of the interest rate. $E_{t-1}(.)$ is the expected value of the associated variable that relies on the information gathered at the conclusion of the preceding period. The expectations are built into the model using a linear projection of the lags of the variables in the system. It is presumed that structural shocks exhibit no serial correlation and are mutually independent across equations.

The most reasonable approach was to prioritize the arrangement of oil price changes, Δoil_t, as this suggests that shocks in oil prices can have a simultaneous impact on the reduced form residuals of all equations and, in turn, on all variables in the system. Additionally, these shocks, Δoil_t, are not contemporaneously influenced by any other external factors. Industrial production is ordered in advance of exchange rates that allow the exchange rate to react to demand shocks contemporaneously. The price variables are ordered by the distribution chain, such as from the import price index to the consumer price index. Interest rates are ultimately negotiated as monetary policy in response to fluctuations in exchange rates and prices in the economy.

$$\Delta\text{oil}_t = E_{t-1}(\Delta\text{oil}_t) + \epsilon_t^{\Delta\text{oil}_t} \tag{1}$$

$$\Delta\text{prod}_t = E_{t-1}(\Delta\text{prod}_t) + \alpha_1\epsilon_t^{\Delta\text{oil}_t} + \epsilon_t^{\Delta\text{prod}_t} \tag{2}$$

$$\Delta\text{exc}_t = E_{t-1}(\Delta\text{exc}_t) + \beta_1\epsilon_t^{\Delta\text{oil}_t} + \beta_2\epsilon_t^{\text{prod}_t} + \epsilon_t^{\Delta\text{exc}_t} \tag{3}$$

$$\pi_t^{\text{IPI}} = E_{t-1}(\pi_t^{\text{IPI}}) + \gamma_1\epsilon_t^{\Delta\text{oil}_t} + \gamma_2\epsilon_t^{\Delta\text{prod}_t} + \gamma_3\epsilon_t^{\Delta\text{exc}_t} + \epsilon_t^{\Delta\pi^{\text{IPI}_t}} \tag{4}$$

$$\pi_t^{\text{CPI}} = E_{t-1}(\pi_t^{\text{CPI}}) + \theta_1\epsilon_t^{\Delta\text{oil}_t} + \theta_2\epsilon_t^{\Delta\text{prod}_t} + \theta_3\epsilon_t^{\Delta\text{exc}_t} + \theta_4\epsilon_t^{\pi^{\text{IPI}_t}} + \epsilon_t^{\pi^{\text{CPI}_t}} \tag{5}$$

$$\Delta\text{interest}_t = E_{t-1}(\Delta\text{interest}_t) + \eta_1\epsilon_t^{\Delta\text{oil}_t} + \eta_2\epsilon_t^{\Delta\text{prod}_t} + \eta_3\epsilon_t^{\Delta\text{exc}_t} + \eta_4\epsilon_t^{\pi^{\text{IPI}_t}} + \eta_5\epsilon_t^{\pi^{\text{CPI}_t}} + \epsilon_t^{\Delta\text{interest}} \tag{6}$$

The second VAR model, unlike the first model, has an extra variable in the price chain. In this model, the changes in the producer price index were also taken into account, and the variables were listed as follows: changes in oil prices, industrial production, exchange rate, import prices, producer prices, consumer prices and interest rates. This ordering also makes sense since the changes in import prices contemporaneously affect producer prices which simultaneously impact consumer prices. In order not to repeat the same equations, only the final part of the second model is shown by equation (7) where $\epsilon_t^{\pi^{PPI_t}}$ is the producer price inflation. The ordering of the variables in this model is the order of the shocks in equation (7).

$$\pi_t^{\mathrm{CPI}} = E_{t-1}(\pi_t^{\mathrm{CPI}}) + \theta_1 \epsilon_t^{\Delta \mathrm{oil}_t} + \theta_2 \epsilon_t^{\Delta \mathrm{prod}_t} + \theta_3 \epsilon_t^{\Delta \mathrm{exc}_t} + \theta_4 \epsilon_t^{\pi^{\mathrm{IPI}_t}} + \theta_5 \epsilon_t^{\pi^{\mathrm{PPI}_t}} + \epsilon_t^{\pi^{\mathrm{CPI}_t}} \tag{7}$$

In the last VAR model, there is a distinct approach where the primary external shock consists of exchange rate fluctuations. The subsequent variables encompass the inflation rates of import prices, producer prices, and consumer prices. Just like we did in equation (7), equation (8) is written as to show only the determinants of CPI inflation.

$$\pi_t^{\mathrm{CPI}} = E_{t-1}(\pi_t^{\mathrm{CPI}}) + \theta_1 \epsilon_t^{\Delta \mathrm{exc}_t} + \theta_2 \epsilon_t^{\pi^{\mathrm{IPI}_t}} + \theta_3 \epsilon_t^{\pi^{\mathrm{PPI}_t}} + \epsilon_t^{\pi^{\mathrm{CPI}_t}} \tag{8}$$

Adding more lags to the model improves fitting performance, so it is important to choose an appropriate lag length for the models. Furthermore, limiting the lag length can lead to model misspecification. Several order selection criteria and LR tests of parameter reduction were utilized to determine the lag order of the VAR model. The Akaike Information Criterion (AIC), Hannan-Quinn (HQ), and Schwarz Criterion (SC) reported different lag values for different countries within each model. However, the number four was the most frequently observed lag across these countries. In order to maintain uniformity in the model across all countries, the VAR models were estimated with a constant and four lags. The LM test results also prove that the model has no autocorrelation problems. This means that a model specification with these lag lengths is sufficient to solve the autocorrelation problem. All inverse roots are less than 1 for model stability. White test results show that the models do not have the problem of heteroscedasticity.

6. Results

In this section, we compare the results of the Vector Autoregression (VAR) models with an Input-Output (IO) model to analyze the exchange rate pass-through effects in various countries. We examine the coefficients obtained from Model 1, Model 2, Model 3, and the IO model. We discuss the reasons behind the higher values observed in the IO model compared to the VAR models and provide country-specific dynamics as supporting evidence. Additionally, we compare the VAR models with each other to highlight any differences.

		VAR Model			I-O Model
		Model 1	Model 2	Model 3	
Fragile Countries:	Brazil	-0.061	-0.059	-0.068	0.125
	Indonesia	0.023	-0.036	0.034	0.147
	India	0.018	-0.060	-0.031	0.179
	Turkiye	0.382	0.370	0.264	0.220
	South Africa	-0.051	-0.048	-0.034	0.209
Developed Countries:	Germany	-0.135	-0.117	-0.131	0.198
	France	-0.101	-0.102	-0.122	0.209
	UK	-0.012	-0.008	-0.032	0.192
	USA	-0.013	-0.014	-0.036	0.096
	Japan	-0.009	0.009	-0.007	0.128

Figure 1: Comparative analysis of VAR and IO Models

The cumulative effects of exchange rate pass-through by VAR analyses are given by Figure 1. The results, which are consistent with the empirical literature, imply that the magnitude of exchange rate pass-through lasts for a maximum of 12 months. When we look at advanced economies, we have similar results across three models for France, Germany, UK and USA. While the aggregated impact of the exchange rate changes on CPI is about -10% for France and Germany, it is just about -1% for the USA and UK. However, model 2 imposes a different result from other VAR structures for Japan since it gives a positive value, whereas the others indicate negative ones. This differentiation among the models has crucial importance since the sign of the effect forces different monetary policies. Also, when we analyze the figure for France given in the Appendix, we see that the first two models follow a different pattern from model 3.

The results for fragile five countries have different implications from advanced economies. The results for Turkey are relatively similar to the ones from the IO table analysis since the cumulative effects are calculated as between 26% and 38%. On the other hand, it is remarkable enough that the findings give such different results in different model specifications. Indonesia and India have similar situations to Japan in terms of the emergence of different results regarding the sign of the cumulative effect. Again, this may lead to monetary policy decisions that may have bad consequences for the economy. Finally, considering the fragile nature of these economies and their need for imported intermediate goods in the production process, the negative effects for Brazil and South Africa cause us to question the effectiveness of VAR models. This is why IO table analysis, which uncovers the sectoral decomposition, might be a more accurate approach.

Overall, the results of three different VAR models suggest a lower-than-expected ERPT effect, except for the Turkey analysis. Although theoretical and empirical studies show that this effect decreases over time, in our opinion, the results obtained as a result of VAR analysis are far below the actual effect.

However, the comparison of the VAR and IO models reveals interesting insights into the exchange rate pass-through effects in different countries. The IO model consistently produces higher coefficients compared to the VAR models across all countries. This discrepancy can be attributed to several factors, which we discuss below:

Firstly, it might be due to country-specific dynamics. Each country has its unique economic characteristics and dynamics that influence the exchange rate pass-through effects. The IO model takes into account sectoral linkages and interdependencies, capturing a broader range of factors that influence the exchange rate transmission mechanism. This broader perspective allows the IO model to capture indirect and spillover effects, leading to higher coefficients. For example, the sector that is most affected by exchange rate changes in Turkey is D19 (Coke and refined petroleum products) with a coefficient of 0.871 (Appendix, Figure 2). This is expected due to the global nature of this sector and its heavy reliance on imports and exports, which are directly affected by exchange rates.

Secondly, the IO model incorporates sector-specific relationships and captures the interactions among different sectors of the economy. This sectoral perspective enables the IO model to capture the complex relationships between exchange rate fluctuations and various economic variables, resulting in higher coefficients. In contrast, the VAR models might overlook these sectoral dynamics, leading to relatively lower coefficients.

Lastly, the IO model employs a different identification strategy compared to the VAR models. The IO model utilizes input-output tables and Leontief inverse matrices to determine the interdependencies between sectors. This methodology explicitly considers the production networks and supply chains, providing a more comprehensive view of the exchange rate pass-through effects. In contrast, the VAR models rely on lagged values and statistical techniques for identification, which might not fully capture the interdependencies and sectoral dynamics, leading to lower coefficients.

7. Conclusion

In summary, this paper has examined the relationship between exchange rates and various sectors of the economy through the utilization of both Vector Autoregression (VAR) and Input-Output (IO) models. The objective was to enhance our understanding of the exchange rate pass-through effects by moving beyond aggregate analysis and adopting a sector-specific approach.

The literature review highlighted the pressing research question regarding the relationship between exchange rates and sectors in the context of globalization. The impact of exchange rate fluctuations on the competitiveness of goods and the cost of imported inputs was emphasized, underscoring the need for a comprehensive analysis of exchange rate sensitivities across sectors. The limitations of traditional VAR models, such as linearity assumptions and aggregation of data, were also discussed, leading to the exploration of alternative methodologies like the IO model.

The methodology section provided an overview of the data used in the analysis and described the selected countries and sectors. The VAR model, employing Cholesky decomposition for identification, was introduced as a traditional approach to understanding the dynamic interrelationships between prices and other variables. The IO model, on the other hand, offered a sector-specific perspective by capturing the flow of goods and services among sectors within an economy.

The results section presented the estimated coefficients from the VAR models as well as the IO model for each country. It highlighted the cumulative effects of exchange rate pass-through obtained from the VAR analyses, indicating a maximum duration of 12 months. While advanced economies showed similar results across the three VAR models, Japan exhibited a different pattern with model 2 yielding a positive coefficient. Fragile economies like Brazil and South Africa experienced negative effects, raising questions about the effectiveness of VAR models. In contrast, the IO model consistently produced higher coefficients, attributing this disparity to country-specific dynamics, sectoral linkages, and the comprehensive depiction of interdependencies.

The conclusion highlighted the importance of sector-specific analysis in understanding exchange rate pass-through effects. It emphasized the limitations of VAR models and the advantages of the IO model in capturing the intricacies of exchange rate transmission. The findings provided insights for policymakers and economists, emphasizing the need to consider sector-specific dynamics and interdependencies in managing exchange rate risks and maintaining economic stability. Further research directions were suggested, including the exploration of additional countries and sectors, and the refinement and extension of methodologies employed in analyzing exchange rate pass-through.

In summary, this study has contributed to the literature by offering a comprehensive analysis of exchange rate pass-through effects using both VAR and IO models. It has highlighted the importance of considering sector-specific dynamics and interdependencies, providing policymakers and economists with more accurate and detailed insights.

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APPENDIX

	Brazil	India	Indonesia	Turkey	South Africa	Germany	France	UK	USA
D01T02: Agriculture, hunting, forestry	0.122	0.047	0.073	0.213	0.271	0.207	0.186	0.227	0.101
D03: Fishing and aquaculture	0.016	0.027	0.024	0.185	0.110	0.185	0.274	0.230	0.059
D05T06: Mining and quarrying, energy producing products	0.150	0.126	0.172	0.293	0.209	0.412	0.035	0.154	0.125
D07T08: Mining and quarrying, non-energy producing products	0.107	0.183	0.099	0.220	0.209	0.128	0.266	0.241	0.095
D09: Mining support service activities	0.092	0.098	0.130	0.126	0.311	0.110	0.047	0.227	0.070
D10T12: Food products, beverages and tobacco	0.128	0.092	0.103	0.216	0.183	0.261	0.221	0.233	0.124
D13T15: Textiles, textile products, leather and footwear	0.133	0.201	0.221	0.237	0.247	0.276	0.306	0.142	0.143
D16: Wood and products of wood and cork	0.117	0.170	0.148	0.309	0.184	0.249	0.211	0.269	0.135
D17T18: Paper products and printing	0.155	0.257	0.208	0.298	0.209	0.264	0.255	0.222	0.126
D19: Coke and refined petroleum products	0.282	0.697	0.312	0.871	0.585	0.617	0.737	0.879	0.327
D20: Chemical and chemical products	0.239	0.268	0.256	0.376	0.302	0.319	0.308	0.286	0.137
D21: Pharmaceuticals, medicinal chemical and botanical products	0.113	0.160	0.189	0.282	0.263	0.205	0.208	0.186	0.114
D22: Rubber and plastics products	0.215	0.265	0.306	0.407	0.324	0.291	0.302	0.281	0.147
D23: Other non-metallic mineral products	0.140	0.258	0.204	0.268	0.350	0.248	0.222	0.211	0.107
D24: Basic metals	0.274	0.304	0.135	0.308	0.276	0.458	0.368	0.320	0.221
D25: Fabricated metal products	0.191	0.227	0.280	0.300	0.240	0.232	0.294	0.199	0.166
D26: Computer, electronic and optical equipment	0.302	0.279	0.356	0.275	0.346	0.251	0.259	0.175	0.070
D27: Electrical equipment	0.230	0.268	0.312	0.454	0.285	0.262	0.354	0.267	0.169
D28: Machinery and equipment, nec	0.203	0.235	0.383	0.337	0.292	0.261	0.331	0.245	0.186
D29: Motor vehicles, trailers and semi-trailers	0.212	0.271	0.177	0.409	0.378	0.291	0.404	0.341	0.277
D30: Other transport equipment	0.360	0.244	0.251	0.136	0.240	0.356	0.496	0.286	0.168
D31T33: Manufacturing nec; repair and installation of machinery and	0.175	0.358	0.236	0.273	0.295	0.249	0.268	0.217	0.113
D35: Electricity, gas, steam and air conditioning supply	0.087	0.379	0.188	0.398	0.190	0.204	0.268	0.297	0.087
D36T39: Water supply; sewerage, waste management and remediation	0.059	0.182	0.190	0.166	0.127	0.116	0.167	0.091	0.068
D41T43: Construction	0.111	0.157	0.199	0.251	0.267	0.177	0.196	0.139	0.110
D45T47: Wholesale and retail trade; repair of motor vehicles	0.051	0.064	0.088	0.104	0.111	0.101	0.144	0.119	0.044
D49: Land transport and transport via pipelines	0.124	0.164	0.113	0.254	0.161	0.134	0.165	0.165	0.063
D50: Water transport	0.158	0.267	0.237	0.155	0.165	0.283	0.266	0.151	0.079
D51: Air transport	0.183	0.240	0.152	0.272	0.238	0.259	0.219	0.292	0.057
D52: Warehousing and support activities for transportation	0.081	0.159	0.114	0.076	0.222	0.163	0.149	0.147	0.062
D53: Postal and courier activities	0.067	0.105	0.113	0.151	0.176	0.138	0.094	0.101	0.071
D55T56: Accommodation and food service activities	0.082	0.057	0.082	0.111	0.102	0.135	0.133	0.130	0.051
D58T60: Publishing, audiovisual and broadcasting activities	0.101	0.184	0.149	0.141	0.171	0.140	0.172	0.146	0.040
D61: Telecommunications	0.070	0.193	0.044	0.104	0.258	0.129	0.155	0.088	0.066
D62T63: IT and other information services	0.065	0.070	0.102	0.028	0.177	0.145	0.105	0.100	0.035
D64T66: Financial and insurance activities	0.041	0.080	0.025	0.079	0.049	0.121	0.143	0.131	0.031
D68: Real estate activities	0.011	0.038	0.037	0.137	0.073	0.038	0.034	0.041	0.023
D69T75: Professional, scientific and technical activities	0.061	0.145	0.076	0.092	0.121	0.088	0.127	0.104	0.036
D77T82: Administrative and support services	0.053	0.128	0.073	0.085	0.147	0.099	0.104	0.121	0.041
D84: Public administration and defence; compulsory social security	0.034	0.046	0.095	0.104	0.108	0.083	0.077	0.119	0.067
D85: Education	0.029	0.053	0.062	0.034	0.047	0.035	0.046	0.062	0.034
D86T88: Human health and social work activities	0.056	0.078	0.126	0.126	0.114	0.084	0.069	0.107	0.043
D90T93: Arts, entertainment and recreation	0.059	0.102	0.064	0.083	0.147	0.069	0.125	0.103	0.033
D94T96: Other service activities	0.104	0.129	0.109	0.181	0.146	0.064	0.115	0.072	0.045
D97T98: Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Figure 2: Exchange Rate Pass Through Rates by sectors in 2018

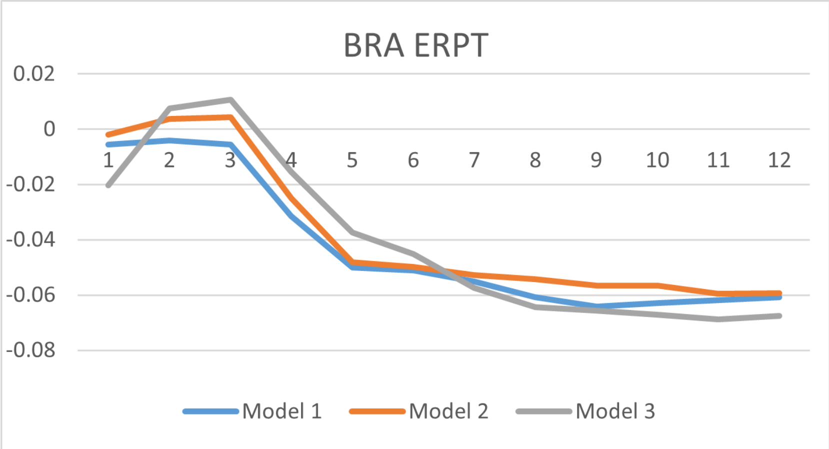

Figure 3: VAR Model for Brazil

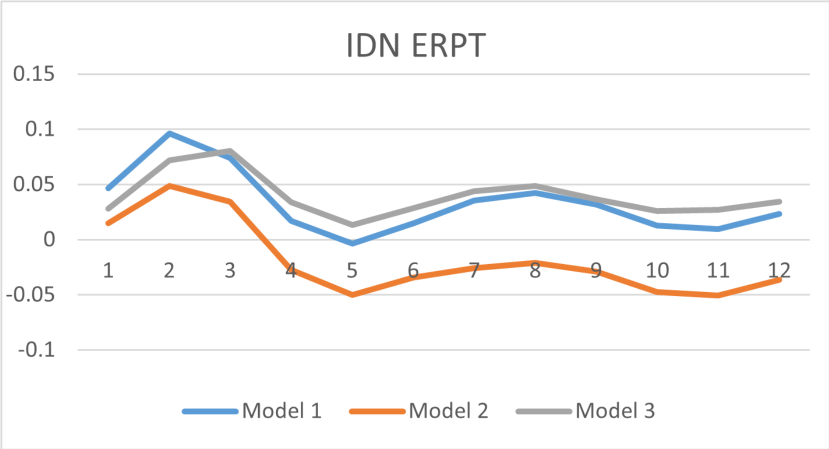

Figure 4: VAR Model for Indonesia

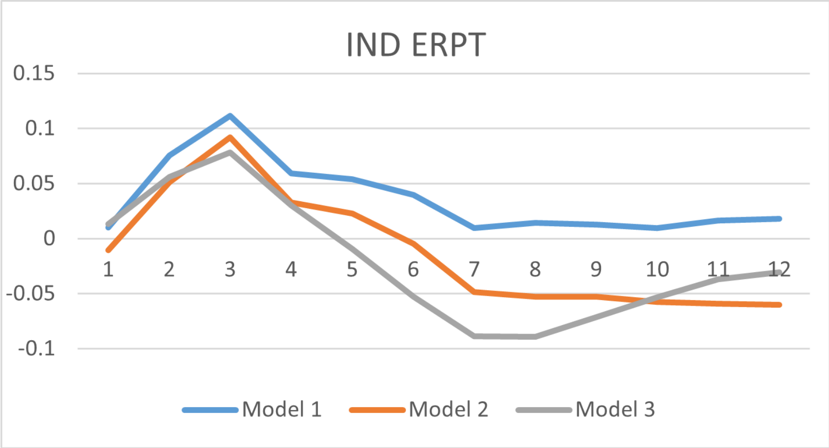

Figure 5: VAR Model for India

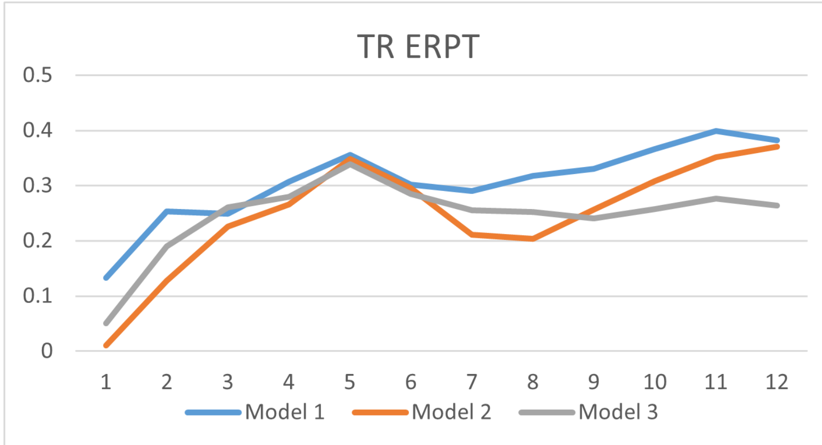

Figure 6: VAR Model for Turkey

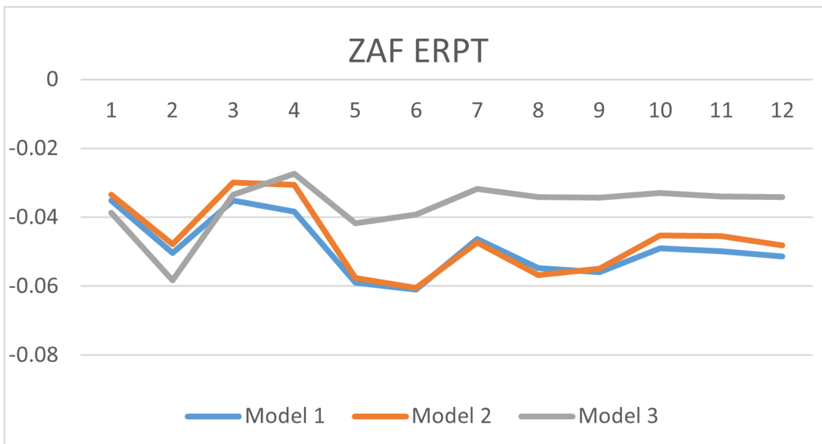

Figure 7: VAR Model for South Africa

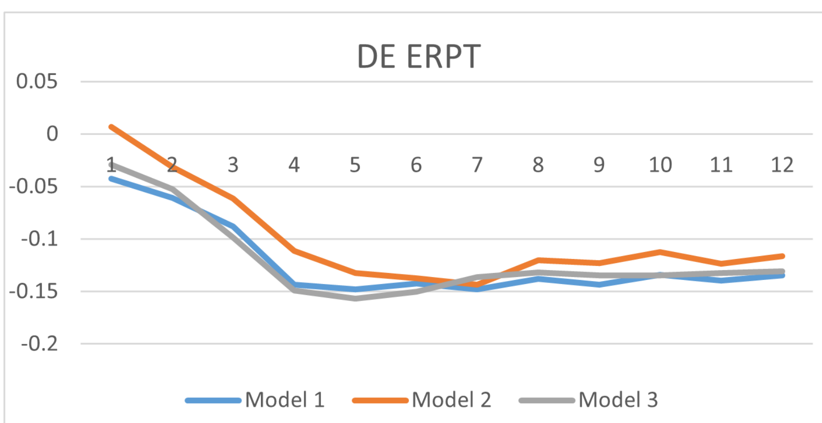

Figure 8: VAR Model for Germany

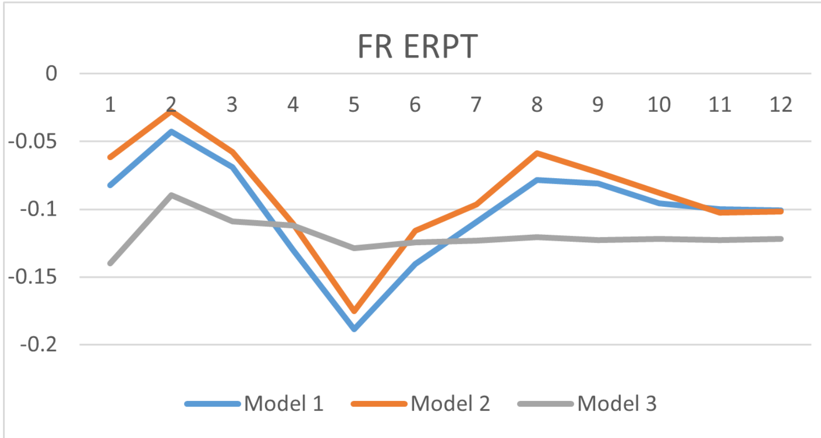

Figure 9: VAR Model for France

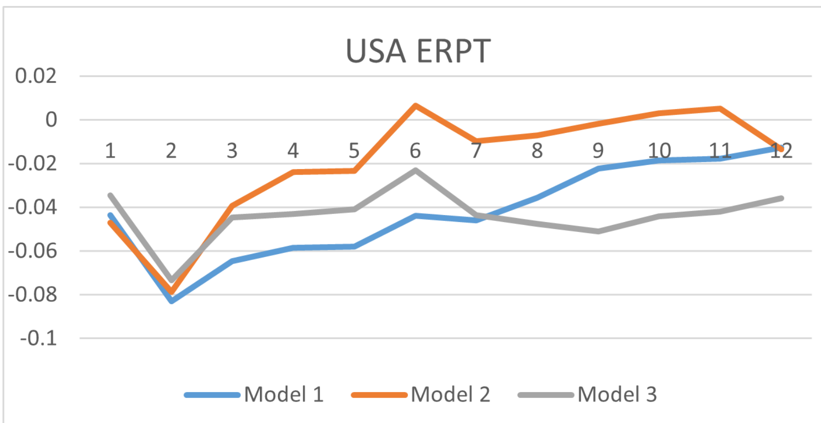

Figure 10: VAR Model for USA

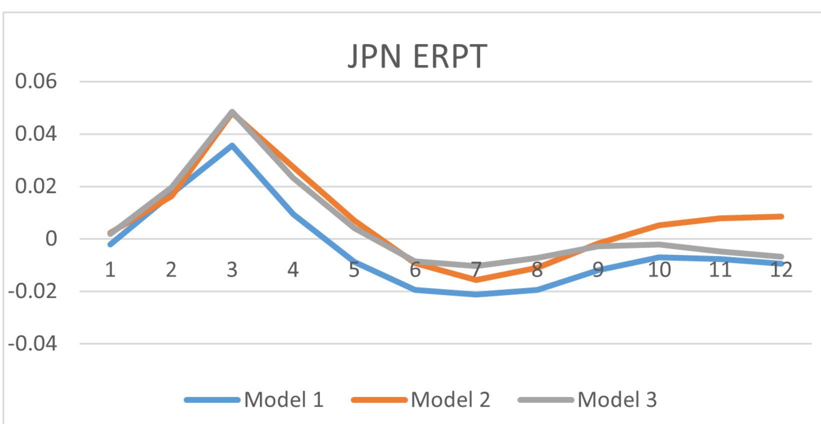

Figure 11: VAR Model for Japan

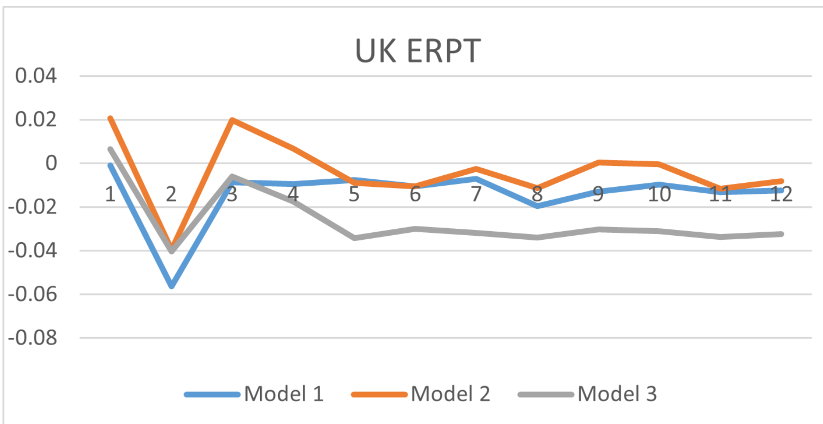

Figure 12: VAR Model for UK