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Original Research Article

Evaluation Of Flexibility of the Exchange Rate Regime's Effect on Pass-Through Phenomenon: An Application of the Multiple-Doses Matching Approach

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Exploring effects of the main determinants on exchange rate pass through is crucial for the adoption of various economic policies, including exchange rate stability as well as trade expansion. An exchange rate regime can be a source of exchange rate and price changes, which is substantial in the implementation of foreign exchange policies. Among the various factors affecting exchange rate pass through, the flexibility of exchange rate regime has received less attention in empirical studies. Accordingly, the present paper seeks to find out how different exchange rate regimes affect the exchange rate pass through, which is proxied by the import price. To answer this question, we have used the multiple-doses matching approach by estimating the dose-response functions, to evaluate the effect of an exchange rate regime on the pass through. To this purpose, we have used data of 118 developing countries employing four types of exchange rate regimes in 2021. The results obtained from the use of dose-response analysis show that there is a negative and significant relationship between the degree of exchange rate pass-through and the degree of flexibility of the exchange rate regime at the significance level of 5%, so that an increase in the flexibility of the exchange rate regime has resulted a decrease in the degree of exchange rate pass-through. As a result, the degree of exchange rate pass-through in the hard-pegged exchange rate regime has been higher than those of other regimes, while, it has been the lowest in the floating exchange rate regime.

Keywords: Exchange Rate Pass Through, Developing Countries, Multiple-Doses Matching Approach, Generalized Propensity Score Matching.

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1 Introduction

Exchange rate changes can influence domestic prices through a change in the price of the composition of imports including consumer, intermediate and capital goods (Doojav, 2009). In the literature of international economics, the transition effect of exchange rate on import price index is known as Exchange Rate Pass Through; which implies percentage of a change in imports price index per one percent change in exchange rate (Goldberg & Knetter, 1997). The effectiveness of inflation-targeting monetary and exchange policies is enhanced when exchange rate pass-through is limited and adjusting current account (Choudhri & Hakura, 2006). Moreover, a reduced level of exchange rate pass-through diminishes the responsiveness of the domestic economy to external shocks, thereby enhancing the nation's overall economic stability of the country (Rasekhi and Montazeri, 2015). In 1970s, the issue of exchange rate pass-through garnered increased focus in advanced economies as rising inflation rates and inflationary expectations emerged from domestic currency devaluation.

Any type of pass-through change influences the domestic prices directly and indirectly, so that the direct effect is through a change in importing final goods, while the indirect effect appears through a change in prices of capital goods, raw materials as well as intermediate goods.

Literature suggests that the flexibility of an exchange rate regime—particularly in developing economies—serves as a critical determinant of exchange rate pass-through. This relationship stems from structural characteristics such as low per capita income lower purchasing power parity of domestic consumers, limited diversification in manufacturing and tradable goods sectors, as well as underdeveloped financial markets, as observed in the majority of these nations (Jabara, 2009). Hence, implementing an appropriate exchange rate regime seems to be a critical requirement among economic policies in developing countries.

The expansion of economic integration, removal of obstacles in real and financial sectors along with globalization increase the willingness of researchers and policy makers to analyze different aspects of exchange rate pass through. Moreover, In the contemporary global economic landscape, the influence of exchange rate pass-through on key macroeconomic indicators has become profoundly significant, positioning it at the heart of monetary and fiscal policy frameworks implemented by central banks worldwide (Forbes, 2016).

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This research primarily aims to investigate the relationship between currency values and price transmission mechanisms across various exchange rate regimes. More specifically, this study examines how the choice of various exchange rate arrangements affects the pliability of pass-through elasticity, using import prices as an indicator, in specific developing countries, To assess this, the relationship is examined using a dose-matching method with generalized propensity score matching, demonstrating whether specific exchange rate regimes correlate with increased or decreased levels of exchange rate pass-through. In this study, because one country (Iran) cannot be a member in treatment and control group at the same time, and also because of increasing the number of observations, a selection of developing countries having different exchange rate regime will be evaluated for analyzing the effect of exchange rate regime on exchange rate pass through. Considering that, different studies have achieved different results regards the manner of the choice of exchange rate regime significantly influences the extent of exchange rate pass-through to domestic prices. this study applying dose-response functions and matching other effective variables in two groups of countries, identify the pure effect of flexibility of exchange rate regime on exchange rate pass through, which presents advantageous Results. In this study, after introduction, the theoretical principles and background of study are evaluated and then pattern and method of study, and in next sections, analysis of findings and conclusion are presented.

2 Literature Review

Exchange rate pass-through (ERPT) denotes the degree to which fluctuations in currency exchange rates are transmitted into adjustments in import prices and subsequently reflected in domestic price levels.

The exchange rate pass through has important policy basis; while small economies and emerging market countries are usually price-taker in global markets and are more vulnerable to inflation caused by exchange rate fluctuations. On the one hand, a higher degree of ERPT leads some concerns about imported inflation and provide the possibility of direct transfer of impulses from trading partner countries; in which this is of special importance for countries with a history of high inflation. Conversely, a reduced degree of exchange rate pass-through impedes the pace of external sector adjustment in an economy. (Ghosh, 2014).

Among different impulses transferred by exchange rate from outside to domestic economy, effects of changes in imports price seem to be critical due to various effects on price indexes of producer and consumer. Responsiveness

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of exchange rate to foreign price impulses is influenced by exchange arrangements adopted by monetary authorities. Hence, exchange rates fluctuations determine the overall dynamics of exchange rate pass through effects on domestic prices.

The impact of exchange rate volatility on inflation, one of the considerable issues of fixed exchange rate regime versus floating regime, implies the relative changes in import and export prices resulting finally in changes in the general prices level. Within fixed exchange rate systems, employing a nominal anchor—typically the currency of a nation with consistently low inflation—serves as an effective mechanism for curbing elevated inflation and stabilizing future price expectations. Consequently, a nation implementing a fixed exchange rate system can anticipate periods of disinflation, particularly when this policy choice is driven by preceding conditions of high inflation. The capacity of a nation to attain price stability within a reasonable timeframe is fundamental for maintaining a fixed exchange rate system. A currency peg to a stable foreign currency can anchor inflation expectations, a crucial factor in analyzing how abrupt exchange rate movements influence domestic prices. (Mirdala, 2014). In fixed exchange rate systems, reduced currency volatility facilitates short-term domestic price adjustments, attributable to the diminished transmission of exchange rate movements to domestic prices under such regimes. Conversely, in economies operating under flexible exchange rate systems, price stability becomes more vulnerable due to the absence of a dependable nominal anchor, especially during short-term periods. Nevertheless, the low inflation levels pursued by central banks demonstrate greater sensitivity compared to external price shocks caused by abrupt and unanticipated currency fluctuations. In flexible exchange rate systems, the price impacts of currency fluctuations may be amplified by either parallel effects from real output or its constituent elements on unexpected exchange rate movements affecting domestic prices, forming an integral component of the exchange rate adjustment mechanism. Consequently, in nations with flexible exchange rate systems, currency fluctuations typically necessitate subsequent adjustments in domestic price levels (id).

Within floating exchange rate systems, substantial price volatility stemming from the unpredictability and uncertain trajectory of currency values - irrespective of the origin or intensity of exchange rate instability - signals the lack of a credible nominal anchor for achieving stabilization. Inflationary expectations influenced by a reliable foreign currency provide a more appropriate framework to keep the price stability. Generally, the choice of exchange rate system is recognized as a significant determinant affecting

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how exchange rate changes transmit to prices, though its impact on pass-through varies across different economies. Notably, the influence of the exchange rate regime on pass-through diminishes as countries achieve higher levels of economic development. Generally, the choice of exchange rate system is recognized as a significant determinant affecting how exchange rate changes transmit to prices, though its impact on pass-through varies across different economies. Notably, the influence of the exchange rate regime on pass-through diminishes as countries achieve higher levels of economic development. Because developed countries do confront fragile monetary and financial institutes and lower diversity in manufacturing and trade rather than developing countries (Choudhri & Hakura, 2001). In developing economies, where monetary policy frameworks are less robust and production structures remain suboptimal, both inflationary impacts of exchange rate movements and the degree of pass-through tend to be more substantial relative to advanced nations. (Ramos, 2012).

Generally, research examining exchange rate pass-through has produced inconsistent results regarding how exchange rate fluctuations influence the pass-through process, leading to two distinct schools of thought in academic discourse. A number of economists contend that as exchange rate systems adopt greater flexibility, the amplified volatility of the currency is anticipated to exert a more pronounced impact on the domestic price level. Consequently, the pass-through coefficient is likely to rise, potentially fostering conditions conducive to inflation within the economy. They also believe that in floating exchange rate regime, along with the increasing of the general level of prices, it causes adjustment of prices towards fluctuations of exchange rate. Because, under conditions of exchange rate uncertainty, firms often lack the capacity to accurately forecast future currency movements. Consequently, if these fluctuations are perceived as persistent rather than temporary, businesses will typically incorporate the associated cost adjustments—including those stemming from the exchange rate—into their pricing strategies, leading to a revision of final prices. In other words, if the fluctuations of exchange rate is considered as permanent, it can be expected that the severity of exchange rate fluctuations have more effect on general level of domestic prices. (Kazerooni et.al, 2012, Aguerre et al., 2012). Some of other studies like Razafimahefa (2012), Gagnon & Ihrig (2004), Byrne et al., (2010), Steel and King (2004). According to Sarlab et al. (2019), a fixed exchange rate regime correlates positively with a higher degree of exchange rate pass-through. The authors argue that this occurs in such regimes due to price stickiness and a prevailing high-inflation environment. In contrast, floating exchange rate systems exhibit

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lower pass-through, which they attribute to greater price flexibility and a more gradual adjustment of domestic prices to currency fluctuations.

In addition to aforementioned studies, other studies like Devereux and Engel (2002), Frankel et al., (2012), Sinyakov et al., (2019) and Ghosh and Rajan (2007) identified exchange rate regime as a determinant affecting exchange rate pass through. A fundamental theoretical framework for analyzing the connection between currency fluctuations and price levels is the Law of One Price (LOOP). This principle posits that the pass-through of exchange rate changes into import prices is theoretically complete. According to this theory, supposing the presence of efficient market, a full arbitrage and lack of trade barriers, homogeneous goods and services are exchanged in equal price in terms of equal currency in different countries. This theory is represented in the following form:

$$P_i = E \times P_i^* \quad (1)$$

where P_i indicates the price of ith good inside the country, P_i^* indicates the price of ith good in foreign country and E is the nominal exchange rate. To evaluate the degree of exchange rate pass through on the level of domestic prices, a regression equation of LOOP can be written as follows:

$$P_i = \mathrm{e} + p_i^* \quad (2)$$
$$P_{it} = \alpha + \delta p_{it}^* + \gamma e_{it} + \varepsilon_{it} \quad (3)$$

where all the variables are in logarithm forms. e and ε denote the exchange rate and error term, respectively, while t stands for the time period. In the above equation, the fulfillment of the Law of One Price, defined by the parameter restrictions δ=γ=1 and α=0, implies that any fluctuation in the exchange rate is fully transmitted to domestic prices. Under these conditions, the pass-through coefficient reaches unity, indicating perfect and complete transmission. A standard empirical approach for quantifying the pass-through of exchange rate fluctuations into import prices involves estimating a regression model, as exemplified in the work of Akofio-Sowah (2009). The typical specification takes the following form:

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$$P_t = \alpha + \gamma e_t + \delta X_t + \varphi Z_t + \varepsilon_t \quad (4)$$

where P_t is the price of import goods as logarithm in term of domestic currency, X_t is the index of exporters costs, e_t is the logarithm of exchange rate, Z_t encompasses a range of control variables, including exchange rate regimes, trade openness, real GDP, and monetary and inflation conditions, and γ indicates the coefficient of exchange rate pass through degree on the price of import goods.

In practice, despite the significant importance of the relationship between exchange rate regimes and exchange rate pass-through, the latter has received relatively little attention in the existing literature:

Junttila and Korhonen (2012) analyzed the impact of the inflation regime on the pass-through of exchange rate changes into import prices for OECD countries over the period 1975-2009, applying a mark-up model based on the nonlinear univariate method as well as using quarterly data, they found instability of exchange rate and manufacturing gap have positive and significant effect on degree of exchange rate pass through, leading to a higher inflation rate. The investigation by Ben Cheikh and Louhichi (2014) focuses on how inflation regimes serve as a determinant in the degree to which exchange rate fluctuations are transmitted to import prices. Utilizing an extensive panel data set encompassing 63 countries from 1992 to 2012, their analysis identifies two distinct threshold points, enabling a segmentation of the sample into three separate inflation regimes. The empirical results indicate a strong correlation between the inflation environment and ERPT magnitude, with country groups characterized by elevated inflation rates showing more substantial pass-through effects. López-Villavicencio and Mignon (2017) estimate the exchange rate pass-through (ERPT) to import and consumer prices for a sample of 14 emerging countries over the 1994Q1-2015Q3 period. To this end, they augment the traditional bivariate relationship between the nominal effective exchange rate and inflation by accounting for monetary stability proxied by the inflation environment, monetary policy regime and central bank behavior and show that both the level and volatility of inflation, as well as adopting an inflation target or the transparency of monetary policy decisions clearly reduce ERPT to consumer prices. Sadat Hosseini et al., (2018) study the Taylor hypothesis (based on the role of the inflation environment) in Iran during the 1988: Q1-2015: Q4 period. Using seasonal time series data from the Iranian economy and employing a smooth transition regression model, they found that import prices in a high-inflation regime are lower than those in a low-inflation regime, thereby confirming Taylor's

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hypothesis. Yazdani's (2018) analysis of four Asian nations explores how exchange rate changes pass through to domestic prices, emphasizing their interaction with monetary policy and the price level itself. Employing a Structural Vector Autoregression (SVAR) model from 1970 to 2015 to account for dynamic feedback effects, the study confirms a dynamic linkage between ERPT and key macroeconomic variables. In their 2019 investigation, Eskandaripour and Esfandiari analyze the impact of exchange rate volatility on import prices under conditions of environmental uncertainty, with a specific focus on dietary patterns from 1962 to 1992. Utilizing an EGARCH model and a Markov switching approach, their findings indicate that exchange rates, GDP, trade openness, and export prices exert a positive and significant influence on import prices. Furthermore, the degree of exchange rate fluctuation in the context of environmental uncertainty exceeds one unit across both identified regimes. Ezzati Shourgoli and Khodaveisi (2020) examine ERPT differentials between medium and high per capita income countries using 1980-2018 data from 59 economies. GMM model results show pass-through rates of 14% and 16% for medium and high-income nations respectively, revealing a positive relationship between income levels and pass-through intensity. Edwards and Cabezas (2021) investigate whether the pass-through coefficient varies with the degree of international tradability of goods and analyze if the pass-through coefficient depends on the monetary policy framework. They consider 12 disaggregated price indexes in Iceland for 2003–2019, a period that includes Iceland’s banking and currency crisis of 2008 and find that the pass-through declined around the time Iceland reformed its flexible inflation targeting, and that the coefficients are significantly higher for tradable than for untradeable. In their 2021 study, Aisen and colleagues employ econometric methods to quantify exchange rate pass-through in Mozambique using data from 2001 to 2019. Their findings reveal a pass-through process that is asymmetric, substantial in magnitude, and rapid in transmission, with half of all exchange rate changes reflected in domestic prices within a six-month period. In their 2021 study, Aisen and colleagues employ econometric methods to quantify exchange rate pass-through in Mozambique using data from 2001 to 2019. Their findings reveal a pass-through process that is asymmetric, substantial in magnitude, and rapid in transmission, with half of all exchange rate changes reflected in domestic prices within a six-month period.

This study holds significant policy relevance for exchange rate management and pass-through frameworks. It aims to systematically analyze the determinants of exchange rate pass-through, with particular emphasis on

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evaluating how the choice of exchange rate regime influences currency volatility and uncertainty. Specifically, the research will assess how pass-through dynamics and price adjustments respond to different exchange rate arrangements in Iran and comparable economies. Also, in this study, dose matching approach with generalized score of propensity is applied for first time to answer the questions of research in this area; because most of studies evaluating the relation between inflation and exchange rate in any way, have used merely the different parametric linear econometrics patterns. It should be mention that, most studies considering exchange rate regime somehow as a variable in their evaluating pattern, employed the exchange rate regime merely as stabilizes and floating as zero and one in the pattern; however, applying dose-matching with generalized score of propensity approach in this study allows exchange rate regime not to be observed merely as zero and one and different exchange rate regimes to be considered with different flexibility which is in turn one the advantageous of this study than others.

3 Methodology

3.1 Model Specification

In this part, experimental studies and theoretical literatures are used to introduce the Model of research and is set out below based on matching approach. In theoretical literatures, Modeling of exchange rate pass through often is performed according to pricing behavior of Importing Firm (Campa & Goldberg, 2005 and Barhoumi, 2006); so that a firm participating in an imperfect competition market in importer country, have comparative pricing power[1] and Solves the Following profit Maximization Problem, (Ben Cheikh & Louhichi, 2014):

$$\max_{P_t^{IM}} \quad \pi = E_t^{-1} P_t^{IM} Q_t(P_t^{IM}, P_t^D, Y_t) - C_t(Q_t(0), W_t) \tag{5}$$

Where π is Profit of Firm, E_t is nominal exchange rate and P_t^{IM} is the price of import good in term of domestic currency. $Q_t(0)$ Is demand for import good which is a function of the price of importing good(P_t^{IM}), the price of The Domestic Competing goods (P_t^D) and The Income level(Y_t). The Production Cost of good in term of foreign currency (C_t) also is determined based on

[1] Pricing in comparison to competition market is different and is not determined based on relation of price versus Marginal Cost.

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Level of Product ($Q_t(0)$) and inputs price (W_t).[1] Considering the first order Condition of Profit Maximizing, the price of importing good is equal to:

$$P_t^{IM} = E_t MC_t \mu_t \quad (6)$$

Where, MC_t is Marginal Cost of production and μ_t is Markup of Price over Marginal Cost of Firm[2]. If the logarithm of two side of Eq. (6) are taken and written in regression mode, we have:

$$p_t^{IM} = \alpha + \beta e_t + \gamma mc_t + \theta m_t + \varepsilon_t \quad (7)$$

Where $p_t^{IM}$is the price of importing good, e_t is nominal exchange rate, mc_t is Marginal cost of Foreign Producer[3] and m_t is Markup of importing Firm[4]. In this relation, if $\beta < 1$, only a part of exchange rate changes is transferred to import price and exchange rate pass through is Incomplete, if $\beta = 1$, all changes of exchange rate are transferred to imports price and exchange rate pass through is Complete. Also, if $\beta > 1$, it indicates the hysteresis induced effect in import market of destination country. Regarding eq. (3), factors effecting on imports price in a country include: exchange rate, Marginal cost of production and Markup of Importing Firm. Concerning to first two factor, as much as exchange rate increases (decreases) in a country and also cost of manufacturing increases (decreases) in destination country, it increases (decreases) assuming other conditions of imports goods price to be fixed. But the most effecting variable on price of importing goods of a country is Markup of Importing Firm (Mann, 1986). If the price of importing good does not change with increase of exchange rate, it is said that Importing Firm absorbed the Increasing of Costs in its Markup, completely and prevented from contagion of exchange rate increase to the price of goods, in which degree of exchange rate pass through is zero (β=0). If the price of importing good increase in lower ratio with increasing the exchange rate, then it is said that

[1] the price of importing good in term of domestic currency (P_t^{IM}) is given by multiplying nominal exchange rate (E) in price of importing good in term of foreign currency (P_t^{EX}), or $P_t^{IM} = E_t P_t^{EX}$. So we have: $P_t^{IX} = E_t^{-1} P_t^{IM}$. Therefore, two side of eq. (1) is in term of foreign currency.

[2] Percentage added to Marginal cost of Firm. The markup is further defined as $\mu = \eta/\eta - 1$, where η is the price elasticity of demand for the product that depends on variables specific to the importing country, mainly, demand conditions y and the price of the competing product

[3] In fact, the marginal cost of foreign producers refers to the costs imposed on the importing firm by the exporters (foreign producers who export their goods to the target destination country.

[4] Small letters indicate the variable in logarithm form.

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Firm has reflected a part of cost increase in its Markup and a part in price of good, in which exchange rate pass through is incomplete. however, if Firm does not absorb the increase of costs resulting from increasing the exchange rate in its Markup and all are reflected in the price of goods, the degree of exchange rate pass through will be complete.

According to current literature, Markup of Firms is influenced by environmental variables of macroeconomic, Trade openness and level of country's income (Mesbahi et al., 2017). Since we have:

$$m_t = f(open_t, gdp_t, \dots) \tag{8}$$

Accordingly, in first step, Model of exchange rate pass through in eq. (7) in Macro Level is:

$$p_t^{IM} = \alpha + \beta e_t + \gamma mc_t + \theta_1 gdp_t + \theta_2 open_t + \varepsilon_t \tag{9}$$

Where $\mathrm{gdp_t}$ and $\mathrm{open_t}$ are Gross Domestic Product and Trade Openness of importing country respectively. Eq. (9) is known as State Equation which is used in experimental studies as basic equation to estimate exchange rate pass through (Al-Abri and Goodwin, 2009, Junttila and Korhonen 2012). It was referred in theoretical basics section, the following regression equation intruded by Akofio-Sowah (2009) is considered also to estimate degree of exchange rate pas through on price of importing goods:

$$P_t = \alpha + \gamma e_t + \delta X_t + \varphi Z_t + \varepsilon_t \tag{10}$$

Where P_t is the price of importing good in term of domestic currency, X_t is index of exporter costs, e_t is nominal exchange rate and Z_t presents a set of control variables like exchange rate regimes, degree of economy openness, real gross domestic product, type of monetary policy and inflation, and γ indicates the coefficient of exchange rate pass through degree on importing goods price.

The final model of this study will be achieved from outcome of state equation (Eq.9) and model introduced by Akofio-Sowah (2009) (Eq.10). Therefore, in order to evaluate the effect of the exchange rate regime on the exchange rate pass-through, based on the experimental studies and the theoretical literature, This Variable is entered into the model qualitatively as treatment variable. It should be noted that studies such as Frankel et al., (2012) and Devereux and Engel (2002) also evaluated the effect of different exchange rate regimes on the effect of exchange rates on prices and proved the significance of this effect. Also, the variables of inflation (inflationary

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environment) and the monetary policy index (liquidity volume), which empirical studies and theoretical literature emphasized their role (as environmental variables) in the amount and degree of exchange rate pass-through, have been used along with other mentioned regressive variables.

In the following, the effect of each of the variables on the exchange rate pass through is presented, so that, accordingly, the final model can be obtained. As mentioned above, one of the variables affecting the exchange rate pass through is trade openness, which directly and indirectly affects the exchange rate pass through. In the direct effect of trade openness on exchange rate pass-through, it is expected that with the increase in the volume of trade, extreme exchange rate fluctuations will be transferred to the prices of importing and consumer goods, and then the degree of exchange rate pass-through will increase (Asgharpour and Mahdilo, 2014). In indirect influence, the more trade openness of the economy, the greater the competitiveness in that economy; and with the increase in competition, the general level of domestic prices decreases. In this Conditions, Firms have an incentive to prevent the increase the price of importing goods by absorbing the increase in costs in the Markup. Thus, there is an inverse relationship between trade openness and the degree of exchange rate pass-through (Ozkan & Erden, 2015). The Final effect of trade openness on exchange rate pass-through is Ambiguous and depends on the outcome of the two aforementioned effects. It should be noted that Aziz et al (2009) in His Research, Recommended the use of trade openness variable for developing countries, and states that in order to reflect and control the structural changes in the trade system of developing countries and to prevent the specification bias of the exchange rate pass through test to import price, use of this variable in exchange rate pass through Model will be useful. Approving this, other studies such as Asgharpour et al., (2015), Ghosh (2013) and Razafimahefa (2012) have also emphasized on trade openness as a variable affecting the exchange rate pass through. Another variable that is included as an Explanatory variable in the exchange rate pass through model is the gross domestic product, so that if the level of production and income in the importing country increases, then the demand for domestic and importing goods increases, which leads to an increase in the price of importing goods. On the other hand, the largeness or smallness of countries' economies is also an effective factor on degree of exchange rate pass-through, so that degree of exchange rate pass-through is lower in larger economies and higher in countries with smaller economies. Because in larger economies, the effect of the increase in the exchange rate (decrease in the value of the domestic currency) on the general level of prices is reduced through the

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reduction of global prices. In other words, with the increase in the size and scale of the market at the same time as the increase in the exchange rate, due to the decrease in the demand for foreign goods and services, the general level of global prices is decreased, and therefore the Exchange rate transfer effect on the general level of domestic prices is relatively slight (McCarty, 2007). In other studies, such as Burstein et al., (2002), Mesbahi et al., (2017) and Junttila and Korhonen (2012), Gross Domestic Product has also been mentioned as a variable influencing the exchange rate pass through. The next Explanatory variable is inflation. Many studies such as Taylor (2000), Campa and Goldberg (2005), Choudhri and Hakura (2001), Sadat Hossini et al., (2018), Lin and Wu (2012) and Ben Cheikh and Louhichi (2014) emphasize on the important role of inflation and the inflationary environment in extent of exchange rate pass through; so that, in countries with high inflation compared to countries with low inflation, the increase in costs is considered more continuous and Firms react more to the increase in costs. An economy with higher inflation causes an increase in exchange rates.so, an economic environment with higher inflation leads to increasing the extent of exchange rate pass through. In other words, by increasing the reaction of prices to the increase in costs due to the increase in the exchange rate, countries with higher inflation have a higher degree of exchange rate pass-through. Choudhri and Hakura (2006) also using the theoretical model of macroeconomics and using the data of 71 countries in the time period of 1979-2000 have shown that inflation is the most Explanation among the macroeconomic variables for changes in the exchange rate pass through and there is strong evidence about a positive relationship between inflation and exchange rates pass through both among the countries and over time.

Another variable affecting the exchange rate pass through is monetary policy. Gagnon and Ihrig (2004) focused on the role of monetary policy in exchange rate pass-through and using a theoretical model showed that inflation stability followed by the central bank's monetary policies reduces exchange rate pass-through, because stabilized monetary policies applied with the goal of inflation control, can reduce inflation fluctuations and thus reduce exchange rate pass through. On the other hand, countries with more stable liquidity and monetary stability will be able to reduce the variance of their money growth and reduce the extent of exchange rate pass through partially (Devereux et al., 2004). Other studies such as Shintani et al., (2013), Kazerooni et al., (2012) and Ebrahimi and Madanizadeh (2016) have used the monetary policy index and the growth of liquidity as variables that determine the exchange rate pass through. The relationship between the changes in the

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exchange rate regime and the exchange rate pass through, as well as the relationship between the exchange rate pass through and other influencing variables (control variables) can be defined as IPI=F(ERR,X). In this regard, IPI is the variable of the price index of importing goods, which, following previous studies such as Campa and Goldberg (2005), is used as a substitute variable for exchange rate pass through and will be Response variable. ERR is the exchange rate regime variable that is included in the model as a treatment variable, and X represents the vector of other variables affecting the import price index, including the nominal exchange rate, exporters' Marginal cost, Gross Domestic Product, Trade Openness, Monetary policy index, and Inflation, which are controlled Effect of these variables in the matching process in some way and often in literatures is known as Confounders. In fact, these variables are considered as matched variables so that the net effect of the exchange rate regime can be determined, so that by matching the effect of other variables affecting the exchange rate pass through in two country groups of treatment and control, changes in the exchange rate pass through can be attributed to the treatment variable (exchange rate regime). Therefore, in order to evaluate the effect of adopting different exchange rate regimes on import prices, relying on the theoretical foundations and according to the matching methods explained in the next section, the experimental model of this study for considered sample is defined as follows:

$$P^{IM}{}_i = F(\mathrm{D}_{ERR_i}, EX_i, MC_i, GDP_i, OPEN_i, LIQ_i, INF_i) \quad (11)$$

In other words, the final model of the study (in regression form) is as follows[1]:

$$P_i^{IM} = \beta_0 + \beta_1 EX_i + \beta_2 MC_i + \beta_3 GDP_i + \beta_4 OPEN_i + \beta_5 LIQ_i + \beta_6 INF_i + \alpha D_{ERR_i} + U_i \quad (12)$$

Where $\mathrm{P^{IM}}$ is the import price index, the data of which is collected from the United Nations Conference on Trade and Development (UNCTAD). DERR is the treatment variable of the exchange rate regime. Due to the fact that there is a spectrum of exchange rate regimes, different doses are attributed to different types of exchange rate regimes based on the degree of flexibility, so that zero is allocated to the hard pegged exchange rate regime and doses

[1] The index i is related to the countries, because in the matching model, the variables are entered in cross-sectional mode.

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more than zero as continuous are allocated to soft peg, managed floating and floating exchange rate regimes[1]. As the flexibility of exchange rate regime increases, these doses also increase from zero to one. It should be noted that in this study, the De Facto classification of exchange rate regimes published by the International Monetary Fund, was used[2]. Based on this information, among the 118 countries evaluated in 2021, 7 countries have a hard pegged exchange rate regime (control group), 69 countries have a soft pegged exchange rate regime, 10 countries have a managed floating exchange rate regime, and 32 countries have a floating exchange rate regime.

EX_i is the nominal exchange rate variable whose information is collected from the United Nations Conference on Trade and Development (UNCTAD)[3]. MC is the marginal cost of exporters (trading partners), which is following most empirical studies obtained from the average of consumer goods price indices of trading partners[4] (Asgharpour and Mahdilou, 2014). The information required for this variable has been extracted from Trade Development Organization website[5] and UNCTAD. GDP is the real gross domestic product variable (in terms of annual average growth rate), whose data is collected from UNCTAD. OPEN is the trade openness variable, which is obtained from the ratio of total exports and imports to GDP in term of percent. Information for this variable is also extracted from UNCTAD. LIQ is the liquidity growth variable which is considered as indicator of monetary policy according to Abtahi (2017)[6]. The data related to this variable was collected from the database of World Development Indicators (WDI). INF is the consumer price inflation variable and its related information also have been collected from the database World Development Indicators (WDI).

[1] In fact, in order to estimate the dose matching model, the doses are considered continuously, so that for countries with a hard pegged exchange rate regime, $0 \leq T \leq 0.25$, and for countries with a soft pegged exchange rate regime, $0.25 < T \leq 0.5$, are allocated, for countries with a managed exchange rate regime, $0.5 < T \leq 0.75$,and for countries with a floating exchange rate regime, $0.75 < T \leq 1$ are allocated.

[2] Annual Report on Exchange Arrangements and Exchange Restrictions 2019

[3] For countries such as Iran that have more than one exchange rate, an unofficial exchange rate has been used).

[4] In terms of competitiveness, the consumer price index is a more appropriate index than the producer index and it also better shows the marginal cost imposed by the exporters on the importing enterprise

[5] https://tpo.ir/countries

[6] Here, the liquidity growth variable is considered as a match variable and what role it plays has not been considered; therefore, whether this variable is endogenous or not to show the monetary policy does not matter here.

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Overall, the variables of the current research model can be categorized within the following conceptual framework:

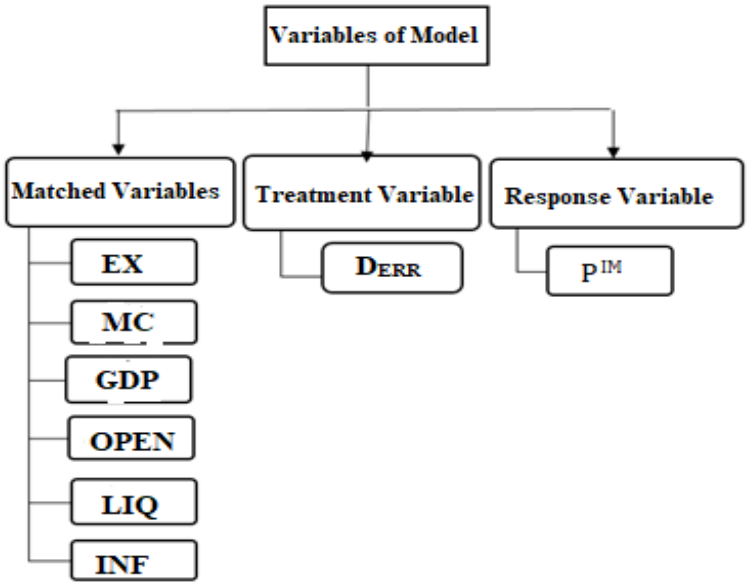

Figure 1. Variables of study model
Source: Research finding

In this study, using the method of dose matching with generalized propensity score (multiple dose matching) in which variables affecting exchange rate pass through are introduced as multiple matched, the reaction of exchange rate pass through to changes in the exchange rate regime is evaluated. For this purpose, the information of 118 developing countries[1] having different exchange rate regime has been used in 2021.

[1] Albania, Algeria, Angola, Argentina, Armenia, Azerbaijan, Bahamas, Bahrain, Bangladesh, Barbados, Belarus, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Brunei Darussalam, Cambodia, Cameroon, Chad, Chile, China, Colombia, Comoros, Republic of Democratic Congo, Congo, Costa Rica, Ivory Coast, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Ethiopia, Fiji, Gabon, Gambia, Georgia, Ghana, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hungary , India, Indonesia, Iran, Iraq, Jamaica, Jordan, Kazakhstan, Kenya, Kuwait, Kyrgyzstan, Republic of Laos, Latvia, Lebanon,

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3.2 Model Estimation Method

In many economic and social contexts, policy intervention takes the continuous form for severe exposure of economic units (countries) to policy and the classification of countries into countries subject to the program (treatment group) and countries non-exposed to the program (control group) in the form of two-options choosing (binary treatment) cannot reflect the intensity of being exposed to the policy, so that, in addition to a country or firm is being exposed to the policy or not, the level and intensity of being exposed to a policy (dose) is also important in evaluating the effects of a policy. In the binary PSM framework, the division of treated and untreated countries is possible only by using arbitrary thresholds. However, recent developments in applied econometrics, provides the possibility that it acts based on the generalized propensity score (GPS), as originally proposed by Gelman and Meng for continuous treatment effect. GPS removes the objectivity that can occur when classifying countries into treated and untreated countries. While in a binary PSM, logit or probit is used for Estimating the probability of a unit (country) being in the treatment group conditional on covariates X, parametric generalized linear models are used with continuous treatment to estimate GPS using alternative distributional assumptions. More precisely, it is assumed that:

$$(T_i|X_i) \sim \psi\{h(\Upsilon, X_i), \sigma^2\} \tag{13}$$

Where g is a link function (e.g., logarithm), ψ is a probability density function (eg, normal, gamma, igamma or beta), h is a variable function depending on the parameter Υ and the vector of covariates X and σ^2 is also a scale parameter. T_i is treatment variable. After estimating the conditional distribution parameters of the treatment γ and σ^2, the GPS is estimated as follows:

Lesotho, Liberia, Libya, Madagascar, Malawi, Malaysia, Maldives, Mali, Mauritania, Mexico, Moldova, Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nepal, Nicaragua, Niger, Nigeria, North Macedonia, Oman, Pakistan, Panama, New Guinea, Paraguay, Peru, Philippines, Poland, Qatar, Romania, Russia, Rwanda, Saint Lucia, Saint Vincent, Samoa, Saudi Arabia, Senegal, Sierra Leone, Solomon Islands, South Africa, Sri Lanka, Sudan, Syria, Tajikistan, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, Ukraine, United Arab Emirates, Uruguay, Vietnam, Zambia, Zimbabwe.

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$$\hat{GPS} = \frac{1}{\sqrt{2\pi\hat{\sigma}^2}} exp\left[-\frac{1}{2\hat{\sigma}^2}\{g(T_i) - h(\hat{\gamma}, X_i)\}\right] \quad (14)$$

Same as the PSM method, GPS also requires that the covariates are sufficiently balanced across units with different treatment levels. Next, the dose-response functions and the average treatment effect should be calculated. In the current research, considering that exchange rate regimes are classified as a spectrum of exchange rate regime with different flexibility, it is not possible to look at them as zero and one (binary), but in the policy of making the exchange rate regime flexible (as a program), the degree of flexibility of the exchange rate regime should be considered in form of dose. In this method, we are faced with two groups of countries: the countries of the control group that are not exposed to the program and the dose assigned to them is zero, and the countries of the treatment group that the dose assigned to them is greater than zero. Therefore, the countries with a hard-pegged exchange rate regime (without flexibility) are members of the control group and receive a zero dose, and countries with other exchange rate regimes (soft peg, managed and floating) are members of the treatment group and are allocated doses greater than zero based on the degree of flexibility. Here, the goal is to determine the degree of influence of the policy dose (the degree of flexibility of the exchange rate regime) on the response variable (exchange rate pass through). It is assumed that the countries member of the treatment and control group have different reactions to the observable variables X_i and the level and intensity of the policy variable t_i, and specifically, the goal is to estimate the dose response function to dose Y_i to the policy t_i. To simplify the symbols $T_i \in \{0,1\}$ is defined as intensity and policy dose for country i and $T_i \in \{0,1\}$ is defined merely as a two-choice option to show whether or not the i-th country is exposed to the policy, so that the total effect of the policy on the people exposed to the policy, using a composite regression can be calculated as follows:

$$ATE(t_i) = T_i\left[ATET + \hat{a}\left[t_i - (1/N)\sum_{i=1}^{N} t_i\right] + \hat{b}\left[t_i^2 - (1/N)\sum_{i=1}^{N} t_i^2\right] + \hat{c}\left[t_i^3 - (1/N)\sum_{i=1}^{N} t_i^3\right] + (1 - p_i)\hat{ATENT}\right] \quad (15)$$

Where $\hat{ATET}(t_i) = \hat{ATE}(t_i)_{t_i>0}$.

The value of this effect is a function of the intensity of being exposed to the policy as a graph, with a confidence interval of 95%. It should be noted that in the multiple doses matching method, the dose-response function in the framework of the generalized propensity score matching provides more

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information about the effectiveness of a program by uncovering heterogeneities in the effects of policy at different levels.

4 Experimental Results and Analysis of Findings

The overall statistics of the estimated Generalized Propensity Score (GPS) for the studied countries are presented in Table 1. As can be observed, the smallest estimated GPS is 0.2220 for Hungary, which belongs to the fourth treatment interval and has adopted a floating exchange rate regime. Conversely, the largest estimated GPS is 1.2781 for Vietnam, which belongs to the second treatment interval and has adopted a soft peg exchange rate regime. The mean, standard deviation, variance, skewness, and kurtosis of the distribution of generalized propensity scores are also visible in this table.

Table 1
Estimated Generalized Propensity Score

Smallest	**Percentiles**	
0.2220	0.2720	1%
0.2720	0.3324	5%
0.2852	0.3478	10%
0.3094	0.4324	25%
	1.0398	50%
Largest		
1.2513	1.1349	75%
1.2578	1.1753	90%
1.2736	1.2068	95%
1.2781	1.2736	99%
Mean	0.8675	
Std.Dev	0.3407	
Variance	0.1161	
Skewness	-0.6573	
Kurtosis	1.6748	

Source: Research findings

Given the presence of four distinct exchange rate regimes, the set of potential treatment values is categorized into four intervals. Additionally, the descriptive statistics of the GPS distribution at the representative point of each of these treatment intervals have been evaluated and are presented in Table 2.

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Table 2
Descriptive statistics of GPS distribution in the representative point of each treatment interval

variable	Obs	Mean	Std. Dev.	Min	Max
gps_1	118	0.3281	0.0849	0.0046	0.6528
gps_2	118	1.0588	0.1396	0.0936	1.2781
gps_3	118	1.1357	0.0879	0.6058	1.2832
gps_4	118	0.3944	0.1312	0.1549	1.2736

Source: Research findings

Next, the balancing test must be conducted to evaluate the generalized propensity score model. The purpose of this test is to check the correctness of this hypothesis that the conditional mean of variables before treatment is not different according to the generalized propensity score matching between units (countries) that belong to a specific treatment interval and units (countries) that belong to other treatment intervals. Table 3 indicates that, across all treatment intervals, the test statistics for auxiliary variables are not significant at the 5% level, and all matching variables are balanced. Therefore, changes in the response variable (exchange rate pass-through) are solely attributable to the degree of flexibility of exchange rate regimes.

Table 3
Evaluation of balancing property, GPS-t test

Treatment Interval	Number of Significant Test Statistics
First Interval $0 \leq T \leq 0.25$	0
Second Interval $0.25 < T \leq 0.5$	0
Third Interval $0.5 < T \leq 0.75$	0
Fourth Interval $0.75 < T \leq 1$	0

Source: Research findings

Finally, the effect of the degree of flexibility of the exchange rate regime on the degree of exchange rate pass-through is evaluated based on dose-response functions and is presented in Figure 2. The results obtained from applying of dose response analysis indicate a statistically significant negative relationship (at the 5% level) between the degree of exchange rate pass-through and the flexibility of the exchange rate regime (received dose) in selected developing countries. This suggests that exchange rate pass-through responds to exchange rate regime flexibility policies—specifically, as the flexibility of the exchange rate regime increases, the degree of pass-through decreases. Therefore, in the hard-pegged exchange rate regime, the exchange

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rate pass through is higher than in other exchange rate regimes, and in the floating exchange rate regime, the exchange rate pass through is lower than in other exchange rate regimes. In the soft pegged exchange rate regime, the exchange rate pass through is higher than in the managed exchange rate regime. In general, it can be concluded that, as the flexibility of the exchange rate regime increases, the amount of intervention of the central bank in the exchange market also decreases, the changes in the exchange rate gradually and with less manipulation by the monetary authority is influenced by the supply and demand conditions of the market and causes that there will not be large and fluctuating changes in the exchange rate, especially in the long term, and as a result, the prices will be gradually adjusted according to the changes in the exchange rate. In general, whatever the exchange rate regime is flexible, assuming the countries' exchange rate regimes are deep and competitive, the exchange rate reacts quickly to the trade surplus and deficit conditions and acts as an automatic stabilizer, but in exchange rate regimes with less flexibility such as the exchange rate regime, there is not such automatic mechanism and monetary authorities decide which exchange rate to respond to trade balances change, and because detection, action and impact are accompanied by interruptions, the imbalances in these systems are longer and deeper, so the degree of exchange rate pass through will also be larger.

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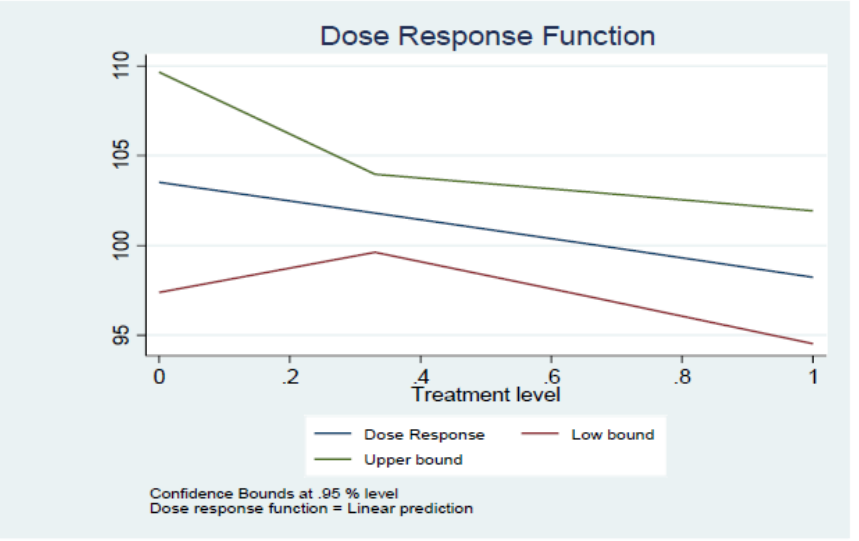

Figure 2. The relationship between the exchange rate pass through and extent of dose received (the degree of flexibility of the exchange rate regime)
Source: Research findings

5 Conclusion and Suggestions

This study aimed to evaluate the effect of exchange rate regimes on exchange rate pass-through in Iran and other selected developing countries in 2021. It assessed the effect of this variable alongside other explanatory variables influencing import prices, including the nominal exchange rate, exporters' marginal costs, real GDP growth, trade openness, liquidity growth, and inflation (inflationary environment). The analysis was based on theoretical foundations and empirical literature, employing a dose-response approach with generalized propensity score matching. The results of the model estimation using this approach indicate that as the dose increases (from 0 to 1), the value of the response variable gradually declines. Given that the dose represents the flexibility of exchange rate regimes, the findings suggest that an increase in the flexibility of exchange rate regimes leads to a decrease in the degree of exchange rate pass-through. Therefore, given the significance of the difference coefficient of the treatment effect (flexibility of the exchange rate regime) on exchange rate pass-through,

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adopting an appropriate and rational exchange rate regime can be an effective strategy to reduce the phenomenon of exchange rate pass-through. Policymakers aiming to minimize the degree of this phenomenon should consider the exchange rate regime as a key factor in their planning. Implementing a suitable exchange rate regime can help mitigate the inflationary pressure resulting from exchange rate pass-through. Based on the findings, a floating exchange rate regime would be a more suitable option for developing countries in terms of limiting exchange rate pass-through. Accordingly, in countries that specifically aim to reduce imported inflation and minimize exchange rate pass-through, economic policymakers and monetary and exchange rate authorities should, over time, create the necessary conditions and groundwork for exchange rate floating. By adopting a floating exchange rate regime, they can facilitate the reduction of the pass-through effects of exchange rate changes on import prices and mitigate imported inflation. On the other hand, given the higher level of exchange rate pass-through in non-floating exchange rate regimes, it is recommended to economic policymakers of countries that, for any reason, adopt a regime other than a floating exchange rate regime, to simultaneously strive to reduce dependency on imports, especially imported intermediate goods, while adopting such regimes which lead to an increase in the pass-through effects of exchange rate changes on import prices. This effort is aimed at preventing the further impact of imported inflation on domestic prices Additionally, considering that, based on the research findings, the managed floating exchange rate regime ranks next to the fully floating exchange rate regime in terms of reducing the degree of exchange rate pass-through, it is recommended that in countries where, for any reason, the necessary conditions and grounds for adopting a fully floating exchange rate regime are not in place, a managed floating exchange rate regime be adopted. This is because it is a more suitable option for reducing the degree of exchange rate pass-through compared to fixed exchange rate regimes. In other words, considering that an increase in the flexibility of the exchange rate regime reduces the degree of exchange rate pass-through, the policy of exchange rate unification can also be considered effective in this regard. This is because, unlike a fixed exchange rate regime that leads

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to the emergence of a parallel currency market, the exchange rate unification policy is itself a managed floating (and sometimes fully floating) exchange rate policy. Coupled with a reduction in the dependency of monetary policy, it can be effective in reducing the degree of exchange rate pass-through.

Overall, considering that the matching model, in a way, enables the utilization of the experiences of other countries and their comparison, the results of this study can contribute to the literature in this field and assist economic policymakers in leveraging the experiences of other countries to reduce exchange rate pass-through.

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