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The Role of Exchange Rate Volatility on the Import Unit Value Index in Countries with Different Monetary Policy Arrangements(Panel ARDL Approach)

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Abstract
The relationship between exchange rate volatility and import value indices is one of the important debates in international finance literature and has been considered empirically in recent years. Hence, the main aim of this paper is to evaluate the long-run effect of exchange rate volatility on the import unit value index as a proxy for exchange rate pass-through in two groups of countries with the exchange rate anchor versus inflation targeting monetary regime over the period of 1990-2015. For achieving this purpose, 15 and 43 countries have been selected as countries with exchange rate anchor and inflation targeting monetary policy regime. The econometric model has been estimated by applying ARDL* approach in panel data for these two groups of countries. Empirical findings of present study indicated that exchange rate volatility has negative effect on the unit value of imports in the two groups of countries. Moreover, interaction effect of monetary regime and nominal effective exchange rate has positive and significant influence on the import unit value index in two groups of countries.

Keywords: Exchange Rate Volatility, Import Unit Value Index, Monetary Regime, Panel ARDL.

JEL Classification: C23:E23:F31

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1. Introduction

The relationship between exchange rate movements and price adjustments of traded goods, which is termed as exchange rate pass-through (ERPT) has long been debated in the field of international economics. Exchange rate pass-through is defined as the percentage of change in local currency import prices resulting from a one percent change in exchange rate between exporting and importing countries. In the exchange-rate pass-through literature, pass-through is considered complete when the response is one-for-one and 1 percentage change in the exchange rate results in a1 percent change in the import price. If pass through is less than complete we have evidence of pricing in the local currency of importers or Pricing to Market (PTM). Incomplete pass through can be due to micro factors such as market structure and product differentiation as well as macroeconomic variables like exchange rate movements, trade openness, monetary policy and trading partner's production cost.

According to An (2006), McCarthy (2009) and Sowah (2009b), exchange rate volatility is one of the main determinants of exchange rate pass-through. The effect of exchange rate volatility on pass-through depends on the whether exchange rate movements are perceived to be transitory or persistent. When exchange rate volatility is high, the cost of price adjustment also rises. If the exchange rate shock is perceived to be transitory, exporters and importers would be more will to adjust their profit margins rather than change prices. However, if the shock is expected to persist, then exporters and importers would be more likely to change prices.

In addition, the exchange rate pass-through is related to monetary regime and inflationary environment. Taylor (2000) argues that in a model with staggered prices and monopolistic competition, low inflationary environment leads to a low exchange rate pass-through to import and domestic prices.

Since the 1980s, there has been a growing interest in examining the relationship of the exchange rate pass-through with monetary policy behavior and exchange rate volatility. Several studies have examined the effect of exchange rate volatility and monetary policy on the exchange rate pass-through in developed and developing countries. Devereux and Engel (2001) shows that low exchange rate variability and stable monetary policy has resulted to the low of exchange rate pass-through. Wickremasinghe & Silvapulle (2003) pointed out that there is a positive relationship between exchange rate pass-through and exchange rate volatility for Japan. Kiptui, Ndolo, and Kaminchia (2005) find that an exchange rate shock leads to a sharp increase of import price index in Kenya. Choudhri and Hakura (2006) provided a link between the low inflationary environment and exchange rate pass-through. Siok Kun and Zhanna (2008) concluded that exchange rate volatility has led to the increase of exchange rate pass-through. Nogueira, Miguel & Ledesma (2010) found that exchange rate pass-through has declined with a shift to a low inflationary environment. Byrne, Chavali & Kontonikas (2010) showed that exchange rate volatility has a negative effect on the exchange rate pass-through. Aguerre, Fuertes & Phylaktis (2012) suggested that exchange rate volatility and monetary policy play a crucial role in exchange rate pass-through.

The review of empirical studies on the nexus between exchange rate volatility and import price index revealed that in most of these researches, long-term relationship among exchange rate fluctuations and import value index with emphasis on the role of monetary policy framework has not considered. Hence, for fill out this gap, the contribution of this paper is to investigate the long-run effects of exchange rate volatility and monetary regime on the import price index in countries with the inflation targeting monetary policy[1] versus

[1] In inflation targeting regime, monetary policy decisions are guided by the deviation of forecasts for future inflation from the announced inflation target, with the inflation

exchange rate anchor[1] over the period of 1990-2015.The rest of the paper has been organized as follows:

In the next section, the review of literature has been stated and then, an empirical model and data resources have been introduced. In section 4, we report the empirical results in two groups of countries and the final section has been devoted to the conclusion and policy implication.

2. Review of Literature

The theoretical literature between exchange rate volatility and exchange rate pass-through indicate that the direction of this nexus is not clear. Higher exchange rate volatility is typically associated with lower ERPT (i.e. negative link) in a highly competitive environment because exporters are prepared to let their markup fluctuate seeking to hold or increase market share (Froot & Klemperer, 1989). On the contrary, if exporters seek predominantly to stabilize their profit margins they will tend to maintain fixed the prices in their own currency, i.e. higher ERPT, and so the expected effect is positive (Devereux & Engel, 2001). As noted by Gaulier, Revil & Mejean (2008), this ambiguous nexus reflects a tradeoff in the exporter's main strategy, namely, to stabilize export volumes or marginal profits. A related argument is whether the volatility shock is perceived as long-lasting or short-lived by exporters; in the latter case, they are more likely to adjust down their profit margins rather than incur the costs associated with frequent price changing (Froot & Klemperer, 1989).

There are theoretical arguments and stylized facts arising from the relationship between the import prices and the exchange rate volatility (Parsley & Cai, 1995; Dhalokia & Raveendra, 2000). Therefore, it is reasonable to assume that the profit margin of exporters depends on the exchange rate volatility. In this case, import prices respond to the changes in domestic prices and the exchange rate volatility. By assuming a perfect competitive situation in the domestic market, exporters consider only the changes in exchange rate volatility and domestic prices in their pricing decisions. In addition, the monetary policy is one of the main determinants in exchange rate pass-through. According to Taylor (2000), Choudhri, & Hakura (2006) and Sowah (2009a) countries with credible monetary regimes such as inflation targeting and low inflationary environment have experienced a lower degree of exchange rate pass-through. So the countries with inflation targeting monetary regime have managed to reduce their inflation rate and have subsequently entered into a period of relative price stability. The stability of relative prices in these countries has resulted in creating more stable inflation environment and declining in exchange rate pass-through.

Export partner's production cost is another variable that is include in the empirical estimation of exchange rate pass-through to import prices. Inclusion of this variable provides support for the notion that exporting firms adjust their mark-ups in response to fluctuations in the exchange rate. The export partner's production cost is used as a proxy for measurement of marginal cost. A rise in the marginal costs in foreign currency should also lead to an increase in import prices through the cost channel as the firms would be looking to recover the cost of production by charging higher prices.

On the empirical aspect, there exist many studies on the estimation of exchange rate pass-through to import prices. For instance, Hooper & Mann (1989) by using of quarterly data over the period of 1973:1-1988:2 estimated the exchange rate pass-through to import prices in United States. The results of this study reveal that exchange rate fluctuations and marginal production costs

forecast acting (implicitly or explicitly) as the intermediate target of monetary policy. These regimes cover the managed floating with no pre-determined path for the exchange rate and independently floating regime.

[1] . In the exchange rate anchor regime, the objective of monetary authority is to buy or sell foreign exchange at given rates to maintain the exchange rate at the certain range. So, the exchange rate serves as the nominal anchor or intermediate target of monetary policy. These regimes consist of exchange rate regimes with no separate legal tender, currency board arrangements, fixed pegs with or without bands, and crawling pegs with or without bands.

have positive and significant effects on the import price index. Goldfajn and Werlang (2000) analyzed the effects of real GDP and exchange rate volatility on the import price index for OECD and non-OECD countries during the 1980-1998. They found that exchange rate volatility and real GDP have positive and significant effect on the import price index. Campa and Goldberg (2001) investigated the main determinants of exchange rate pass-through for twenty three OECD countries over 1975-2000. The results of this study indicate that exchange rate volatility, real GDP and exporter's marginal cost have positive effects on the import prices in these countries. Bailliu and Fujii (2004) using annual data for 11 industrialized countries during the 1977-2001 found that exchange rate pass-through has declined with a shift to a low-inflation environment brought about by a change in the monetary policy regime. More specifically, the results suggest that pass-through to import, producer, and consumer price indices decline following the inflation stabilization that occurred in many industrialized countries in the early1990s.

Hilmi kal, Arslaner & Arslaner (2015) investigated the non-linear relationship between exchange rate pass-through and import price pass-through in Turkey during 2003-2014. According to the results of this paper, ERPT and IPPT are lower during low volatility periods of nominal exchange rate.

Ayadi and Jeremiah (2016), by applying GARCH method and ECM have studied the relationship between exchange rate volatility and domestic price instability in Nigerian economy during the period of 1970-2010. Main empirical findings of this study revealed that the exchange rate volatility has positive impact on consumer price index in short-run and long-run. Mendali and Das (2017) examined the impact of exchange rate variation on the domestic prices in India during the period of 1985-2015. The results of their study showed that the exchange rate variation and inflation have positive and significant influence on the consumer price index in India. Villavicencio and Mignon (2017) estimated the exchange rate pass-through to import and consumer prices for a sample of 14 emerging countries over the period of 1994-2015. Results of this paper revealed that both 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. However, uncertainty about domestic monetary policy seems less relevant in explaining the pass-through to the price of imports.

In the case of Iran, none of previous studies has attempted to look at the impact of exchange rate volatility and monetary regime on the import price pass-through (IPPT) simultaneously, so the prime objective of this study is to fill out this gap by investigating the effects of exchange rate volatility and monetary regime on the import price pass-through for two categories of countries. The first category consists of the countries with the exchange rate anchor and the second group comprises of countries with the inflation targeting monetary regime. In order to examine the responsiveness of import prices to the exchange rate volatility in the presence of the monetary regime in selected countries, the defacto exchange rate classification and ARDL approach have been used over the period of 1990-2015.

3. Empirical Model and Data Sources

In order to investigate the effects of monetary regime and exchange rate volatility on the unit value of import in countries with the exchange rate anchor versus inflation targeting monetary regime[1] and according to the economic literature as well as empirical studies by Kim (2007), Siok Kun and Zhanna (2008), Sowah (2009), Junttila and Korhonen (2012), and

[1] . On the base of IMF monetary regime and exchange rate classification (2017), countries with exchange rate anchor regime consist of 15 countries which Iran is on the fifteen countries in this group. In second group, there are 43 countries with inflation targeting monetary regime and managed float or independently floating exchange rate arrangements.

Ayadi and Jeremiah (2016), the dynamic model in terms of logarithmic form has been specified as follows:

$$LIV_{it} = \beta_i + \beta_1 LIV_{it-1} + \beta_2 LNEER_{it} + \beta_3 Regime * LNEER_{it} + \beta_4 EX - VOL * LNEER_{it} + \beta_0 LMC_{it} + \varepsilon_{it} \quad (1)$$

In the above equation, IV is unit value of imports (as a proxy for exchange rate pass-through); LIV_{t-1} represents the first order lag of unit value of imports; $NEER$ is nominal effective exchange rate. This variable is defined as the trade weighted average of country's exchange rate against other currencies. Using the NEER instead of nominal or real exchange rate allows for some variation in the exchange rate and makes it possible to estimate the degree to which the exchange rate fluctuations get passed through to import price index. On the basis of IMF definition for NEER, this variable is expressed as an index of the foreign currency value per unit of domestic currency. Hence, an increase of NEER represents the appreciation of domestic currency. $Regime * LNEER$ is the cross effects of monetary regime with nominal effective exchange rate in two groups of countries. Regime is a dummy variable that take the value of one, if the countries adopt exchange rate anchor or inflation targeting monetary regime between 1990-2015[1] and zero otherwise. $EX\_VOL * LNEER$ is cross effects of the exchange rate volatility with nominal effective exchange rate in two groups of countries. EX_VOL is exchange rate volatility that defined standard deviation of nominal effective exchange rate over there years. According to Barhoumi (2005), Kim (2007) and Sowah (2009) exchange rate volatility has been defined as follows:

$$EX\_VOL = \sqrt{\frac{1}{T}\sum\left(\frac{NEER_{i,t+3} - NEER_{i,t}}{NEER_{i,t}}\right)^2} \quad (2)$$

In the above formula, T and NEER are the number of periods and nominal effective exchange rate for country i. MC is marginal cost of export partner's. To measure exporting partner's production cost, we follow Campa and Goldberg (2001), Sowah (2009) and Ceglowski (2010) methodology and construct a proxy as follows:

$$MC = \left(\frac{NEER_t^j}{REER_t^j}\right) * P_t^j \quad (3)$$

In this formula, NEER and REER are the nominal and real effective exchange rate for importing country j respectively, and P^j is the consumer price index in importing country j.

As mentioned in review of the literature, the expected sign of coefficients are: $\beta_1, \beta_5 > 0, \beta_2, \beta_4 < 0$ and β_3 should be negative in first group and positive in the second group.

For the investigation of monetary regime and exchange rate volatility effects on the import unit value index in two group countries, the empirical model has been estimated by ARDL approach in panel data.

Autoregressive Distributed Lag (ARDL) models are standard least squares regressions which include lags of both the dependent variable and independent variables as regressors. In panel data models with individual effects, standard regression estimation of ARDL models is incorrect due to bias caused by correlation between the mean-differenced regressors and the error term. This bias only vanishes for large numbers of observations, and cannot be corrected by increasing the number of cross-sections. In large time series, a popular alternative is the Pooled Mean Group (PMG) estimator of Pesaran, Shin and Smith (1999). This model takes the co-integration form of the simple ARDL model and adapts it for a panel setting by allowing the intercepts, short-run coefficients and co-integrating terms to differ across cross-sections.

The data set for all variables of model

[1] .The defactco exchange rate classification has been reported by IMF after the 1990, for this reason, the period of this study has limited to the period of 1990-2015.

has been collected from World Bank Indicators (WDI) and International Financial Statistics (IFS) CD-ROM over the period of 1990-2015.

4. Empirical Results

This section presents the results of model estimation by ARDL approach for two groups of countries. At first, the result of variables unit root tests by IPS and ADF-PP are presented in Table 1. The stationary of the panel data is necessary for examining the co-integration relationship among the variables of the model, as most of the time series data has unit root problem which makes regression results spurious. In this study we use ADF and PP unit root test for solving the unit root problem in our panel data series.

Table 1. Results of unit roots test

Variables	IPS	ADF-PP
LIV	-2.082709	-1.443104
$LNEER_t$	-1.498616	-1.560738
$\text{Re}gime * LNEER_t$	-3.149177**	-5.78677**
$EX\_VOL * LNEER_t$	-5. 440642**	-5.445577**
LMC_t	-0.493254	-0.192798

Note: The asterisks ** denote the significant at 5% level.

Source: Authors Computations

The results of both IPS and ADF-PP show that the interaction effect of monetary regime and logarithm of nominal effective exchange rate and exchange rate volatility are stationary at level. Whereas import unit value index, nominal effective exchange rate and marginal cost are not stationary at level so we cannot reject null hypothesis of non-stationary for all variables. But, after taking first difference, these variables become stationary and we reject null hypothesis and accept alternative hypothesis. With respect to the different order of integration for all variables, we can use ARDL co-integration technique to test of co-integration between variables.

The next step in estimating the long-run relationship between variables is the selection of optimal lag for dependent and independent variables by using information criterion. In this study, we used the Akaike information criterion due to sample size of countries in the two categories. Hence, the optimal lag of dependent and independent variables is determined to be 1, 0,0,0,0, respectively.

Table 2. Estimated long run Coefficients using the ARDL approach for countries with exchange rate anchor Monetary Regime (ARDL (1,0,0,0,0)

Intercept and Explanatory Variables	Coefficient	t-statistic	Probability Value (PV)
C	0.19	0.14	0.891
LIV_{t-1}	0.47	628	0.000
$LNEER_t$	-0.19	-11.33	0.018
$\text{Re}gime * LNEER_t$	-0.027	-2.98	0.003
$EX\_VOL * LNEER_t$	-0.07	-3.87	0.000
LMC_t	0.38	7.29	0.000
Number of countries: 15 Number of observations: 256 Log likelihood: -846.9317			

Source: Authors Computations

The results of Table 2 show that nominal effective has negative and significant effect on the import unit value index in the first group of countries. In other words, an increase of nominal effective exchange rate is accompanied with the increase of demand for domestic produced goods and consequently a decrease in import unit value level. The first order lag of unit value of imports has a positive effect on the unit value level in current period. This result indicates that with increase of import unit value in the former period, per unit value of imports in these countries will increase. In

addition, the cross effect of monetary regime with nominal effective exchange rate has negative effect on the unit value of import index. Hence with adoption of exchange rate anchor monetary regime in these countries, it is expected that the exchange rate pass-through increased. The cross effects of exchange rate volatility with the nominal effective exchange rate has also negative and significant effect on the per unit value of imports. Therefore, with increasing exchange rate volatility, cost of price adjustment also rises and consequently import price index will also increase. The elasticity of import unit value index with respect to export partner's marginal cost is estimated at about 0.38 and one percent increase of marginal cost in exporting partners has resulted to the 0.38 percent of increase in import unit value level. According to the results of model estimation in countries with exchange rate anchor monetary regime, we can conclude that the degree of exchange rate pass-through in presence of monetary regime and exchange rate volatility is estimated in about of -0.27. Hence, the adoption of exchange rate anchor monetary regime and increase of exchange rate volatility has intensified the exchange rate pass-through to import prices in these countries. Moreover, the value of log likelihood is -846.93 which indicates that the sum of square residual has been minimized. In next stage, results of short run dynamics are reported in the framework of error correction model.

Table 3. Error correction model for Selected ARDL Model

Regressor	Coefficients	t-statistic	Probability Value
dC	-1.37	-1.24	0.23
dLNERR	-0.29	-1.95	0.06
$d\,\mathrm{Re}gime^{*}LNEER_t$	-0.09	-1.53	0.12
$dEX\_VOL^{*}LNEER_t$	-0.17	-2.79	0.011
$dLMC_t$	0.39	1.48	0.16
ECM_{t-1}	-0.73	-3.12	0.002

Source: Authors Computations

The estimated short-run equation reveals that difference of nominal effective exchange rate has negative and significant relationship with import unit value index. The results reveal that 1 percent increase in nominal effective exchange rate results in 0.29 percent decrease in unit value of import. The short run results show that interaction effect of monetary regime and nominal effective exchange rate has negative and insignificant relationship with import price index. Interaction effect of exchange rate volatility and nominal effective exchange rate has negative and significant effect on unit value of import in short run. The negative and statistically significant coefficient of ECM_{t-1} -0.73 leads to support a long run relationship between the exchange rate volatility and unit value of import in case of Iran. Hence, coefficient is statistically significant at 1% level and significant value of ECM shows the speed of adjustment from short run to long run. The short run deviations from the long run equilibrium are corrected by 73% towards long run equilibrium path each year.

In next section, the results of model estimation in long-run for countries with inflation targeting monetary regime has presented in Table 4.

Table 4. Estimated long run Coefficients using the ARDL approach for countries with inflation targeting Monetary Regime (ARDL (1,0,0,0,0)

Intercept and Explanatory Variables	Coefficient	Z-value	Probability Value (PV)
C	-0.33	-5.38	0.000
LIV_{t-1}	0.78	193.86	0.000
$LNEER$	-0.12	7.88	0.000
$\mathrm{Re}gime^{*}LNEER$	0.008	20.10	0.000
$EX\_VOL^{*}LNEER$	-0.08	-27.76	0.000
LMC	0.36	24.03	0.000
Number of countries: 43 Number of observations: 429 Log likelihood: -324.98			

Source: Authors Computations

The empirical results for countries with inflation targeting indicate that first order

lag of per unit value of imports has positive effect on the import unit value index in current period. The coefficient of nominal effective exchange rate is negative, which shows that an increase of foreign currencies versus domestic currency causes in decrease of demand for imported inputs and finally import unit value index will decrease. In addition, cross effects of monetary regime with nominal effective exchange rate in these countries is positive and significant. Furthermore, with the adoption of inflation targeting monetary regime, it is expected that exchange rate pass-through will be declined. The cross effect of exchange rate with nominal effective exchange rate has negative and significant effect on the exchange rate pass-through. This result shows that, with increase of exchange rate volatility, the cost of price adjustment will increase and finally the price of imported goods tend to increase. The marginal cost in exporting countries has a positive and significant effect on the import price index. So, with increase of marginal cost in export partners, the cost of imports rises and the price level of imports will increase. As overall result, the estimated degree of exchange rate pass-through under the monetary regime and in presence of exchange rate volatility is -0.16, which is less than of exchange rate pass-through in countries with the exchange rate anchor monetary regime. This result suggests that in second group countries, the adoption of inflation targeting monetary regime has led to decrease of exchange rate pass-through in import unit value index.

Finally, the results of error correction model for adjustment of short-run speed to the long-run equilibrium has been reported as follow table.

Table 5. Error correction model for Selected ARDL Model

Regressor	Coefficients	t-statistic	Probability Value
dC	-1.14	-0.87	0.54
dLNERR	0.07	3.57	0.000
$d\,\mathrm{Re}\,gime * LNEER_t$	-0.02	-1.29	0.12
$dEX\_VOL * LNEER_t$	-0.08	-4.25	0.000
$dLMC_t$	0.21	1.3	0.19
ECMt-1	-0.83	-3.07	0.005

Source: Authors Computations

The estimated short-run dynamic equation indicates that difference of nominal effective exchange rate has negative and significant impact on import unit value index. The results reveal that a 1 percent increase in nominal effective exchange rate results in a 0.07 percent decrease in unit value of import. The short run interaction effect of monetary regime and nominal effective exchange rate has negative and insignificant impact on import price index. Moreover, cross effect of exchange rate volatility and nominal effective exchange rate has negative and significant on unit value of import in short-run. The negative and statistically significant coefficient of ECM_{t-1} -0.83 leads to support a long run relationship among the exchange rate volatility and unit value of import in case of Iran. Hence, coefficient is statistically significant at 1% level and significant value of ECM shows the speed of adjustment from short run to long run. The short run deviations from the long run equilibrium are corrected by 81% towards long run equilibrium path each year. The comparison of error coefficient model in two groups of countries show that in second group the adjustment speed to long-run equilibrium is more than of countries with exchange rate anchor monetary regime.

An overall result, the effects of exchange rate volatility with presence of monetary policy is more than in countries with exchange rate anchor. So, the monetary policy can increase or decrease the effect of exchange rate volatility on the import unit

value index. In countries with inflation targeting monetary policy arrangement, the inflation rate is low and as a result, the effect of exchange rate volatility on the import unit value index is relatively low. Moreover, the effect of marginal cons on the import unit value index in two groups of countries is positive.

5. Conclusion and Policy Implication

This paper analyzes empirically the effects of monetary regime and exchange rate volatility on the unit value of import as a proxy for exchange rate pass-through in countries with exchange rate anchor versus inflation targeting monetary regime during the 1990-2015.

For this purpose, by using of IMF defacto exchange rate classification and ARDL co-integrating technique, empirical model has been estimated for two groups of countries.

The main findings of this study indicate that nominal effective exchange rate and cross effect of exchange rate volatility with nominal effective exchange rate has negative and significant effect on the per unit value of imports in two groups of countries. In addition, the first lags of unit value of imports and marginal cost of exporting countries have positive effects on the import price index. Moreover, cross effects of monetary regime with nominal exchange rate has negative effect in countries with exchange rate anchor regime and positive in the second groups of countries. Cross effects of exchange rate volatility with nominal exchange rate has negative and significant effect on the per unit value of imports in both groups of countries. Hence, with increase of exchange rate volatility, the adjustment of prices will avoidable. The elasticity of import unit value index due to marginal cost is positive, which indicate that increase in marginal cost of exporting partners causes a proportional increase in import unit value index in these countries. The results of this paper are consistent with theoretical framework of exchange rate pass-through and empirical studies such as Sowah (2009a), Nogueira et al (2010) and Ivohasina (2012).

An important policy implication of this study is that the exchange rate volatility with presence of monetary policy has positive influence on import unit value index. Hence, the economic policy makers in the two groups of countries can adopt best monetary policies such as control of inflation and decrease of domestic goods indices for increase of competitiveness degree in global market. Moreover, the decrease of marginal cost in two groups of countries for increase of production and export is another important policy implication to these groups of countries.

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