

# The exchange rate pass-Through to customer price index in Iran, Quantile regression approach

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## ABSTRACT

The aim of this study is to evaluate the influence of exchange rate pass-through (ERPT) to customer price index (CPI) in Iran using quantile regression approach and seasonal data of 1991-2016. According to model estimations, there is a significant positive relationship between ERPT and CPI. In other words, as ERPT increases, CPI increases so that the mean influence of ERPT to CPI in different quantiles is 0.41. In addition, the relationship of production gap and liquidity (cash flow) with CPI is positive and significant. In other words, the increase of exchange rate, production gap and liquidity deteriorate the status of CPI. Furthermore, there is a significant inverse relationship between economy openness index and CPI. Resampling (bootstrap) results confirm quantile regression results.

**Keywords:** Consumer price index, exchange rate pass-through, Quantile Regression

## Introduction

Acquiring more benefits and having higher market share in different countries is the main challenge of all countries in the global economy. Different countries have different currencies. Therefore, exchange rate is the most influential index in international trading. In economy literature, exchange rate is a policy-making determinant across all economies of the world. It is of special important in developing countries because it serves as a tool for formulating macro-economy policies <sup>[1]</sup>. Exchange rate affects the domestic price of goods, in-country importing services and the price of capital goods. Domestic production, and its fluctuations, affects CPI as well as wholesale price index (WPI). Therefore, any change to exchange rate affects the price indices of the importer country and, in turn, affects inflation <sup>[2]</sup>.

Exchange rate has been the subject of different debates while ERPT is a concept attracted the attention of economists in 1980s. In economic studies, the identification of the quality and

degree of ERPT is of high importance because both can affect the formulation of macro-economy policies both in short-term and long-term periods <sup>[3]</sup>. In the international financial literature, ERPT or the effect of the transmission of exchange rate is defined as the change to the price of domestic goods (percent) for 1% change of the exchange rate between the exporter and importer countries <sup>[4]</sup>. In 1987, Dorenbosch was first accurately study the effect of ERPT to CPI using a model. His studies underpinned next studies on this field.

In the framework of macro-economy models, ERPT to domestic prices is an important factor in the determination of the effects of monetary policies <sup>[5]</sup> because the degree of ERPT to CPI implies the short-term dynamism of the balance of trade of a country following the increase/decrease of exchange rate. It is a determinant factor of countries volume of transactions. Exchange rate determines the relationship between domestic and global market prices through commodity market and assets. Therefore, it is an important factor in making policies and adopting appropriate approaches to improving the commercial status of countries. Moreover, any change to the nominal exchange rate affects CPI and WPI based on which inflation rate is calculated. This factor, in turn, can affect the competitive power of producers, and production and employment rates (Junttila, 2012). If exchange rate increases due to government economic policies or external factors, both retail and wholesale prices of goods and services will change because a considerable portion of imports is intermediate goods used in production cycle. This, in turn, changes the price of imported consuming

### Access this article online

Website: [www.japer.in](http://www.japer.in)

E-ISSN: 2249-3379

**How to cite this article:** Alireza Kazerooni, Hossein Asgharpur, Hanieh Hemmati Shahgoli. The exchange rate pass-Through to customer price index in Iran, Quantile regression approach. *J Adv Pharm Edu Res* 2018;8(S2):41-49.

**Source of Support:** Nil, Conflict of Interest: None declared.

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goods and increases the price of domestic-made products. This makes it necessary to analyze the effect of ERPT to CPI in order to apply anti-inflation policies in countries such as Iran experiencing double-digit inflation.

Considering the importance of exchange rate and its effect on CPI, this study aims to evaluate the effect of ERPT to CPI during 1991-2016 using quantile regression approach (The data and information used are collected from the central bank). The main hypothesis of study is the incomplete (partial) ERPT to CPI during the studied period. To examine this hypothesis this article has been structured as follows. Section 2 reviews previous studies on this field following the statement of the theoretical fundamentals of this subject. Section 3 introduces the used model, and presents estimated results with tables and plots and Section 4 concludes the article and presents policy-based suggestions.

## Theoretical Fundamental

ERPT debates were first emerged in economic studies in 1970 after the collapse of fixed exchange rate system. Since that time, the effect of ERPT on import has been the subject of many studies. Economists have evaluated the effect of ERPT on other price indices over time. Dorenbosch (1992) was the first economists who organized the studies using a model. The term of ERPT, or exchange rate transfer, is defined as the changes of importing/exporting prices, or domestic prices (in percent) for 1 percent change in exchange rate in terms of domestic currency<sup>[3]</sup>. In other words, ERPT assesses the relationship of changes to the value of a domestic currency with its transactions. Higher or lower ERPT indicates the sensitivity of the volume of transactions to domestic currency<sup>[6]</sup>. ERPT can be assessed in three models: complete path-through, incomplete pass-through or no pass-through. If for 1 percent change to exchange rate, importing price index (MPI) changes by 1 percent, the pass-through will be complete and if it is less than 1 percent, it will be incomplete. If price indices experience no change following changes to exchange rate, there will be no pass-through. ERPT degree generally varies between 0 and 1 (Kazeroni *et al.*, 2012:86).

In recent years, ERPT has been the subject of economy literature. Evaluations associated with the likelihood of the asymmetric ERPT were initiated in middle 1980s. Exchange rate asymmetry means the different response of prices to the changes of exchange rate in terms of size and direction<sup>[5]</sup>. This asymmetry may be occurred both in short-term and long-term. This asymmetry often occurs due to the downward stickiness of prices. Theoretically, different situations result in asymmetric responses. Market share, which was first introduced by Clamper Marston in 1990, is one of them. This means that if the currency value of the importer country increases and, in response to this increase, the exporter enterprise adjusts prices or considers discounts, the market share of the exporter will increase. Moreover, in the case of devaluation of the currency of the importer country, if the exporter enterprise bears parts

of inflation pressures in order to maintain its market share and reduce the price of goods, the ERPT will be asymmetric, despite the fact that the exporter will gain fewer benefits. ERPT will be higher in case of increased prices compared to decreased prices (pillbeam, 1992:63).

Making changes in production method is another cause of asymmetric ERPT. This means that in the event of exchange rate change, the producer enterprise tends to make changes in its production method in favor of itself. In the event of the increased value of the currency of the importer country, or in the event of the increased price of inputs, the exporter enterprise will tend to produce only by internal inputs. However, in the event of the devaluation of the currency of the importer country, or in the event of the reduced price of inputs, the exporter enterprise will tend to produce using imported inputs. Unlike two previous views, where ERPT is higher in case of increased value of the importer currency compared to devaluation case, in the limiting constraints, introduced by Kenter and Gill, ERPT to domestic prices is higher in devaluation case compared to increased value of currency. This happens when the producer who exports its goods to that country fails to increase its sales due to the increased currency value of the importer country.

**Table 1: Summary of views on the direction of asymmetric exchange rates pass-through**

Explanation	Pass-through
Market share	Appreciation > Depreciation
Production Switching	Appreciation > Depreciation
Quantity Constraints	Appreciation < Depreciation

Source: Pollard & Coughlin, 2004

The above-mentioned three causes are among factors triggering asymmetric response of prices to exchange rate change. List price cost is another cause of asymmetric ERPT generated due to the change of exchange rate size. According to Pollard and cogling (2004), asymmetric exchange rate size depends on the currency (exporter or importer) by which the exported/imported prices are deposited into accounts. If the price of imported goods is deposited in accounts in the currency of the importer country, higher exchange rate fluctuations will result in higher ERPT compared to small fluctuations. In contrast, if it is deposited in the currency of the exporter country, ERPT will be higher in case of small fluctuations of exchange rate (Bussiere, 2014, 158)

### ERPT to price indices occurs as direct and indirect pass-through

#### Direct pass-through effect:

- Direct EXPT is a two-stage process. In the first stage, exchange rate change affects imports. This implies ERPT to importing prices through the external department of a country. Since the change of exchange rate changes the price of importing goods, where the goods are generally intermediate or final products, consumer prices and expenses will change and exchange rate change, in turn, changes domestic

prices (stage 2). Of course, EXPT occurs when the producer considers no price discrimination. In this case, importing prices will change proportionally to exchange rate change.

#### Indirect pass-through effect:

- ERPT effect depends on the competitiveness of goods in international markets. In other words, the exchange rate change makes changes to the price of domestic goods in foreign markets (Morales, 2016). Therefore, the demand and consequently the exporting volume of the country changes, assuming price elasticity for exporting goods. Since the total demand for the considered good changes, the price of exporting goods may change in domestic markets too.

In addition to the above-mentioned direct and indirect effects, Taylor outlines expectation effect. According to Taylor, ERPT is higher when exchange rate change continues and prices are adjusted due to people expectations (Taylor, 2000). The following plot illustrates the direct and indirect pass-through effects (devaluation of the currency of the own country). According to the plot, consumer prices will increase through both direct and indirect effects.

#### Backgrounds

Dozens of studies have been conducted in Iran and foreign countries on ERPT. However, the majority of them have been concentrated on ERPT to import and export. This section briefly reviews the experimental studies in Iran and foreign countries.

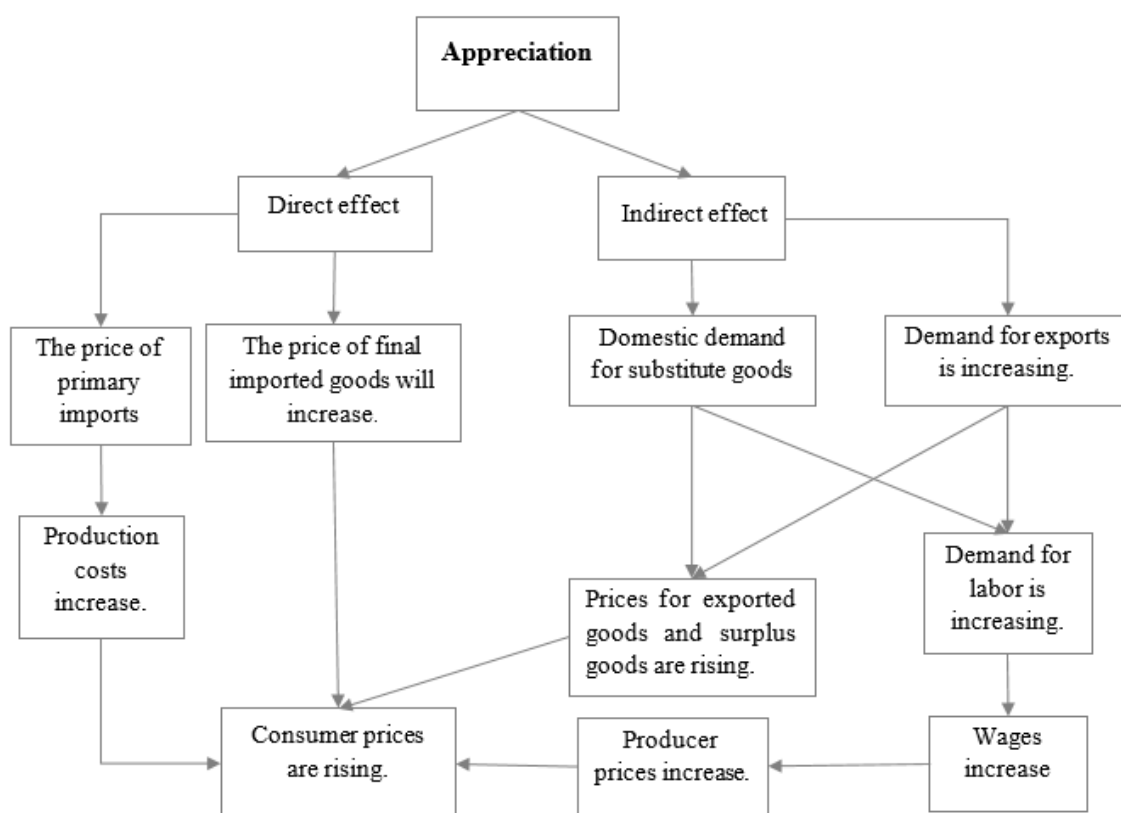


Figure 1: How to influence the exchange rate on domestic prices (Source: Kazeroni & Soleimani al-Wanq, 1394)

#### • International studies

In a study entitled "Crossing the Exchange Rate in Emerging Economies," Zurzzi *et al.* (2007) examined the degree of exchange rate pass-through on consumer prices in 12 Latin American, Central and Eastern European and Asian markets. In this study, seasonal data from 1994-1994 were used to estimate the VAR model. The results of this study indicated that the exchange rate passes both on the consumer price index and the import price index in emerging economies is more than the developed economies.

In 2009, Rajaan and Goswh examined the "trends and factors determining the degree of exchange rate pass-through in Korea and Thailand". This study used seasonal data from 1980 to 2006

and the DOLS (dynamic least squares) approach. According to the results of the study, the degree of exchange rate pass-through on the consumer price index in Thailand was higher than Korea. In addition, another finding was that the degree of US dollar exchange rate pass-through over consumer prices in both Thailand and Korea was higher than the Japanese yen.

Ben Sheikh in his 2013 study, studied "the exchange rate and consumer price index with the same approach of VAR (CVAR) among the 12 countries of the euro area". This study used seasonal statistics from 1980 to 2010. Using the Johansson Coagulation Test, he concluded that there is at least one coherent vector for all studying countries. The results of the estimates showed that in the long run, the spread of the

exchange rate pass-through over the consumer price index among countries (central and peripheral economies) is very high, resulting in a one percent change in the exchange rate pass-through in Portugal, the rate of exchange rate pass-through on the consumer price index in the long run is 84% and in France is less than 20%. In addition, the long-term rate of exchange rate pass-through in all of the 12 countries studied is very slow.

In 2014, Mirdala reviewed the "Crossing the Exchange Rate pass-through on Consumer Price Indicators in European Transit Economies." In this study, he used the VAR econometric model to estimate two equations. The data used in the first equation are monthly and from the years 2000-2007 and in the second equation, the monthly data are from 2000 to 2012. The results showed that as a result of exchange rate changes, the decline in consumer prices in different economies varied. On the other hand, better responses to the shock of oil prices in different countries will reduce the effect of the exchange rate's impact on domestic prices, which is expected to lead to a reduction in inflationary pressures in the target countries.

Santiago and Andres in 2015 studied the "exchange rate pass-through in Chile with the VAR approach". In this study, monthly data from 1987 to 2013 have been used. The average rate of exchange rate pass-through on the total consumer price index in the medium term is estimated to be between approximately 0.2-0.1. It has also been concluded that the rate of exchange rate pass-through on the consumer price index is close to zero, and the reason is that food prices are not entirely dependent on exchange rate changes. Similarly, the rate of exchange rate pass-through on the energy price index in the country in the 90's is almost zero, but since mid-2000 it has reached 50%.

Bahramshah and Siew-Voon, in their 2017 study, entitled "Crossing the exchange rate pass-through on domestic prices with a nonlinear approach", during the period 1990: 1- 2015: 4, examined the exchange rate pass-through in Malaysia. In this study, the Markov Switching Model (MSIAH-AR) was used and two regimes of high and low exchange rates are considered. Finally, it has been concluded that the exchange rate pass-through on the domestic price index in Malaysia is incomplete and asymmetric, according to the results of this study, the effect of an increase in the exchange rate (or the same, the devaluation of the national currency) relative to the time the exchange rate drops (Or, in other words, the national currency is strengthened) has a greater impact on domestic prices.

Li and his colleagues in 2017 tested the asymmetric effects of exchange rate pass-through movements in Thailand. In this study, monthly data from 2002-2010 and TAR and MTAR asymmetric co-integration models were used. The results of this study indicated that there is a coincidence in non-dimensional threshold values. Also, the effect of exchange rate pass-through on the consumer price index is asymmetric. In addition, the results of this study indicated that the strengthening of the national currency has a significant effect on the consumer price index, while the increase of the exchange

rate, or the same, does not have a significant effect on the monetary devaluation.

Comounel and Simola (2018) studied the exchange rate pass-through in the CIS consumer price index (CIS) and the role of the exchange rate, commodities, and other factors on the exchange rate pass through on the consumer price index. In this study, seasonal data for the years 1999-2014 and the heterogeneous panel approach have been used. The results of the research showed that the degree of the effective nominal exchange rate pass-through on domestic prices is higher compared to the bilateral exchange rate pass-through of the US dollar and the studied countries.

#### • Iranian studies

Tayyebnia and Rahimi (2006) evaluated in their study titled "ERPT to internal Prices of Iran (1990-2006)" ERPT to the MPI and CPI using vector auto-regression method. They used the monthly statistics of 1990-2006. The results of impulsive response functions indicate the incomplete ERPT to domestic prices in Iran. Moreover, ERPT to MPI is higher than CPI. According to variance decomposition results, exchange rate change well justifies price changes in Iran. In addition, exchange rate change has the highest contribution to the generation of inflation in Iran.

Khoshbakht and Akhbari (2007) evaluated in a study titled "effect of the influencing process of exchange rate change on CPI and MPI inflation in Iran" the quality and rate of EXPT. They used the seasonal data of 1990-2003, structural auto-regression model, impulsive response functions and Cholesky variance decomposition. They concluded that ERPT to MPI is higher than CPI. In addition, they concluded that the pass-through of money supply change to CPI is higher and quicker than MPI. Their results indicated incomplete ERPT in the studied period.

Moosavi Mohseni and Sobhanipour (2008) evaluated in their study titled "ERPT in Iranian Economy" the effect of exchange rate fluctuations on CPI, MPI and RPI using recursive VAR (recursive vector auto-regression) and the seasonal data of 1994-2006. They used response and variance decomposition functions and concluded that the effect of exchange rate fluctuations on prices in Iran is incomplete. Furthermore, they conclude that ERPT to MPI is higher than RPI and ERPT to RPI is higher than CPI, and it is less than unit in the three indices. According to variance decomposition table, inflation changes are originated from exchange rate change to some extent. Bahrami et al (2014) evaluated in a study titled "asymmetric ERPT to domestic price indices using SVAR" the quality of ERPT to price indices using the seasonal data of 1990:1-2013:2. Model estimations and the results of impulsive response functions showed that ERPT is asymmetric in Iran with alternating pass-through to domestic prices. In addition, among four variables indicating asymmetric ERPT (market share, change of production technology, limiting constraints and price list costs), small decreased fluctuations has a neutralized effect on price fluctuations while changes exceeding the threshold point of exchange rate change have the maximum effect.

Moreover, the durability of the pass-through to CPI is higher than other variables.

Kazerooni and Soleimani Alvanagh (2015) evaluated the degree of ERPT to CPI in Iran using time series data of 1978-2008 and ARDL method. They used ARDL, calculated the deviation of the actual value of exchange rate to long-term balanced values, and evaluated, then, ERPT rate using the deviated values. According to their results, ERPT is very low in short-term while it increases over time so that ERPT reaches from 0.07 to 0.42. Nevertheless, ERPT is again incomplete. In addition, they found that there is a significant positive relationship between the deviation of the actual value of exchange and CPI and the effect of the deviation of the actual value of exchange on CPI increases over time.

Ebrahimi and Madanizade (2016) evaluated ERPT changes and its influential factors in Iran. They calculated ERPT to domestic prices using SVAR and maximum likelihood function. To estimate the model, they used the seasonal data of 1992-2014. According to their results, ERPT in Iranian economy was 30% to 40% in the studied period. In addition, they found that ERPT to CPI is higher than PPI. Also, they concluded that as economy becomes more open, ERPT becomes more. They found that the reduced fluctuations of exchange and inflation rates can decrease ERPT but in low-inflation periods, ERPT does not decrease.

As one can observe, the majority of these studies have evaluated the linear relationship of CPI and exchange rate and have not used quantile regression to estimate ERPT to CPI in different quantiles. Therefore, this study aims to evaluate the degree of ERPT to CPI in different quantiles using the non-linear quantile approach.

## Introduction to model and result estimation

### Quantile regression

According to the fundamentals of statistics, the distribution of random variables can affect the interpretation and even prediction of variables. To this end, there are different criteria providing the researcher with different information. For example, variance shows dispersion and kurtosis and skewness show the distribution of variables. The aim of regression analysis is to define a relationship between prediction variables and the output, or the dependent, variable. It is impossible to estimate the accurate value of the dependent variable using prediction variables. Rather, the output value of each prediction variable will be a random variable. Therefore, the fixed values of core indices, computed for prediction variables, are used to obtain the behavior of the dependent variable against prediction variables. The indices are average, mean and MOD. The ordinary regression analysis is concentrated on mean by which it evaluates the relationship between prediction variables and the dependent variable using mean description for each fixed value of prediction variables and conditional mean function. Modeling and the use of conditional mean function is the focus of area of

regression-based modeling approaches including linear regression, multiple regression and models with heteroscedastic errors along with least squares method and non-linear regressions. Quantile regression is a statistical analysis method identifying more effects compared to ordinary techniques. In other words, it does not limit its concentration to conditional mean and, therefore, can assess almost whole conditional distribution range of the dependent variable. This method was first developed by Koenker and Basses in order to extend the least squares method of conditional mean models to conditional quantile functions (Koenker, Bassett:1987). The background idea of the development of quantile regression was to adopt it as an optimization approach. This idea made this method a fit mathematical tool to be used in conditional mean functions [7]. Since the introduction of quantile regression in 1970 it has continuously been developed as an applied statistical method. It is used in the inferences associated with conditional quantile functions. In 1990s, this method was widely being used in econometrics. It is a strong method for conducting a more comprehensive analysis on the relationships of random variables. It provides more flexible estimations from total conditional distribution of the output variable affected by covariate. This has made it a popular method.

Standard linear regression techniques briefly display a relative relationship between regress set and the output variable based on conditional mean function.  $E(y|x)$ . These functions can display only a part of available relationships while the description of the relationships in different points of the conditional distribution of  $y$  may seem necessary and Quantile regression offers such a capability. Furthermore, quantile regression method shows better performance in abnormal errors compared to least square method. Eliminating the limitations of ordinary regression assumptions, quantile regression enables the intervention of independent variables in all distribution sections, especially in the start and end sequences. Unlike ordinary least squares method, where conditional mean functions are estimated based on minimizing the total sum of squares of residuals, quantile regression is based on the asymmetric minimizing of the absolute value of residues. The aim is to estimate conditional mean functions and a wide range of other quantile conditional functions. The parameters of quantile regression model are estimated using least absolute deviation (LAD) [Bigane et al, 2016: 2]. The most important application of quantile regression is more likely in the identification of the distribution form of the dependent variable of model at different levels of descriptive variables. This is done by the fitting various regression models for different quantiles on a set of data [Bamani and Khoshgooyan, 2007: 15]. The advantages of this technique are as follows:

- 1- Unlike ordinary least squares technique, LAD is robust to outliers. In other words, outliers sign and value could not affect LAD.
- 2- There is no closed form for estimating model parameters and numerical techniques are used. Under such a condition, the final solutions of quantile

regression for a data set are likely not unique and the problem may be solved by selecting a criterion.

- 3- If  $\varepsilon_{\theta_i}$  is random variables with normal distribution, regression lines will be parallel for different quantiles

Quantile regression can generally be defined as follows:

If  $Y_i = \beta_{\theta}x_i + \varepsilon_{\theta_i}$  is the general form of linear regression and  $Q_{\theta}(\varepsilon_{\theta_i}|X_i) = 0$ , the  $\theta^{th}$  conditional quantile of distribution  $y$  will be the condition of random variables  $X$  as follows:

$$Q_{\theta}(Y|X_i) = \beta_{\theta}x_i, i = 1, 2, \dots, n$$

Where  $\beta_{\theta} = (\beta_1, \beta_2, \dots, \beta_k)$  and  $x_i = (1, x_{i1}, \dots, x_{ik})$  are a vector of unknown parameters,  $\beta_{\theta}$ , and known values,  $x_i$ , respectively and  $\varepsilon_{\theta_i}$  is a latent random variable. The above equation is called the linear regression of the  $\theta^{th}$  quantile. In the estimation of quantile regression, the objective function of the  $\theta^{th}$  quantile should be minimized.

$$Q(\beta_{\theta}) = \sum_{i: y_i \geq x_i' \beta} \theta |y_i - x_i' \beta_{\theta}| + \sum_{i: y_i < x_i' \beta} (1 - \theta) |y_i - x_i' \beta_{\theta}|$$

This is a non-differentiable function and is minimized using a non-composite and simple technique. In this way, it is possible to achieve an optimized solution through an unlimited number of iterations [8] (Davino et al, 2013).

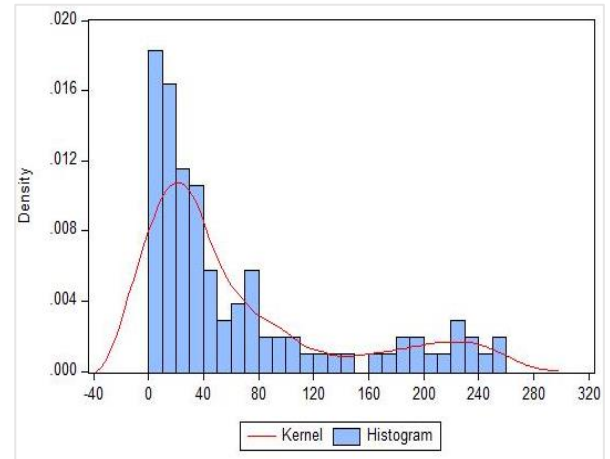
### Introduction of model and study variables

The overall research model is based on the study of Kozmanja and Mania (2010) as follows:

$$lcp_i = \alpha_1 + \alpha_2 gap_t + \alpha_3 lm2_t + \alpha_4 lexr_t + \alpha_5 opn_t + U_t$$

In the equation above,  $lcp_i$  is the logarithm of the consumer price index,  $gap_t$  production gap,  $lm2_t$  logarithm of liquidity,  $lexr_t$  logarithm of the free market exchange rate (informal exchange rate) and  $opn_t$  is the degree of openness of the economy. In the present study, seasonal data of 1370-1395 was used. To calculate the production gap, the Hodric-Proscat filter is used.

According to econometrics literature, if the distribution of the dependent variable is not normal, ordinary least squares regression cannot be used and quantile regression model should be used, instead, to estimate the model. According to plot 1, the distribution of the dependent variable is not normal. Therefore, quantile regression technique is the most effective method for model estimation because OLS regression estimation results will be biased.



Graph1. Histogram of consumer price index (1370: 1-1395: 4)

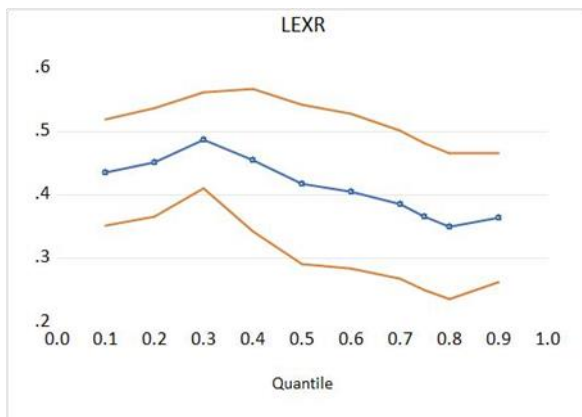
In the above plot, CPI is skewed to the right with outliers. On the other hand, outliers do not affect estimation results in quantile regression. Therefore, this method will yield better results. According to the above plot and the nature of data, the study model was estimated using quantile regression. Table 2 reports estimation results.

Table2: The results of the quantum regression estimation in deciles of 0.1-0.9 (Dependent variable: consumer price index logarithm)

Deciles	Intercept [prob.]	Gap [prob.]	lm2 [prob.]	Lexr [prob.]	Opn [prob.]
0.1	-8.69[0.000]	0.17[0.108]	0.45[0.000]	0.43[0.000]	-0.37[0.000]
0.2	-9.87[0.000]	0.26[0.023]	0.42[0.000]	0.45[0.000]	-0.37[0.000]
0.3	-9.76[0.000]	0.24[0.060]	0.41[0.000]	0.48[0.000]	-0.28[0.096]
0.4	-10.38[0.000]	0.31[0.088]	0.42[0.000]	0.45[0.000]	-0.38[0.138]
0.5	-12.12[0.000]	0.46[0.030]	0.41[0.000]	0.41[0.000]	-0.40[0.061]
0.6	-11.52[0.000]	0.42[0.047]	0.42[0.000]	0.40[0.000]	-0.41[0.023]
0.7	-11.49[0.000]	0.43[0.041]	0.42[0.000]	0.38[0.000]	-0.45[0.006]
0.8	-10.03[0.000]	0.32[0.173]	0.45[0.000]	0.35[0.000]	-0.43[0.023]
0.9	-13.12[0.000]	0.59[0.001]	0.41[0.000]	0.36[0.000]	-0.60[0.000]

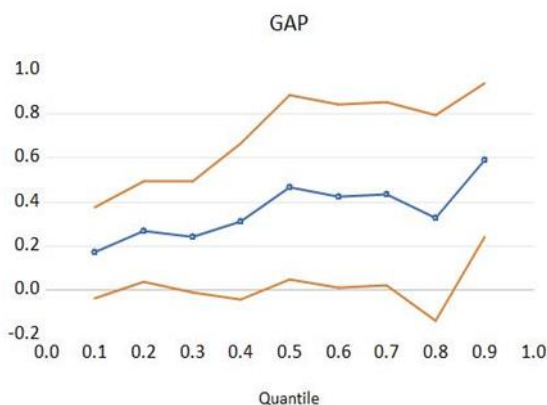
Source: Research findings

The values of table 2 indicate that all selected variables, including production gap, liquidity, exchange rate in free market and economy openness degree have a significant influence on CPI. According to the model results, there is a significant positive relationship between exchange rate and CPI in all deciles. This means that the increase of exchange rate will lead to the increase of CPI and will deteriorate inflation status. Mean exchange rate factor is 0.41 with 0.35 and 0.48 as the minimum and the maximum factors. According to the following plot, exchange rate factor has an increasing trend in initial deciles and then it becomes decreasing. Another conclusion that can be derived from the factors is the possibility of calculating ERPT to CPI which is known in each decile. Since exchange rate is introduced to the model in a logarithmic manner, the factors are the degree of ERPT to CPI.



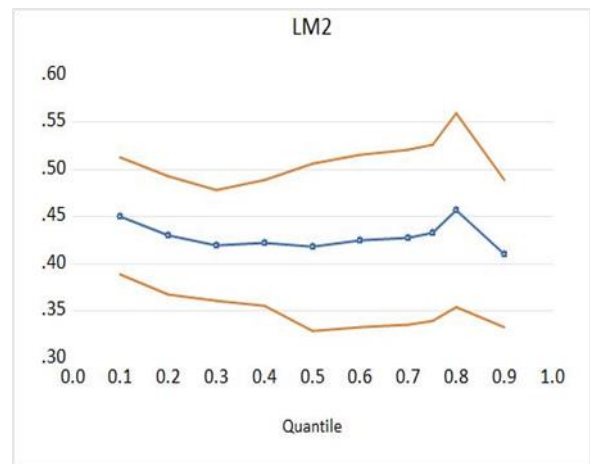
**Figure 2:** Effect of the degree of the exchange rate pass-through on the consumer price index in different deciles (rate of exchange rate pass-through on the consumer price index)

In addition, model estimation results indicate that in all deciles, except 0.1, 0.3, 0.4 and 0.8, there is a significant positive relationship between production gap and CPI. According to the plot of production gap factors, the intensity of the effect of GDP on CPI is significant and increasing in all deciles. This means that during the studied period, CPI has increased by 0.46, on average, for one-unit increase in production gap.



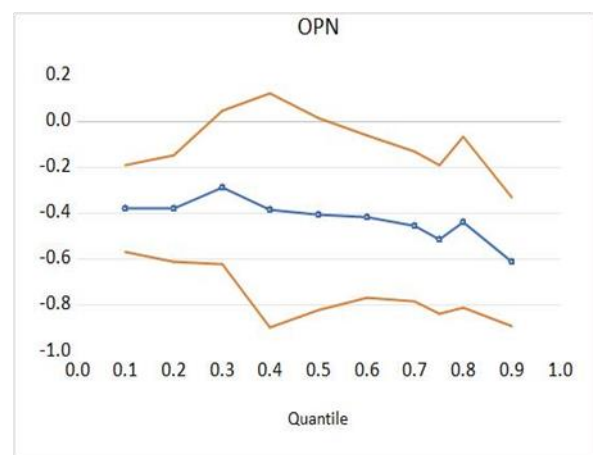
**Figure 3:** Effect of production gap on consumer price index in different deciles

Moreover, according to estimation results, there is a significant positive relationship between CPI and liquidity in all deciles. This means that as liquidity increases, CPI increases. Generally, liquidity affects CPI by 0.41. In addition, the maximum factor (effectiveness) of liquidity is 0.45. The evaluation of liquidity factors in the model indicate that the intensity of the effect of liquidity on CPI follows a decreasing trend from the first decile to the 7<sup>th</sup> one while it has an increasing trend from the 7<sup>th</sup> decile to the 8<sup>th</sup> one and again becomes decreasing. Plot 4 shows the intensity of the effect of liquidity on CPI (liquidity factors in the model).



**Figure 4:** Effect of liquidity on consumer price index in different deciles

Plot 5 shows the factors of economy openness degree in the equation. According to the model results, in all deciles, except 0.3, 0.4 and 0.5, there is a significant inverse relationship between economy openness degree and CPI. This means that CPI decreases for 1-unit increase in economy openness degree. The intensity of the effect of economy openness degree on CPI is significantly decreasing in all deciles. Mean factor is -0.41 with -0.37 and -0.60 as the maximum and minimum factors.



**Figure 5:** Effect of openness of the economy on the consumer price index in different deciles

Following the evaluation of model estimation factors, the quantile regression fitness lines were plotted for different deciles. Plot 6 shows the regression lines of 9 regression deciles fitted on data for deciles 0.1 to 0.9.

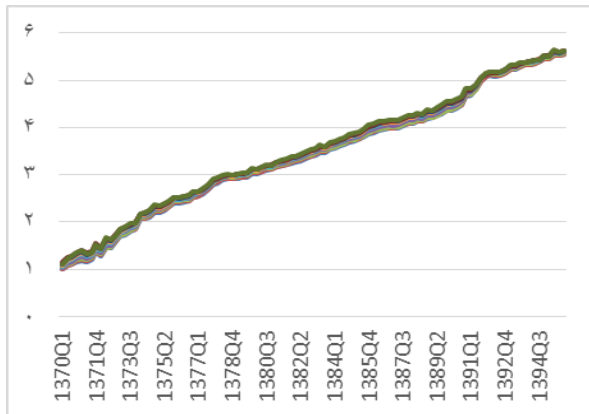


Figure 6: Quantum regression fitting lines

Wald test was used to examine the equality of coefficients across deciles 0.1-0.9. Table 3 shows the results. According to the likelihood of Wald test statistics, the hypothesis of the equality of coefficients is rejected and it can be argued that ERPT to CPI is significantly different between different quantiles.

Table 3: Equivalent coefficient test results

	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
$\chi^2$	0.	0.	0.	0.	0.	0.	0.	0.	0.
[prob.]	0015	0033	0052	0033	0042	0005	0004	0064	0022

Source: Research findings

Bootstrap (MCMB-A) technique was used to confirm quantile regression estimations. This technique makes the condition of samples closer to the condition of population by creating plenty of samples without any hypothesis and confirms coefficient estimations and confidence distance of them considering all possible states of the samples [9]. Therefore, MCMB-A algorithm was used to analyze quantile regression results. Table 4 shows MCMB-A bootstrap results that confirm quantile regression results.

Table 4: Results of MCMB-A bootstrap estimation of quantum regression in deciles of 0.1-0.9 (Dependent variable: consumer price index logarithm)

Deciles	Intercept [prob.]	Gap [prob.]	lm2 [prob.]	Lexr [prob.]	Opn [prob.]
0.1	-8.69 [0.000]	0.17 [0.050]	0.45 [0.000]	0.43 [0.000]	-0.37 [0.000]
0.2	-9.87 [0.000]	0.26 [0.009]	0.42 [0.000]	0.45 [0.000]	-0.37 [0.001]
0.3	-9.76 [0.000]	0.24 [0.127]	0.41 [0.000]	0.48 [0.000]	-0.28 [0.218]
0.4	-10.38 [0.000]	0.31 [0.060]	0.42 [0.000]	0.45 [0.000]	-0.38 [0.169]
0.5	-12.12 [0.000]	0.46 [0.003]	0.41 [0.000]	0.41 [0.000]	-0.40 [0.054]
0.6	-11.52 [0.000]	0.42 [0.001]	0.42 [0.000]	0.40 [0.000]	-0.41 [0.013]
0.7	-11.49 [0.000]	0.43 [0.002]	0.42 [0.000]	0.38 [0.000]	-0.45 [0.002]
0.8	-10.03 [0.000]	0.32 [0.023]	0.45 [0.000]	0.35 [0.000]	-0.43 [0.001]
0.9	-13.12 [0.000]	0.59 [0.001]	0.41 [0.000]	0.36 [0.000]	-0.60 [0.000]

Source: Research findings

## Conclusion

Adopting quantile regression approach, this study evaluated the relationship of the selected macro-economy variables with CPI using 1991-2016 seasonal data to calculate ERPT degree. Based on economy literature, the devaluation of national currency deteriorates CPI inside country. The experimental estimations of model agree with current theories. In other words, according to model estimations, the increase of exchange rate (devaluated currency) in deciles 0.1-0.9 increases CPI. In addition, it was found that other studied variables including production gap, liquidity and economy openness degree have a significant effect on CPI. According to our results, considering the positive and significant effect of exchange rate on CPI, it is necessary to control exchange rate fluctuations in order to control domestic prices because by the devaluation of national currency, the price of imported goods increasingly rises. Since the majority of imported goods are intermediate goods, any change in the price of imported goods is transferred, both directly and indirectly, to the price of production goods and this, in turn, changes internal price indices, both CPI and PPI. Therefore, Central Bank should control exchange rate fluctuations and prevent the devaluation of national currency. On the other side, since increased liquidity leads to the ever-increasing rise of CPI, Central Bank should control liquidity in order to control inflation-induced problems. This can be practiced by both saving and using current cash flow in productive activities that results in both economic growth and increased employment. This, in turn, increases GDP, decrease production gap and improves CPI. Moreover, inflation pressures are lower in economies that are more open. Therefore, economic policies should increase economy openness degree in order to lower CPI increase.

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