Journal of Money and Economy
Vol. 12, No. 1, Winter 2017
pp. 1-21

The Effects of Exchange Rate on Price-Setting in Manufacturing Sector: Applying Price Micro Data of Iran

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Received: 24 Jul 2018 Approved: 04 Sep 2018

This paper uses monthly price indices of 448 items of manufacturing sector in 2004:4 to 2016:01, to study the effect of exchange rate and its volatilities on price setting behavior of manufacturing sectors. Given that, many manufacturing sectors in Iran need to import raw materials, intermediate and capital goods in their production process, it is expected that exchange rate variations affect price setting behavior indices (frequency and size of price changes) in various manufacturing sectors. The results show that an increase in the exchange rate and also an increase in the exchange rate volatility lead to an increase in the frequency of price changes. In addition, while the exchange rate, itself, does not affect the size of price changes, the exchange rate volatility negatively affects the size of price changes. That is, manufacturers' response to the exchange rate increase is limited to an increase in the frequency of price changes, but an increase in the exchange rate volatility increases the frequency of price changes and decreases the size of price changes. Also, the frequency of price changes in manufacturing sectors with high level of competitiveness and low level of raw material inventory is positively affected by the exchange rate increase.

Keywords: Exchange Rate, Frequency of Price Changes, Size of Price Changes, Monetary Policy
JEL Classification: D22, E31, E52

1 Introduction

This paper investigates the effect of exchange rate variation and exchange rate volatility on price setting behavior of manufacturing sectors by using monthly price indices of 448 items of the manufacturing sector in 2004:4 to 2016:01. The importance of such studies is to help policy makers choose the appropriate exchange rate policy. Choosing suitable, accurate exchange rate policy is important because nearly 52% of Iranian products are manufacturing products,

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and many sectors of manufacturing need to import raw materials, intermediate and capital goods in their production process. Therefore, exchange rate variations affect the performance of manufacturers.

For their target profit margin, manufacturers change their production and price setting behavior, including frequency and size of price changes, in response to exchange rate variations. In most of the manufacturing sectors, decisions about the amount of production and price setting behavior are not taken independently, rather taken simultaneously and based on a specific logic to meet the targeted profit margin. The present paper explores price setting behavior in response to exchange rate variations and volatility. The findings help to discover some information about the behavioral logic of manufacturers in response to macroeconomic shocks.

The effect of exchange rate variations on the price of manufacturing products, termed exchange rate pass-through in economic literature, is revealed either in the form of the frequency of price changes or in the form of the size of price changes, because in the midst of any changes in price, there is a change in the frequency and size of price changes. So if the effects of exchange rate variations on the frequency and size of price changes are investigated, appropriate policy recommendations are obtained for the monetary policymaker. Given that there is an inverse relationship between the frequency of price changes and price rigidity, exploring the relationship between exchange rate and the frequency of price changes usually indicate the relationship between exchange rate changes and the degree of price rigidity. An example is if an increase in exchange rate decreases the degree of price rigidity, the real effects of monetary policy decrease (Alidou, 2014). It is worth considering that the real effects of monetary policy is asymmetric relative to inflation rate such that in low levels of inflation, the real effects of monetary policy is stronger than in high levels of inflation (Madanizadeh & Bayat, 2016).

The results show that increases of exchange rate growth and exchange rate volatility will increase the frequency of price changes. On the other hand, the effect of exchange rate growth on the size of price changes is not statistically significant, but exchange rate volatility negatively affect the size of price changes. That is, manufacturers' response to the exchange rate increase is limited to an increase in the frequency of price changes, but an increase in the exchange rate volatility increases the frequency of price changes and decreases the size of price changes. Also, the frequency of price changes in manufacturing sectors with a high level of competitiveness and low level of raw material inventory is positively affected by the exchange rate increase.

The remainder of this paper is organized as follows. Section 2 describes the theoretical foundation of the research. Section 3 reports the main features of the dataset. Section 4 presents the research methodology. Section 5 reports the results of econometric models. And the last section is conclusion and policy recommendations.

2 Theoretical Foundations

Economic policymakers should pay attention to exchange rate fluctuations and volatilities which affect the price-setting behavior of manufacturing sectors from various channels. Understanding these channels can clarify the mechanisms through which exchange rate changes affect price setting behavior. In this section, the relationship between the exchange rate and price setting behavior is investigated.

2.1 Exchange Rate and Price-Setting Behavior

Nearly 52% of Iranian products are manufacturing products, and many manufacturing sectors need to import raw materials, intermediate and capital goods in their production process. Therefore, exchange rate volatilities can affect the price setting behavior of manufacturers quickly. If, after an exchange rate shock, producers want to keep their profit margins as before, they should change the frequency and size of price changes such that the new price of their products includes exchange rate fluctuations and volatilities. For example, if suddenly exchange rate increases, price setter faces three choices. The first is that the frequency of price changes increases. The second one is that without any changes in the frequency, the size of price changes increases in each period of price change. The third choice for producers is that the combination of the first two choices is adopted. It is obvious that for each choice, price setting behavior of producers is affected by exchange rate fluctuations and volatilities.

In addition, it seems that price setting behavior of producers is affected by exchange rate volatilities. Because an increase in exchange rate volatilities increases uncertainty in the macro environment, and surely producers try to input uncertainty in their price setting models. Increase in uncertainty is usually reflected by a sudden change in demand as some buyers decide to order the production of the manufacturer more than before to cover themselves against future exchange rate risks, and some others decide to postpone their purchases until the foreign exchange market stabilizes. So, the manufacturers' decision to change the frequency and size of price changes is usually driven by changes in their demand. For example, a producer who faces a sudden

increase in his product demand may decide to increase the frequency and size of price changes in order to increase his profit margin. It turns out that predicting the effect of exchange rate volatilities on price setting behavior is not as easy as predicting the effect of exchange rate fluctuations on price setting behavior, and it is necessary to apply statistical methods to investigate the relationship between exchange rate volatilities and price setting behavior.

There are some studies on the effect of exchange rate fluctuations on price setting behavior. For example, Kochen and Samano (2016) investigate the relationship between exchange rate and price-setting behavior in Mexico and found a positive relationship between the exchange rate and the frequency of price changes. Also, Gopinath and Itskhoki (2009) explore the relationship between real exchange rate and the frequency of price changes. Berger and Vavra (2015) examine the relationship between exchange rate pass-through and the distribution of price dispersion (the second-order moment of price setting behavior index) and find a positive relationship between them.

Most researches in this field investigate the effect of inflation rate on price setting behavior. For example, Alvarez and Lippi (2011), Alvarez et al (2013), Gagnon (2009) and Bayat and Madanizadeh (2016) investigate the effect of inflation on price setting behavior in Argentina, Mexico and Iran. There are other studies that emphasize on the positive effect of inflation on price setting behavior (see Golosov and Lucas (2007), Sheshinski and Weiss (1977), Benabou and Konieczny (1994)). Also, Klepacz (2016), using price microdata, investigate the effect of shocks caused by oil price uncertainty on price setting behavior in the manufacturing sector of USA economy and show that when oil price uncertainty increases, the degree of price rigidity decreases. In literature, similar studies are available (see Vavra (2014), Bachmann et al (2013), Baley and Blanco (2016)). Jonker et al (2004) examine the VAT policy on price setting behavior and find that this policy has a direct effect on price setting behavior.

The reason why most studies are devoted to examine the impact of inflation on price setting behavior is that researchers believe that inflation rate is a variable that is simply available to price setters and they can adjust the price of their products in an optimal way by observing inflation rate (Gagnon, 2009). Exchange rate information is available to everyone as well as inflation rate, but because the exchange rate, unlike the inflation rate, are monitored daily, it is likely that price setters pay more attention to the exchange rate than the inflation rate. So, the goal of the paper is to examine the effect of exchange rate fluctuations on price setting behavior.

3 Data and Methodology

To investigate how exchange rate fluctuations affect price setting behavior of manufactures, several databases are used. Exchange rate data is quarterly growth of exchange rate in the free market during 2004 to 2016 and to calculate the volatility of exchange rate, Ggeneralized Autoregressive Conditional Heteroscedasticity [GARCH] (1,1) is used. The data of manufactures' price, as dependent variable, is available in four-digit ISIC codes. Description of the important variables are shown in Table 1. Based on table 1, quarterly average of exchange rate growth (US dollar growth) during 2011 to 2016 is 5.98 % and CPI growth is 4.59 % in this period.

Some other reported variables in Table 1 refer to the features of manufactures. The characteristics such as investment, inventory, ownership and management in the industry, the number of firms in the industry, and export and import-related manufactures are extracted from the reports of major industrial firms. Based on 2004 data, in terms of the number, 97%, in terms of the employment, 94%, and in terms of management, 97%, of these firms are private. In addition, the purchase of foreign capital goods accounts for 11.85% of the total investment in the industrial sector in 2004. Export to production ratio shows that manufacturing firms export 22% of their production. Also, about 17% of raw materials of the manufactures is supplied from abroad. Price indices of 448 items of manufacturing sector in four-digit ISIC codes in 2004:4 to 2016:01 are used to calculate frequency and size of price changes. The number of manufacturing sector items is more than 448, but because base year has changed to 2011, only 448 common items in 2004 and 2011 are taken into account.

To calculate frequency and size of price changes, rolling window method is used. This way, the frequency of price changes is calculated over a period of time and then by rolling the window a time path is obtained for the frequency of price changes. The length of each window is 12 months, so the frequency of price changes of each item in one year is equivalent to the number of price changes of the item in each year.

If p_{it} is the price of item i at time t, and I_{it} is index of the price change of the item, and T is the number of total observations, then

$$f_{ik} = \frac{\sum_{t=k}^{t_1+k-1} I_{it}}{t_1} \qquad For\ k = 1,13, \dots, T - t_1 + 1$$
$$I_{it} = \begin{cases} 1 & if\ |\Delta p_{it}| > 0.005 \\ 0 & if\ |\Delta p_{it}| < 0.005 \end{cases}$$

For each item in consumer basket, there is a time series for frequency of price changes. Frequency of price changes is divided into positive and negative frequency of price changes. Positive (negative) frequency of price changes include the number of price changes that price increases (decreases). The sum of positive and negative frequencies of price changes is equal to the frequency of price changes.

To calculate the time series of the size of price changes Δp_{ik} using rolling window method, the first step is that average size of price changes is calculated in a time period. For this, price changes for each month compared to the month before is calculated. Then the average size of price changes in these months is calculated. Then by rolling the window, a time series for the size of price changes is obtained:

$$\Delta p_{ik} = \frac{\sum_{t \in K} |\Delta p_{it}|}{f_{ik}} \qquad For\ k = 1,13, \dots, T - t_1 + 1$$
$$\Delta p_{it} = \log(p_{it}) - \log(p_{it-1})$$

According to Table 1, the frequency of price changes in manufactures is 32%, and the portion of positive frequency of price changes is more than the portion of negative frequency of price changes. Also, the average of the size of price changes is 1.35 and the portion of positive size of price changes is more than the portion of negative size of price changes.

3.1 Correlation Analysis

To investigate the relationship between the exchange rate changes and firms' price setting behavior, the correlation coefficients of the variables are reported in this section. We calculate the correlation coefficients between price setting behavior indices and exchange rate fluctuations in the industry level to clarify the level of the difference of these correlations between the industries and confirm the heterogeneity of this relationship in the industry level.

Figure 1 compares the correlation coefficients of the exchange rate and the frequency of price changes between different industries. According to this figure, the correlation sign between the exchange rate and the frequency of price change is positive in most of industries.

Table 1
Summary Statistics of the Main Variables

	Variable	Data Structure	Observations	Mean	Standard Deviation
Price & Macroeconomic Variables	Exchange Rate (US Dollar/Rial) Growth (%)	Monthly	142	1.10	4.59
	Exchange Rate (US Dollar/Rial) Volatility (GARCH Model)	Monthly	142	0.0024	0.0069
	CPI Growth Rate (%)	Monthly	142	1.38	0.93
	Frequency of Price Change	Monthly	63616	0.32	0.26
	Frequency of Positive Price Change	Monthly	63616	0.23	0.19
	Frequency of Negative Price Change	Monthly	63616	-0.09	0.13
	Size of Price Change	Monthly	63168	1.35	1.16
	Size of Positive Price Change	Monthly	63168	1.83	15.87
	Size of Negative Price Change	Monthly	63168	-0.48	2.48
Industry Characteristics	Private Ownership Ratio Based on Number of Firms (%)	Annual	336	96.86	5.02
	Private Ownership Ratio Based on Number of Workers (%)	Annual	336	93.97	10.26
	Private Management Ratio (%)	Annual	336	96.93	5.02
	Number of Firms In Each Industry	Annual	336	121.05	167.09
	Export Per Output Ratio (%)	Annual	336	22.22	28.29
	Investment Per Output Ratio (%)	Annual	336	4.32	7.49
	Number of Workers Per Output Ratio	Annual	336	0.074	0.045
	Expenditure on Foreign Investment Per Total Investment Ratio (%)	Annual	336	11.85	12.47
	Expenditure on Foreign Raw Materials Per Total Input Ratio (%)	Annual	336	17.03	13.17
	Total Stock Inventory Per Output Ratio (%)	Annual	336	65.06	33.10

Source: Research Findings

Furthermore, the correlation of the exchange rate and the production growth rate in the industries are presented in Figure 1. The correlation coefficient between the frequency of price change and the exchange rate is higher in industries in which the correlation coefficient between production growth rate and the exchange rate is lower. This means that the price

adjustment or the production adjustments are two methods that industries choose to react to exchange rate shocks.

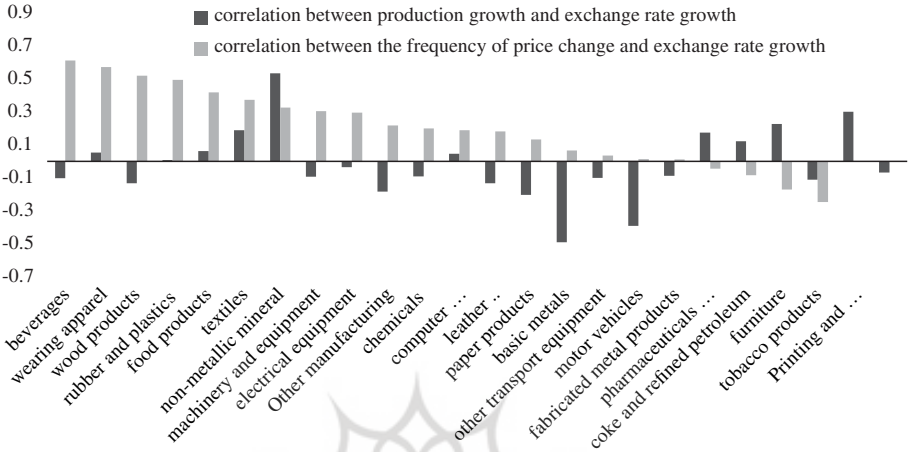

Figure 1. Exchange rate correlation with the frequency of price change and production growth among the industries. *Source*: Research Findings

The relationship between the exchange rate correlation with the frequency of price changes and size of price changes is negative. The relationship between these variables' correlations (with exchange rate) is depicted in Figure 2 in a scatter plot which the horizontal axis indicates the correlation of exchange rate and the frequency, and the vertical axis indicates the correlation of exchange rate and the size of price changes. The dispersion of the points in Figure 2 shows that there is a negative relationship between these correlations which means a depreciation of exchange rate leads to increase in one of these two items (size and frequency). So there are some industries with a high reaction in the size of price change and lower reaction in the frequency of price change and vice versa.

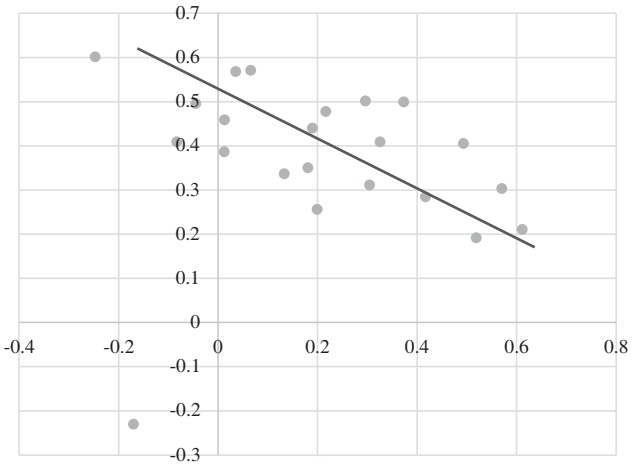

Figure 2. Scatter plot between the correlation of exchange rate with the size of price change (vertical axis) and with the frequency of price change (horizontal axis). *Source*: Research Findings

Figure 3 is another scatter plot which shows the relationship between the percent of state-owned firms and the correlation of the exchange rate and the frequency of price change at the industry level. According to the figure, there is an inverse relationship between the variables. The higher level of share of the government in the industries is correlated with the weaker correlation between the frequency of price change and the exchange rate. Indeed, when an exchange rate shock happens, the government will try to restrict the price adjustment in industries which have a strong ownership relationship with the government.

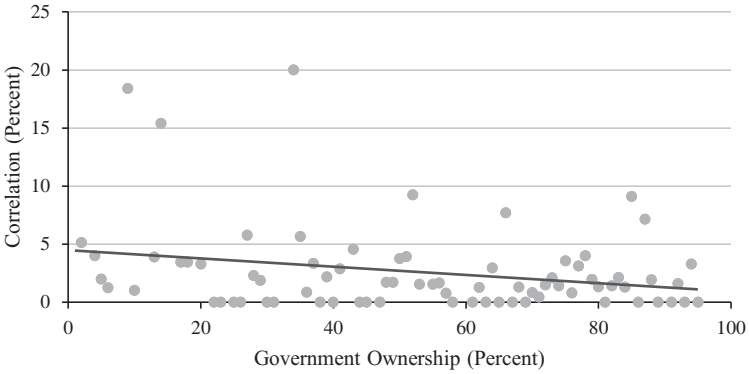

Figure 3. Scatter plot of the percent of government ownership and the correlation between exchange rate and Price adjustment among the industries. *Source*: Research Findings

3.2 Methodology

In this research, a weighted panel regression model is used to estimate the effects of exchange rate growth and volatility on the price setting behavior of industrial firms. The regression specification is:

$$Freq_{it} = \alpha_0 + \alpha_1 NER_t + \alpha_2 VER_t + \alpha_3 \pi_t + u_{it} \quad (1)$$

Where i is the 4-digit ISIC code of each industry, t is the year, Freq is the frequency of price changes, NER is annual growth rate of nominal exchange rate (US Dollar in free market), VER is volatility of exchange rate and π is annual growth rate of CPI index (inflation rate). Also in all regressions, industry fixed effects are used based on 4-digit ISIC codes.

Nominal exchange rate is not a correct measure to identify the accurate effects of exchange rate growth on frequency and size of price changes, so considering a stable foreign inflation rate, it is reasonable to use internal CPI growth rate to get the real exchange rate. In addition, weight of each ISIC code is calculated regarding to its share in the CPI index of 2011 as the base year. Size of price change regressions are similar to equation (1) and only the dependent variable is shown by size.

5 Estimation Results

We estimate the models which the frequency of price change and the size of price change are as dependent variables. The estimation results are reported in Table 2. According to the table, the exchange rate growth and the exchange

rate volatility have significant and positive effects on the frequency of price changes, but CPI inflation does not have any significant effects on the frequency. In other words, increase in exchange rate volatility and depreciation of the local currency lead to increase in the frequency of price changes but we cannot find any evidence to confirm the relationship between the inflation level and the frequency of the price changes. Also the size of price changes is not affected by the exchange rate fluctuations, but it is affected negatively by the exchange rate volatility and positively by CPI inflation. Increase in the foreign currency price lead to increase in the frequency of price change but the size of price change is not affected. Moreover, exchange rate volatility increases the frequency of price change and decreases the size of price change. Also, between the size and frequency of price changes, only the size of price change responses to the inflation change.

Table 2
Regression Results of the Frequency and Size of Price Changes

	Frequency of Price Change	**Frequency of Price Change**	**Size of Price Change**	**Size of Price Change**
Exchange Rate Growth	**0.000971*****	**0.000933*****	**0.0603**	**-0.0162**
	(0.000219)	(0.000223)	(0.100)	(0.102)
Exchange Rate volatility	**5.167*****	**4.028****	**-565.2**	**-2,861*****
	(1.238)	(1.803)	(567.4)	(819.8)
CPI Growth		**0.000918**		**1.850*****
		(0.00106)		(0.480)
Constant	**0.298*****	**0.285*****	**10.62*****	**-16.07****
	(0.00482)	(0.0160)	(2.210)	(7.270)
Observations	936	936	936	936
R^2	0.146	0.147	0.001	0.018
Industry Fields	78	78	78	78

Notes: *, **, *** denote significance at 1%, 5% and 10% levels respectively. Robust standard errors are reported in parentheses. Annual data from 2004 to 2015 has been used and estimation method is weighted panel regression with industry fixed effects where weights are based on industries share in CPI index at 2011 base year. *Source*: Research Findings

In addition to the sign of the effects of explanatory variables on the dependent variables, magnitudes of these effects are also important. According to the Table 1, the average frequency of price change is 0.32 (means that on average, industrial firms change their price 3 times in each year). Based on Table 1 statistic and the estimated coefficient of Table 2, if Dollar price (in term of Rial) rises 1 percent, it leads to an increase in the frequency of price change only by 0.00093 percent. But the effect of exchange

rate volatility is much stronger than the effects of exchange rate fluctuations. So that one standard deviation increase in the exchange rate volatility leads to 0.028 percent increase in the frequency which is considerable. Moreover although one percent increase in the CPI inflation does not affect the frequency of price changes, but increases the size of price change by 1.85 percent.

As mentioned earlier, the effects of exchange rate fluctuations and its volatility on price setting behavior indices is different among the industries. To test this claim, we divide the sample of industries in two groups based on the industries' properties such as degree of export-orientation, import dependency, ownership and management structure (in term of private or public shares in the industries) labor-intensity, capital intensity, competitiveness, and the inventory level of output and intermediate goods. Then we estimate the model in the sub-samples and compare the extracted coefficients of exchange rate in two different sub-samples to identify the effects of the benchmark characteristic (which is the benchmark to divide the sample). More specifically, first we order the sample of industries in each year based on a benchmark property (like degree of export-orientation). Next, the observations in the first 33 percentile are categorized as low export-oriented industries and the observations in the last 33 percentile are categorized as high export-oriented industries. Then, to identify the effect of the benchmark measure (such as export-orientation) on the relationship between the exchange rate and price setting variables in different industries, we estimate the model in two sub-samples (which separated by the benchmark) and compare the obtained exchange rate coefficients. This approach is applied for 8 industry properties and the results are reported in Table 3 to Table 6.

The benchmark measure in the first four columns of Table 3 is the degree of export-orientation. According to the results, exchange rate growth does not have any significant effects on the frequency and also the size of price change in both sub-samples; export-oriented industries and non-export- oriented industries. However, CPI inflation has significant effects on these two variables (the size and the frequency) in both sub-samples. While a positive CPI inflation reduce the frequency of price change in export-oriented industries, it has significant and positive impact on the size of price change. So in response to an increase in CPI inflation, export-oriented industries decrease the frequency of their price change and increase the size of price change. Moreover, exchange rate volatility in these industries only induces an increase in the frequency of price change. In other side, CPI inflation in non-

export-oriented industries leads to an increase in both of the size and the frequency of price changes.

Table 3
Regressions Results in Different Subsamples Divided by Export-Orientation and Access to Preferential Exchange Rate

	Export Per Output Ratio			
	Frequency of Price Change		Size of Price Change	
	Lower Tale	Upper Tale	Lower Tale	Upper Tale
Exchange Rate Growth	**0.000449**	**-0.000278**	**-0.0177**	**0.0143**
	(0.000345)	(0.000498)	(0.0120)	(0.0142)
Exchange Rate volatility	**0.668**	**17.38*** **	**89.17**	**-101.5**
	(2.783)	(4.023)	(96.92)	(114.8)
CPI Growth	**0.00356****	**-0.00442***	**0.162*****	**0.202*****
	(0.00163)	(0.00236)	(0.0568)	(0.0672)
Constant	**0.170*****	**0.410*****	**0.570**	**0.0948**
	(0.0247)	(0.0357)	(0.859)	(1.018)
Observations	264	264	264	264
R^2	0.155	0.124	0.141	0.124
Industry Fields	22	22	22	22
	Access to preferential exchange rate			
	Frequency of Price Change		Size of Price Change	
	Lower Tale	Upper Tale	Lower Tale	Upper Tale
Exchange Rate Growth	**0.000345**	**0.000532**	**-0.00169**	**-0.0224**
	(0.000282)	(0.000413)	(0.00841)	(0.0143)
Exchange Rate volatility	**2.130**	**10.58*****	**179.6*****	**135.9**
	(2.279)	(3.338)	(67.91)	(115.5)
CPI Growth	**0.00200**	**-0.000909**	**0.0798****	**0.156****
	(0.00134)	(0.00196)	(0.0398)	(0.0677)
Constant	**0.218*****	**0.280*****	**1.476****	**1.075**
	(0.0202)	(0.0296)	(0.602)	(1.024)
Observations	288	276	288	276
R^2	0.140	0.191	0.254	0.111
Industry Fields	24	23	24	23

*, **, *** denote significance at 1%, 5% and 10% levels respectively. Robust standard errors are reported in parentheses. Annual data from 2004 to 2015 has been used and estimation method is weighted panel regression with industry fixed effects where weights are based on industries share in CPI index at 2011 base year. *Source*: Research Findings

Another benchmark to divide the sample is whether the industries access to the preferential exchange rate or not. It should be noted that the exchange rate regime in the study periods was dual exchange rate regime and some segments in the industries had access to the preferential exchange rate. We want to examine whether access to preferential exchange rate leads to different

exchange rate effects among industries. The columns 5 to 8 in Table 3 present the estimation results of these sub-samples (based on access to preferential exchange rate). Although the insignificant effect of the exchange rate growth on the size and the frequency of price changes remain stable across the sub-samples, the exchange rate volatility effects in these two groups are different. So that, an increase in exchange rate volatility pushes up the frequency of price change and (no effect on the size) in the industries with access to preferential exchange rate. In the industries with less access to preferential exchange rate, the size is the only component of price change which is influenced by exchange rate volatility. Consequently, when the firms or sectors with less access to preferential exchange rate are facing increased exchange rate volatility, adjust their size of price change positively. In this condition, the firms with sufficient access to this subsidy support react by increasing their frequency of price change. The sign of CPI inflation effects on the size of price change are not different between these groups as well as the sign of CPI inflation effects on the frequency. However, the effect of inflation on the size of price changes is stronger in the industries with access to preferential exchange rate.

The first part of Table 4 reports the estimation results of the sub-samples which are divided based on the industries' ownership structure index (in term of share of private sector in industries' ownership). According to the results, in the industries with lower share of private owners the exchange rate growth and its volatility impact positively on the frequency of price change and do not affect the size of price change. Also the inflation has positive effect only on the size of price changes. In the industries with higher share of public sector owners, the estimated coefficients show that exchange rate growth and its volatility have significant effect only on the size components of price changes. CPI inflation in this group increases both size and frequency of price change.

The last four columns of Table 4 identify the effects of import dependency in the relationship between price setting indices and exchange rate across the industries. Import dependency ratio (value of imported raw materials to total value of input) is taken as a sample divider. Comparing the estimated coefficients demonstrates while the size of price change is not affected by exchange rate growth in both sub-samples, the effect of exchange rate on the frequency of price change is positive and significant only in the industries with lower dependency on import. Also exchange rate volatility only impacts negatively on the size of price change in the less import dependent industries. Moreover, positive effects of CPI inflation on the frequency of price change appear only in the industries with higher level of import dependency.

Accordingly, the price setting indices in industries with higher dependency on imported input is influenced only by CPI inflation and exchange rate fluctuations which do not have any significant effects on the price setting. But, the frequency and size of price change in the less import dependent industries are affected by exchange rate growth and volatility.

Table 4
Regressions Results in Different Subsamples Divided by Ownership Structure Index and Import Dependency

	Private Ownership Ratio			
	Frequency of Price Change		Size of Price Change	
	Lower Tale	Upper Tale	Lower Tale	Upper Tale
Exchange Rate Growth	**0.000886****	**-0.000083**	**0.0135**	**-0.0366*****
	(0.000432)	(0.000376)	(0.0118)	(0.0118)
Exchange Rate volatility	**6.025***	**4.097**	**-106.4**	**186.0***
	(3.488)	(3.033)	(95.39)	(95.37)
CPI Growth	**-0.000191**	**0.00487*****	**0.168*****	**0.160*****
	(0.00204)	(0.00178)	(0.0559)	(0.0559)
Constant	**0.333*****	**0.182*****	**0.362**	**0.722**
	(0.0309)	(0.0269)	(0.846)	(0.846)
Observations	264	264	264	264
R^2	0.143	0.218	0.115	0.174
Industry Fields	22	22	22	22
	Foreign Raw Materials Per Total Input Ratio			
	Frequency of Price Change		Size of Price Change	
	Lower Tale	Upper Tale	Lower Tale	Upper Tale
Exchange Rate Growth	**0.00161*****	**0.000258**	**0.0214**	**0.00166**
	(0.000570)	(0.000316)	(0.0147)	(0.0110)
Exchange Rate volatility	**7.108**	**1.720**	**-426.1*****	**50.91**
	(4.601)	(2.550)	(119.1)	(88.52)
CPI Growth	**-0.00120**	**0.00355****	**0.300*****	**0.146*****
	(0.00270)	(0.00149)	(0.0698)	(0.0519)
Constant	**0.473*****	**0.178*****	**-0.979**	**0.535**
	(0.0408)	(0.0226)	(1.056)	(0.785)
Observations	264	264	264	264
R^2	0.149	0.181	0.101	0.177
Industry Fields	22	22	22	22

*, **, *** denote significance at 1%, 5% and 10% levels respectively. Robust standard errors are reported in parentheses. Annual data from 2004 to 2015 has been used and estimation method is weighted panel regression with industry fixed effects where weights are based on industries share in CPI index at 2011 base year. *Source*: Research Findings

The next benchmark applied is labor intensity index which is reported in the first part of Table 5. The results show that the exchange rate growth increases the frequency of price change in the capital intensive industries (less labor intensive industries), while decreases the frequency of price change in

the labor intensive industries. Moreover, the exchange rate volatility only affects the frequency of price change in the labor intensive industries. CPI inflation increases the frequency of price change only in the labor intensive industries.

Table 5
Regressions Results in Different Subsamples Divided by Labor Intensity and Competitiveness Index

	Number of Workers Per Output (Labor Intensity)			
	Frequency of Price Change		Size of Price Change	
	Lower Tale	Upper Tale	Lower Tale	Upper Tale
Exchange Rate Growth	**0.000742***	**-0.000754***	**0.0140**	**0.00362**
	(0.000426)	(0.000403)	(0.0122)	(0.0129)
Exchange Rate volatility	**4.623**	**8.533*****	**-132.9**	**-100.1**
	(3.437)	(3.253)	(98.85)	(103.8)
CPI Growth	**0.00136**	**0.00551*****	**0.183*****	**0.284*****
	(0.00201)	(0.00191)	(0.0579)	(0.0608)
Constant	**0.303*****	**0.196*****	**0.233**	**-1.347**
	(0.0305)	(0.0288)	(0.877)	(0.920)
Observations	264	252	264	252
R^2	0.150	0.280	0.112	0.229
Industry Fields	22	21	22	21
	Number Of Firms In Industry (Competitiveness)			
	Frequency of Price Change		Size of Price Change	
	Lower Tale	Upper Tale	Lower Tale	Upper Tale
Exchange Rate Growth	**0.000259**	**0.00157*****	**-0.0198***	**0.0202***
	(0.000322)	(0.000503)	(0.0113)	(0.0122)
Exchange Rate volatility	**4.183**	**4.891**	**240.1*****	**-381.6*****
	(2.604)	(4.065)	(91.24)	(98.72)
CPI Growth	**0.00141**	**0.00130**	**0.0812**	**0.287*****
	(0.00153)	(0.00238)	(0.0535)	(0.0578)
Constant	**0.220*****	**0.390*****	**1.768****	**-1.164**
	(0.0231)	(0.0360)	(0.809)	(0.875)
Observations	276	276	276	276
R^2	0.136	0.201	0.158	0.131
Industry Fields	23	23	23	23

*, **, *** denote significance at 1%, 5% and 10% levels respectively. Robust standard errors are reported in parentheses. Annual data from 2004 to 2015 has been used and estimation method is weighted panel regression with industry fixed effects where weights are based on industries share in CPI index at 2011 base year. *Source*: Research Findings

The second part of Table 5 presents the regression results in two sub-samples divided based on competitiveness (which is measured with number of active factories in the industry). According to the results, positive effects of exchange rate growth on the frequency and size of price change only appear in more competitive industries. On the other side, the volatility of exchange

rate affects the size of price change positively in less competitive industries and negatively in more competitive industries. Also, CPI inflation only impacts on the size of price change in the more competitive industries.

Inventory level of final goods and raw material is the next property that we trace its effect on the relationship between the exchange rate and price setting in the industries. Each industry stores raw materials, intermediate goods, and final goods with regard to requirements of its production process. So it is expected that the level of inventories impacts on price setting behavior especially when firms are faced the exchange shocks. The regressions results reported in the first part of Table 6 are related to the samples which is divided based on raw material inventory ratio[1]. The findings suggest that the frequency of price change in industries with low level of raw material inventory is affected by exchange rate growth while this significant effect of exchange rate on the frequency is not confirmed in the industries with high level of raw material inventory. Instead, the exchange rate volatility only affects the frequency of price change in the industries with high level of raw material inventory.

According to the second part of Table 6, variation in the inventory of final goods causes the effects of exchange rate on the frequency of price change vary across the industries. So the exchange rate growth effects on the frequency is significant and positive only in the industries with higher level of final good inventory and exchange rate volatility affects only the frequency of price changes in the industries with lower level of final good inventory.

[1] It is defined as total value of raw material inventory in end of the year to total used raw material in the end of the year.

Table 6
Regression Results for Samples Separated Based on Raw Materials & Final Goods Inventory

		Raw Materials Inventory Per Total Input Ratio			
		Frequency of Price Change		Size of Price Change	
		Lower Tale	Upper Tale	Lower Tale	Upper Tale
Exchange Growth	Rate	**0.00104****	**0.000270**	**0.0142**	**-0.036****
		(0.000438)	(0.000412)	(0.0116)	(0.0149)
Exchange volatility	Rate	**1.534**	**11.02*****	**-138.4**	**163.6**
		(3.533)	(3.327)	(93.45)	(119.9)
CPI Growth		**0.00209**	**-0.000355**	**0.190*****	**0.161****
		(0.00207)	(0.00195)	(0.0547)	(0.0703)
Constant		**0.310*****	**0.229*****	**0.100**	**1.075**
		(0.0313)	(0.0295)	(0.829)	(1.063)
Observations		264	264	264	264
R^2		0.138	0.199	0.130	0.106
Industry Fields		22	22	22	22
		Final Goods Inventory Per Total Output Ratio			
		Frequency of Price Change		Size of Price Change	
		Lower Tale	Upper Tale	Lower Tale	Upper Tale
Exchange Growth	Rate	**0.000628**	**0.000785***	**-0.0228**	**-0.0011**
		(0.000464)	(0.000426)	(0.0148)	(0.0164)
Exchange volatility	Rate	**9.406****	**4.475**	**1.643**	**-72.98**
		(3.745)	(3.437)	(119.3)	(132.4)
CPI Growth		**-0.00172**	**0.00417****	**0.239*****	**0.214*****
		(0.00219)	(0.00201)	(0.0699)	(0.0775)
Constant		**0.301*****	**0.199*****	**0.00778**	**-0.457**
		(0.0332)	(0.0305)	(1.058)	(1.174)
Observations		252	264	252	264
R^2		0.129	0.264	0.124	0.084
Industry Fields		21	22	21	22

*, **, *** denote significance at 1%, 5% and 10% levels respectively. Robust standard errors are reported in parentheses. Annual data from 2004 to 2015 has been used and estimation method is weighted panel regression with industry fixed effects where weights are based on industries share in CPI index at 2011 base year. *Source*: Research Findings

6 Conclusion and Policy Recommendation

In this research, the effects of growth and volatility of the exchange rate on the price-setting behavior of Iranian industrial firms are investigated. It is concluded that the frequency and size of price change have a significant correlation with the growth of the exchange rate. An increase in exchange rate growth and its volatility leads to an increase in the frequency of price change. On the other hand, the exchange rate growth has no significant correlation with the size of price change, but the volatility of exchange rate has a significant negative effect on the size of price change. Therefore, industrial firms in response to an increase in the growth of exchange rate only increase

their frequency of price change, but an increase in volatility of exchange rate results in an increase in the frequency of price change and a decrease in the size of price change.

These results are based on the entire data, but robustness checks show that there is a remarkable difference between various industries' behaviors. To detect these differences, industries have been sub- sampled based on specific properties and the main regression is run in each sub-group. Properties such as export per output ratio, dependency on imported raw materials, and access to preferential exchange rate, type of ownership, labor intensity, and competitiveness in industry and stock of inventory are main indicators that are considered for the analysis. Some of the most important results are as follows:

- The volatility of the exchange rate positively affects the frequency of price change in the export-oriented industries.
- The volatility of exchange rate has a positive effect on the frequency of price change for firms that have more access to preferential exchange rate and the size of price change in firms that have less access to preferential exchange rate are positively affected by the exchange rate volatility.
- There is a positive correlation between the growth of exchange rate and frequency of price change in less private industries, but in more private industries, a negative correlation between the growth of exchange rate and the size of price change is identified.
- Industries that are less dependent on imported raw materials increase their frequency of price change in response to an increase in the growth of the exchange rate.
- The growth of exchange rate has a positive correlation with frequency of price change in less labor-intensive industries and has a negative correlation with frequency of price change in more labor-intensive ones.
- In more competitive industries there is a positive correlation between the size of price change and growth of the exchange rate, but in less competitive industries the correlation reverses.
- Industries that have less raw materials inventory increase their frequency of price change in response to an increase in exchange rate growth, but firms that have more raw materials inventory only decrease their size of price change.
- The exchange rate volatility has a positive effect on the frequency of price change in firms with less final goods inventory and frequency of price change in firms with more final goods inventory has a positive correlation with the exchange rate growth.

This research indicates that when exchange rate growth and volatility rise up, firms will increase the frequency of price change and it makes the consumer prices more unstable. In the macro level, this could lead to economic uncertainty with harmful effects on agents' economic decisions. The Central Bank should control the exchange rate volatility to lessen the effects of exchange rate growth on social uncertainty.

References

Alidou, S. (2014). *Degree of Price Rigidity in LICs and Implication for Monetary Policy*, *[Working Papers*, no 59844], Munich Personal RePEc Archive.

Alvarez, F., & Lippi, F. (2011). A Note on Price Adjustment with Menu Cost for Multi-Product Firms. *Tech. rep., EIEF*. URL http://sites.google.com/site/francescolippi/research3.60

Alvarez, F., Gonzalez-Rozada M., Neumeyer A., & Beraja, M. (2013). *From Hyperinflation to Stable Prices: Argentina's Evidence on Menu Cost Models.* Stanford University, [Working Paper, no 470].

Bachmann, R., Born, B., Elstner, S., & Grimme, C. (2013). Time-Varying Business Volatility, Price Setting, and the Real Effects of Monetary Policy, *Mimeo*.

Baley, I., & Blanco, J. (2016). *Menu Costs, Uncertainty Cycles, and the Propagation of Nominal Shocks.*[Working Paper].

Benabou, R., & Konieczny, J. D. (1994). On Inflation and Output with Costly Price Changes: A Simple Unifying Result. *The American Economic Review*, 135, 290–297.

Berger, D., & Vavra, J. (2015). Volatility and Pass-Through. *National Bureau of Economic Research Working Paper Series*, 19651.

Gagnon, E. (2009). Price Setting during Low and High Inflation: Evidence from Mexico. *The Quarterly Journal of Economics*, 124(3), 1221-1263.

Golosov, M., & Lucas, R. (2007). Menu Costs and Philips Curves. *Journal of Political Economy*, 115(2), 171-199.

Gopinath, G., & Itskhoki, O. (2009). Frequency of Price Adjustment and Pass-Through. *Quarterly Journal of Economics*, 125(2), 675-727.

Jonker, N., Folkertsma, C., & Blijenberg, H. (2004). An Empirical Analysis of price Setting Behavior in the Netherlands in the Period 1998-2003 using Micro Data. *ECB Working Paper*, 413.

Klepacz, M. (2016). Price Setting and Volatility: Evidence from Oil Price Volatility Shocks. *College of William and Mary.*

Kochen, F., & Samano, D. (2016). Price Setting and Exchange Rate Pass Through in the Mexican Economy: Evidence from CPI Micro Data. *Bank of Mexico Working Papers*, 13.

Madanizadeh, S. A., & Bayat, S. (2016). The Threshold Effects of Inflation Rate of Price Setting Behavior: Applying CPI Micro Data in Understanding Price Rigidity Changes. *forthcoming.* In Persian.

Sheshinski, E., & Weiss, Y. (1977). Inflation and Costs of Price Adjustment. *Review of Economic Studies*, 44(2), 287–303.

Vavra, J. (2014). Inflation Dynamics and Time Varying Volatility: New Evidence and an SS Interpretation, *Quarterly Journal of Economics*, 129 (1), 215-258.