Asymmetric effects of exchange rate pass-through: an empirical analysis among China, the United States and Japan

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Abstract

From the perspective of exchange rate direction fluctuations, this paper comparatively studied the asymmetric effect of movements in the nominal exchange rate on consumer prices among China, the United States, and Japan. To this end, the paper used the error correction model (ECM) to conduct an empirical analysis from the first season of 1994 to the last season of 2010 period. The results showed that: (1) the pass-through of exchange rate movements to consumer prices was incomplete; (2) exchange rates fluctuated in different directions, meaning that when the exchange rate appreciated and depreciated, the pass-through of exchange rate movements to consumer prices was asymmetric. However, the direction varied among the three countries. The influence of depreciation on consumer prices was higher in both China and the United States, while Japan was the opposite; (3) exchange rate pass-through was different in the three countries. The level of exchange rate pass-through in China was higher than the other two countries; (4) when short-term fluctuations deviated from long-term equilibrium, the adjustment was higher in the United States, followed by Japan, and China was relatively lower. These results had important implications for current monetary policies and practices.

Keywords: exchange rate, consumer prices, exchange rate pass-through, asymmetry

1 Introduction

In 2005, China reformed the exchange rate regime by moving into a managed floating exchange rate system based on market supply and demand with reference to a basket of currencies. Exchange rate movements increased, and the impact on the national economy increased. Exchange rate changes may cause fluctuations in domestic price levels, i.e. the exchange rate pass-through. Exchange rate pass-through is a hot issue in the field of international economics researches. It usually assumes that the relationship between the price level and the exchange rate is symmetric. This means that appreciation and depreciation will be transmitted to the final price with the same magnitude. However, in real situations the asymmetry is widespread within the prices of final goods, and is often manifested in the fact that prices rise easier than they fall. Such phenomenon is contrary to traditional assumptions, meaning the assumption of symmetric pass-through does not match with reality. Meanwhile, omitting the asymmetric effect will lead monetary policy effects to serious deviations. Therefore, the symmetric pass-through assumption has been relaxed in some new empirical researches [1].

Current studies have mostly focused on the asymmetric pass-through in developed countries; few studies have been done on developing countries. Moreover, the literature generally focuses on import prices, and the analysis of consumer prices is quite sparse. However, compared with other prices, there are large differences in the pass-through mechanism associated with consumer prices. Furthermore, due to different backgrounds, there may be large differences in asymmetry across different countries. Most importantly, as the largest developing country in the world, and due to the fact that it is in a context of transition, it is very important for China to analyse asymmetric exchange rate pass-through to consumer prices. Based on the above considerations, this paper selected consumer prices as the research object. It comparatively analysed the asymmetric effects of exchange rate pass-through on consumer prices by looking at China, the United States and Japan. On one hand, we can measure changes in the domestic price level caused by exchange rate fluctuations. On the other hand, CPI is a measure of inflation. Therefore, to analyse the impact of exchange rate changes on CPI, we can uncover the impact of exchange rate changes on domestic inflation. This allows us to provide policy guidance for inflation forecasts as well as policy recommendations. A comparative analysis of these representative countries can contribute to a better understanding of the status, and also provide some references for current monetary policy practice.

This paper selected the three above countries for the following considerations: first, these three countries have an important influence around the world, and they have important positions in the global economy. Second, the level of economic development differs among these countries. The United States and Japan belong to developed countries, and China is a developing country. Third, these countries are at different stages of economic

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development. The United States has a mature economy with a higher level of economic development. Its development is more robust. China has an emerging and developing economy that features rapid economic development. Meanwhile, Japan's economy has been experiencing a prolonged slump; the pace of economic development here is slow. Fourth, there is a great deal of differences in the exchange rate systems of these countries. The United States and Japan implement the free floating exchange rate system, while China is implementing a managed floating exchange rate system. Fifth, China has close economic ties with both the United States and Japan; they are China's important trading partners. Sixth, the availability of data is quite good for all of these countries.

Early studies of asymmetric pass-through adopted differential equations for analysis [2]. Although differential conversion can overcome the non-stationary problems associated with time series, the transformation will cause a loss of long-term information on the relationship between economic variables. It can also lead to a serial correlation of the regression model error, resulting in a failure of the regression analysis. There are also studies which use a distributed lag model [1]. However, because the model uses time-series data, it is possible for residuals to create autocorrelation problems within this regression method. Based on the above considerations, we used the error correction model (ECM). This method can better characterize both the long-term and short-term dynamic changes in variables. It maintains the long-term dynamic information of the relationship between variables. It also ensures the effectiveness of the regression analysis. In specific applications, this paper will introduce dummy variables into the model for analysis. Furthermore, it introduces a monetary policy variable into the model, and selects a foreign price index constructed to measure the cost of foreign exporters. By taking into account the lagged impacts of the exchange rate and monetary policy changes on the price index, this model takes a lag respectively.

In conclusion, this paper selected three representative countries: China, USA and Japan. It empirically studied the asymmetric effect of nominal exchange rate changes on consumer prices. The results showed that the pass-through of exchange rate changes to consumer prices was incomplete. For different directions of fluctuations the asymmetry of pass-through existed, but there were differences in the direction. In the United States and China, the impacts of exchange rate depreciation on consumer prices were higher; Japan was exactly the opposite. When the short-term fluctuations deviated from the long-term equilibrium, the adjustment was higher in the United States, followed by Japan, while China was relatively lower.

The remaining parts of the article are organized as follows: Section 2 reviews and summarizes the existing literature; Section 3 presents a theoretical model that has been constructed for studying the asymmetric effect of exchange rate changes on consumer prices; Section 4 presents the empirical results, comparatively studying asymmetric effects of exchange rate changes on consumer prices in China, the U.S. and Japan; Section 5 provides the main conclusions.

2 Literature review

2.1 THEORETICAL STUDIES

According to the causes of asymmetric pass-through in the direction of exchange rate movements, there are currently four accepted theoretical explanations.

Market share: When the goal of manufacturers is to build up market share, an appreciation in the importing country's currency will cause manufacturers to reduce import prices in order to increase their market share while maintaining mark-up. However, when there is depreciation, exporters will offset the potential increase in prices to maintain their market share by lowering mark-up. Therefore, the pass-through effect is higher in the case of appreciation than for that of depreciation [3].

Production switching: In this model, when making use of inputs, foreign manufacturers will switch between imported and domestically produced inputs depending on prices. When the importing country's currency appreciates, foreign manufacturers will only use domestically produced inputs. At that time, the level of pass-through depends on the elasticity of the mark-up. Foreign manufacturers will use inputs from the depreciating country during instances of devaluation, and then no pass-through takes place [4].

The two above theories both believe that the pass-through effect is higher for appreciation than depreciation. The following two explanations provide exactly the opposite interpretation. Here, the extent of exchange rate pass-through is higher during the depreciation.

Quantity constraints: This theory is also known as capacity constraints. Here, an appreciation of the importing country's currency will cause foreign manufacturers to reduce import prices. However, quantity rigidities will limit the expansion of its sales through low prices. Therefore, foreign manufacturers will increase mark-up to keep import prices unchanged in the currency of the importing country so as to guarantee sales and raise profit margins. In the case of depreciation, foreign firms are likely to increase the price of products in the importing country in order to reduce losses caused by devaluation. Therefore, the pass-through effect is higher for depreciation than appreciation [3].

Market structure: This theory holds that different levels of the pass-through effect during appreciation and depreciation are caused by monopoly. When the home currency appreciates (if foreign firms have monopoly power within the domestic market), they are likely to keep commodity prices unchanged in the local currency (a corresponding increase in the price level measured in the currency of foreign firms). This can increase the profits of foreign firms (measured in the currency of foreign firms), then, it shows a lower exchange rate pass-through effect or

no exchange rate pass-through effect at all. Conversely, if the home currency depreciates, foreign firms will raise the price of goods in order to maintain their profits (measured in foreign currency). This shows higher exchange rate pass-through effect [1].

2.2 EMPIRICAL STUDIES

Early asymmetry studies generally focused on the direction of exchange rate fluctuations to conduct tests. Studies usually used two methods. One analysed whether the pass-through effect differed during periods of appreciation and depreciation. For example, [5] studied whether there were differences in the level of pass-through to U.S. import prices in the periods of exchange rate depreciation (1977-1980) and appreciation (1981-1985). The other introduced dummy variables to identify exchange rate appreciation and depreciation. These studies were generally performed from the two levels of the industry and aggregated price.

Industry level studies have discovered that, in the United States, the level of pass-through is higher during periods of depreciation [6, 7]. Other studies found that the extent and direction of asymmetric pass-through varied between the industries and countries. Even within the same industry, there were also differences in the direction of asymmetric pass-through across countries [2]. By contrast, only a few studies have investigated the issue at the aggregated price. Studies found asymmetry in pass-through, the extent was higher for appreciation than depreciation [5, 8]. Instead, [4] found the extent of pass-through was higher for depreciation than appreciation in seven Asian countries.

At the same time, the literature involving consumer prices is relatively sparse. Studies found the existence of asymmetric responses. Here, the effect of exchange rate depreciation on consumer prices was higher than for appreciation [1].

3 Theoretical model

3.1 MODEL SPECIFICATION

Making use of the profit-maximization behaviour of an exporting firm, we analysed the relationship between the price level for exporting firms and exchange rate fluctuations.

$$\pi = P(Q)\cdot Q - C(Q). \tag{1}$$

Given profit-maximization, we know

$$MR = MC,$$

$$MR = \partial P(Q)\cdot Q / \partial Q = P + Q\cdot dP / dQ$$
$$= P + P\cdot (Q / P)\cdot dP / dQ$$

That is $MR = P + P\cdot(1/E_d) = MC$,

where E_d denotes the price elasticity of demand. We can get

$$P = MC / \left[1 + 1/E_d\right], \tag{2}$$

Set $\mu = 1/\left[1 + 1/E_d\right]$,

where π denotes profits, expressed in the exporting country's currency. P is the price of goods in the foreign currency. e is the exchange rate, adopting the direct quotation method, measured in units of home currency per unit of the exporting country's currency. $C(\cdot)$ is the cost function in the exporting country's currency, Q is the quantity demanded for goods. P^d denotes the price of goods in domestic currency. From Equation (2) we can get:

$$P^d = eC_q\mu, \tag{3}$$

where C_q is the marginal cost and μ is the mark-up, which depends on the price elasticity of demand for goods. Therefore, the price of goods in domestic currency depends on exchange rate, marginal cost, and mark-up. The marginal cost depends on local input cost. The mark-up depends on the demand conditions in the importing country.

Taking Equation (3) in logarithm, the price equation can be expressed as follows:

$$P_t^d = \alpha_0 + \alpha_1 e_t + \alpha_2 P_t^* + \alpha_3 Y_t + \varepsilon_t, \tag{4}$$

where P^* denotes the exporting firm's marginal cost and Y denotes demand conditions in the importing country. From the reviewed literature on pass-through, it can be seen that Equation (4) is generally used for model specification. Equation (4) is generalized as follows:

$$P_t = \alpha + \delta X_t + \gamma E_t + \psi Z_t + \varepsilon_t, \tag{5}$$

where P_t represents the price index, X_t means the control variables abroad (usually using the cost or price to be measured according to the type of research). E_t refers to the exchange rate, Z_t refers to domestic control variables.

With regard to P_t, we selected consumer prices as a research object. Given that consumer prices are different from other prices, and the pass-through mechanism varies. We adopted the consumer price index (CPI) as a proxy variable for consumer prices. For a control variable X_t, by referring to [9], we utilized foreign price index as a proxy variable to measure the cost for foreign exporters. $WPI_t = \left(CPI_t \cdot Neer_t / Reer_t\right)$, *Neer* and *Reer* denote nominal effective exchange rate and real effective exchange rate. For control variable Z_t, we selected GDP and money supply; the former reflects domestic demand conditions, while the latter reflects the monetary policy

factor. By referring to [10] and introducing monetary policy, we established the following model:

$$LCPI_t = \beta_0 + \beta_1 \cdot LNER_t + \beta_2 \cdot LM2_t + \beta_3 \cdot LGDP_t + \beta_4 \cdot LWPI_t + \varepsilon_t, (t=1,2,3\ldots n), \quad (6)$$

where *LCPI*, *LNER*, *LM2*, *LGDP*, and *LWPI* respectively refer to the consumer price index, RMB nominal effective exchange rate, money supply, gross domestic product, and foreign price index. All of the variables are expressed in logarithms.

LCPI, *LNER*, *LM2*, *LGDP*, and *LWPI* and certain linear combinations of the variables are stationary. We can make use of ε_t generated from Equation (6) to construct an error correction model (ECM). The error correction model settings are as follows:

$$\Delta LCPI_t = \sum_{i=0}^{p} \alpha_{1i} \cdot \Delta LNER_{t-i} + \sum_{i=0}^{q} \alpha_{2i} \cdot \Delta LM2_{t-i} + \alpha_3 \cdot \Delta LGDP_t + \alpha_4 \cdot \Delta LWPI_t + \alpha_5 \cdot AR(1) + \alpha_6 \cdot \varepsilon_{t-1} + \mu_t, \quad (7)$$

where *p*, *q* represents the *LNER*, *LM2* lags respectively. Here, the lags are taken because of the lagging impact that the exchange rate and monetary policy changes have on the price index. This often manifests itself over several periods.

In order to analyse asymmetry in exchange rate pass-through to consumer prices, we introduced a dummy variable. This was done in order to investigate whether the effect of exchange rate pass-through varied in the case of appreciation and depreciation.

Assuming that,

$$D_1 = \begin{cases} 0, if\ effective\ exchange\ rate\ appreciates \\ 1, if\ effective\ exchange\ rate\ depreciates \end{cases},$$

we constructed the model as follows:

$$\Delta LCPI_t = \alpha_0 + \alpha_1 * \Delta LNER_t + \gamma_1 * D_1 * \Delta LNER_t + \sum_{i=1}^{p} \alpha_{1i} * \Delta LNER_{t-i} + \sum_{i=0}^{q} \alpha_{2i} * \Delta LNM2_{t-i} + \alpha_3 * \Delta LGDP_t + \alpha_4 * \Delta LWPI_t + \alpha_5 * AR(1) + \alpha_6 * \varepsilon_{t-1} + \mu_t. \quad (8)$$

We presented following hypotheses:

H_0: $\gamma_1 = 0$, meaning there are no statistical differences, and exchange rate pass-through is symmetric.

H_1: $\gamma_1 \neq 0$, meaning there are statistically significant differences, and exchange rate pass-through is asymmetric.

The above hypotheses will be tested in the empirical analysis. If the coefficients of the dummy variable are significant statistically then the null hypothesis will be rejected.

3.2 SOURCES OF DATA AND DESCRIPTION

3.2.1 Sources of data and processing

With the use of Eviews 6.0, we selected quarterly data from the first season of 1994 to the last season of 2010 to conduct our empirical analysis. We selected the consumer price index as a proxy variable for consumer prices, and selected the nominal effective exchange rate as a proxy variable for the exchange rate, taking the indirect quotation, an increase of the index means exchange rate appreciation. Given the different base periods for the original data, we converted various indexes to the first season of 1994 as the base period. In order to eliminate the impact of seasonal factors, the variables were seasonally adjusted. China's consumer price index, money supply and GDP were derived from the China Economic Information Network statistics database. The effective exchange rate was obtained from the IMF International Financial Statistics (IFS). The U.S. and Japanese data was mainly collected from the IFS.

3.2.2 Data description

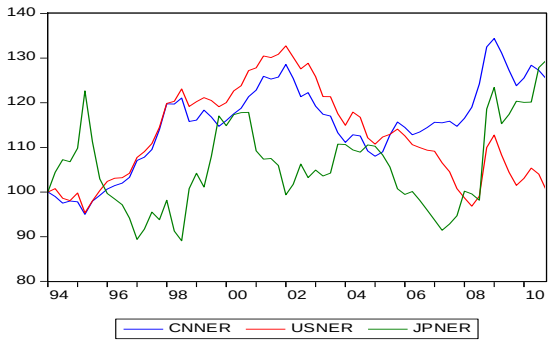

FIGURE 1 Exchange rate chart showing China, the U.S. and Japan

Figure 1 shows that, after 1995, the RMB nominal effective exchange rate experienced a waved rise, reaching its peak in 2002, and then fell to its lowest level in 2005. After the exchange rate system reform, the RMB exchange rate experienced a wave of rapid rise, reaching its maximum in 2008, and after the financial crisis it declined. From the figure, we can see that the magnitude of exchange rate appreciation was higher than depreciation. In the United States, the exchange rate also experienced a waved rise from 1995 to 2002, and then it declined until 2009. After that, it rebounded after the financial crisis and later fell again. On the whole, the sizes of appreciation and depreciation were considerable. The Yen exchange rate appreciation and depreciation were staggered. Exchange rate depreciation lasted a long time. The magnitudes of appreciation and depreciation were considerable. After both the 1998 Southeast Asian economic crisis and the 2008 financial crisis, the yen exchange rate showed a wave of rapid rise. It reached its maximum in 2010.

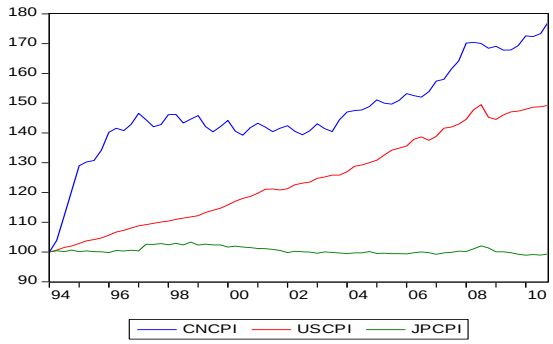

FIGURE 2 CPI chart showing China, the U.S. and Japan

As can be seen from Figure 2, prior to 1996, China experienced a wave of rapid rise in CPI and then it tended to be stable. After that, it entered an upward trend, and the exchange rate declined during the financial crisis. Overall, there has been an upward trend in U.S. CPI and the exchange rate declined briefly during the financial crisis. Japan's CPI showed low level fluctuations generally. The trend was relatively stable. During Southeast Asian economic crisis and the financial crisis, CPI fluctuated greatly.

4 Empirical results

4.1 UNIT ROOT TEST

In order to produce more robust results when studying the relationship between variables, it is necessary for the *LCPI*, *LNER*, *LM2*, *LGDP*, and *LWPI* sequences to conduct a unit root (ADF) test. According to Information Criterion (AIC) and Schwarz Criterion (SC) we chose lags according to the principle of minimum. The null hypothesis is that a unit root is present. Table 1 shows the unit root test results.

The unit root test shows that at the 5% significance level, the *LCPI*, *LNER*, *LM2*, *LGDP* and *LWPI* original series are non-stationary series. However, after the first difference they all become stationary series. Therefore, we can consider that the LCPI, *LNER*, *LM2*, *LGDP* and *LWPI* are integrated with order 1 processes.

TABLE 1 ADF test results

Variable	China		The U.S.		Japan	
	ADF statistics	*Result*	*ADF statistics*	*Result*	*ADF statistics*	*Result*
LCPI	0.624	Non-stationary	-0.894	Non-stationary	-2.214	Non-stationary
LNER	-2.017	Non-stationary	0.381	Non-stationary	-2.001	Non-stationary
LM2	0.788	Non-stationary	0.231	Non-stationary	-1.147	Non-stationary
LGDP	1.871	Non-stationary	-2.424	Non-stationary	-1.101	Non-stationary
LWPI	-0.547	Non-stationary	-1.931	Non-stationary	-2.129	Non-stationary
ΔLCPI	-4.541	Stationary	-8.697	Stationary	-3.455	Stationary
ΔLNER	-5.527	Stationary	-6.017	Stationary	-3.764	Stationary
ΔLM2	-6.68	Stationary	-8.908	Stationary	-3.028	Stationary
ΔLGDP	-3.865	Stationary	-6.264	Stationary	-6.955	Stationary
ΔLWPI	-5.567	Stationary	-3.209	Stationary	-9.583	Stationary

4.2 CO-INTEGRATION ANALYSIS

Since the premise of the error correction model is the existence of a co-integration relationship between variables, we needed to conduct a co-integration test. This is because the variables are first difference stationary series. Then, we applied the EG two-step method to do a co-integration test for the variables to determine the long-term stable relationship among them. First, we performed the OLS regression model. Then we performed an ADF test for the residual sequence. Table 2 shows the results.

TABLE 2 Co-integration equation results

Variable	China		The U.S.		Japan	
	Coefficient	*T-statistics*	*Coefficient*	*T-statistics*	*Coefficient*	*T-statistics*
LNER	-0.249**	-2.458	-0.158***	-17.67	-0.049***	-4.92
LM2	0.215*	1.907	0.125***	4.98	-0.155***	-4.39
LGDP	-0.549***	-3.483	0.118***	2.809	-0.249***	-8.04
LWPI	1.952***	5.304	0.52***	11.98	0.225***	6.78
C	-0.29	-0.191	0.297	0.957	10.01***	20.39
R^2	0.88		0.997		0.72	
Residual ADF statistics	-2.68***		-3.1**		-3.05**	

NOTES: ***, **, * indicate the statistical significance at the 1%, 5% and 10% levels, respectively.

The residuals of the regression equation above are stationary. Therefore, the model specification is reasonable. It indicates the presence of a long-term co-integration relationship between *LCPI*, *LNER*, *LM2*, *LGDP* and *LWPI*. The results also indicate that the long-term exchange rate pass-through to consumer prices is not

complete. The pass-through effects of exchange rate changes on consumer prices are: -0.249, -0.158, -0.049 in China, the U.S. and Japan respectively. Meanwhile, the pass-through effect of the RMB exchange rate on consumer prices is -0.249. This means that the RMB nominal effective exchange rate appreciates by 1% and consumer prices fall 0.249 percentage points. In this regard, our argument is that this is because the consumer goods contain a lot of non-tradables on their own. The delivery of non-tradable goods to consumers require many distribution chains. This further increases the ingredients of non-tradables in the consumer goods. However, the impact of exchange rate changes on non-tradables is smaller. This results in the incomplete exchange rate pass-through to consumer prices.

4.3 ERROR CORRECTION MODEL ESTIMATE

From the direction of the exchange rate changes in Model (8), during the appreciation and depreciation we tested whether the degree of exchange rate pass-through to consumer prices varied. Namely, we tested for the existence of asymmetric pass-through. Table 3 gives the results.

TABLE 3 Error correction model estimate results

Variable	China		The U.S.		Japan	
	Appreciation	*Depreciation*	*Appreciation*	*Depreciation*	*Appreciation*	*Depreciation*
ΔLNER	-0.106***	-0.168**	-0.021	-0.051**	-0.04*	-0.02**
	(-2.997)	(-2.644)	(-1)	(-2.417)	(-1.904)	(-2.235)
ΔLNER(-1)	0.012	0.051	0.01	-0.02	-0.031	0.035***
	(0.36)	(0.693)	(0.487)	(-0.782)	(-1.321)	(3.558)
ΔLM2	-0.019	-0.176**	-0.081*	-0.174***	-0.063	-0.071
	(-0.491)	(-2.747)	(-1.804)	(-2.939)	(-0.464)	(-1.412)
ΔLM2(-1)	-0.027	0.105*	-0.004	0.019	-0.068	-0.057
	(-0.732)	(2.086)	(-0.095)	(0.369)	(-0.596)	(-1.157)
ΔLGDP	-0.025	-0.021	-0.09	-0.327***	-0.139*	-0.361***
	(0.881)	(-0.694)	(-1.547)	(-3.602)	(-1.977)	(-10.101)
ΔLWPI	0.867***	0.728***	0.426***	0.254	0.439***	0.208***
	(10.451)	(3.764)	(3.262)	(1.538)	(3.537)	(4.276)
ΔECM(-1)	-0.013	-0.211*	-0.174	-0.291*	-0.092	1.005***
	(0.202)	(-1.865)	(-1.112)	(-1.731)	(-0.706)	(-6.574)
AR(1)	0.362**	0.728**	0.663**	0.578**	0.505*	0.733***
	(2.456)	(2.505)	(2.651)	(2.613)	(1.676)	(7.513)
AR(2)	0.318**	0.711**				
	(2.608)	(2.335)				
R^2	0.92	0.97	0.75	0.92	0.67	0.81
D.W.	1.93	2.23	2.01	2.11	1.52	1.77

NOTES: ***, **, * indicate the statistical significance at the 1%, 5% and 10% levels, respectively. The values in the bracket are t-statistics

The results show that when exchange rate depreciates, the pass-through elasticity of the RMB exchange rate to consumer prices is -0.168, meanwhile, the pass-through rate is -0.106 in the case of appreciation. For the United States, when depreciating, the pass-through rate is -0.051, the value is -0.021 in the case of appreciation. For Japan, the pass-through rate is -0.02 for depreciation, and conversely, -0.04 for appreciation. It is clear that there is a negative relationship between prices and exchange rate changes. In other words, exchange rate depreciation (appreciation) will drive prices to increase (decrease). This result is consistent with traditional economic theory. Secondly, responses from prices according to exchange rate fluctuations are statistically significant. However, there are differences in the level of pass-through. For appreciation and depreciation, the degree of exchange rate pass-through to consumer prices varied. Namely $\gamma_1 \neq 0$, meaning the pass-through of exchange rate changes to consumer prices is asymmetric. Therefore, the hypothesis H_1 holds.

Thus, there are asymmetric effects of exchange rate changes on consumer prices. This means that the effect of exchange rate pass-through on consumer prices is influenced by the direction of exchange rate fluctuations. For different directions of fluctuations, the exchange rate pass-through is asymmetric, but the direction varies for both. When the yen appreciates, the pass-through effect on consumer prices is higher. For these results, we argue that it may be related to the long-term downturn in the economic environment. Since the 1990s, the Japanese real estate bubble has burst and the economy declined. This decline has lasted a long time and Japan has still not emerged from a state of economic downturn. In a recession, the price level generally shows a downward trend. Even though exchange rate depreciates, firms do not adjust the price in proportion to the rise in costs. Here, the smaller the change in price, the lower the exchange rate pass-through effect is. On the contrary, appreciation will depress price levels. Furthermore, the recession will accelerate the declines in the price level. The larger the change in prices, the higher the exchange rate pass-through

effect is. By contrast, in China and the United States, when the currency depreciates, the pass-through effect on consumer prices is larger. In this regard, we argue that this phenomenon should be consistent with market structure theory. This is because monopoly power exists in the market. This results in differences in the degree of exchange rate pass-through for appreciation and depreciation. Specifically, and in the short-term, when exchange rate depreciates there is upward pressure on prices. Here, production costs increase, firms have incentive to adjust prices upward, prices are vulnerable to adjustment and the pass-through effect on consumer prices is greater. Meanwhile, for appreciation there is downward pressure on prices, but because of incomplete competition, firms have some monopoly power in prices. Here, price adjustments are smaller or they remain unchanged, and the effect of exchange rate pass-through on consumer prices is smaller.

In addition, the effect of exchange rate pass-through on consumer prices varies across countries. China's exchange rate pass-through stays at the higher level, followed by the United States, while Japan is the lowest. Among them, when the RMB exchange rate depreciates, the pass-through rate is -0.168. Meanwhile, in Japan, this value is only -0.02. Why is China's pass-through rate higher than two other countries? Regarding this, our argument is that this may be related to the composition of imports. Within China's imports, primary products are relatively high. Here, the proportion increased from 12.4% in 1985 to 25.4% in 2007. Recently, according to the needs of economic development, China imported a large proportion of resources products. The proportion of mineral fuels, lubricants and related raw material imports accounted for primary products increased from 6.5% in 2002 to 11% in 2007. Here, the proportion of non-food raw materials increased from 7.7 % to 12.4%. The prices of primary products are more sensitive to exchange rate changes. This results in a higher level of exchange rate pass-through in China than in the U.S. and Japan.

Finally, from the coefficients of the error correction term, it can be seen that the coefficient is higher in America, followed by Japan, and China is relatively low. This means that short-term fluctuations deviate from the long-term equilibrium in China. Here, the magnitude of adjustment is weak. On the contrary, in the United States the adjustment from non-equilibrium to equilibrium is relatively high. These results may be related to the fact that the U.S. has a relatively mature market environment. On the one hand, the U.S. implements a freely floating exchange rate system. When shocks burst out in the market it causes a deviation from the long-run equilibrium level. Here, the floating exchange rate system can adjust the exchange rate to absorb these shocks, tending to the equilibrium level. On the other hand, there are relatively mature participants and a perfect organizational system in the U.S. market. Here, the responses to shocks are high, and through their reactions, this tends to make the deviations tend towards equilibrium. Therefore, relative to the U.S., it is relatively backward for China in the participants or organization system involved in, it is natural that the magnitude and speed of adjustment is lower than that of the United States.

5 Conclusions

Exchange rate pass-through is a hot issue in the field of international economics researches. From the perspective of the direction of exchange rate fluctuations, we comparatively studied the asymmetric effect of nominal exchange rate changes on consumer prices in China, the United States and Japan. We applied the error correction model (ECM) to perform an empirical analysis on quarterly data from the first season of 1994 to the last season of 2010. The conclusions are summarized as follows:

First, exchange rate pass-through to consumer prices was incomplete. Regardless of whether we looked at long-term or short-term, exchange rate changes had an effect on consumer prices. However, the degree was incomplete. For different directions of exchange rate changes, exchange rate pass-through to consumer prices was asymmetric. However, the direction varied in all three countries. In the United States and China, the effect on consumer prices was higher during the depreciation, but in Japan exactly the opposite was true. For the former, this paper has argued that the results may be related to imperfect competition within the market. Meanwhile, the latter may be related to a long-term downturn in the economic environment. In order to further reveal an intrinsic relationship, micro-economic corporate pricing behaviour should be the key point of focus. Based on this assumption, industry-level data would provide more valuable information.

Second, exchange rate pass-through varied across countries. The level of China's exchange rate pass-through was higher, followed by the United States, and Japan was the lowest. Among the first two countries, when the RMB exchange rate depreciated, the pass-through rate was -0.168, whereas this value was only -0.02 for Japan. We argued that this may be related to the composition of China's imports. When short-term fluctuations deviated from the long-term equilibrium, the magnitude of adjustment was higher in the United States, followed by Japan, and China was relatively low. This may be related to the U.S.'s relatively mature market environment. This indicates that China needs to further improve its own market environment, and improve policy efficiency. On one hand, China should improve the market organization system. It should also strive to improve the transparency and efficiency of policy formulation, and improve its policy transmission mechanism. Furthermore, China should improve its policy transmission efficiency and strengthen legal constructions. It should also regulate market operations more effectively. On the other hand, China needs to foster and enhance the ability of market participants. It should also regulate the behaviour of

various parties, and improve the maturity of market participants.

Finally, the asymmetric effect of exchange rate pass-through will have a significant impact on monetary policy, driving policymakers into dilemmas as they try to pursue price stability and export competitiveness. Under equivalent conditions, currency depreciation assists in reducing export prices. It also strengthens export competitiveness. However, depreciation has inflationary effects on domestic price levels. The results also imply that when making monetary policy rules in the context of incomplete exchange rate pass-through, the direction of exchange rate variations also needs to be considered. When the exchange rate fluctuates in different directions, the pass-through effect varies, and the impact on domestic prices is asymmetric. Therefore, the policy departments should consider these differences when setting monetary policy rules.

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