Asian Journal of Economics and Finance. **2020**, 2, 1

ARF INDIA
Academic Open Access Publishing
www.arfjournals.com

A Simultaneous-Equation Model of Estimating Exchange Rate Pass-Through to Consumer Prices in South Korea

Yu Hsing

Joseph H. Miller Endowed Professor in Business, Professor of Economics, Department of Management & Business Administration, College of Business, Southeastern Louisiana University, Hammond, Louisiana 70402, USA, E-mail: yhsing@selu.edu

Received: 12 September 2019; Revised: 25 October 2019; Accepted 11 January 2020; Publication: 15 February 2020

Abstract: Applying an extended IS-LM-AS model, this paper finds that a 1% depreciation of the Korean won causes the CPI to rise by 0.0668%. In addition, more money supply, more government borrowing, a higher crude oil price, a higher U.S. CPI, and a higher expected price will raise South Korea's CPI. Therefore, exchange rate pass-through to the consumer price is partial and relatively small.

JEL Codes: F31, F41

Keywords: exchange rate pass-through, exchange rates, consumer prices, money supply, crude oil prices

Introduction

Exchange rate pass-through (ERPT) to domestic prices has been studied extensively. It is a concerned subject as the exchange rate of the Korean won per U.S. dollar was volatile during times of a financial crisis. In the Asian financial crisis, the exchange rate changed from 771.27 in 1995 to 1401.44 in 1998, indicating that the value of the Korean won declined 81.71% versus the U.S. dollar during 1995-1998. The consumer price index rose 17.82% during 1995-1998. During the global financial crisis, the exchange rate changed from 929.26 in 2007 to 1276.93 in 2009, suggesting that the value of the Korea won declined 37.41%. The consumer price index increased 7.56% during 2007-2009. Large depreciation of the Korean won is expected to raise import costs, wholesale prices, and consumer prices. It is an empirical question as to how much the increase in the consumer price index is attributable to the depreciation of the Korean won.

To the author's knowledge, few of previous studies have applied and extended the IS-LM-AS model in studying ERPT to consumer prices in South Korea.This paper differs from previous studies in several aspects. First, the paper uses an extended IS-LM-AS model incorporating the exchange rate in the money demand and aggregate supply functions. Second, in the aggregate supply function, external shocks represented by the exchange rate and the energy cost are considered. Third, comparative static analysis is employed to determine how exchange rate movementswould affect the price level.

Literature Survey

Several recent studies have examined ERPT to prices for South Korea and related countries. Based on a sample of twenty-four developing countriesduring 1980-2003 and applying the FMOLS and DOLS methods, Karim (2005) foundthat ERPT to import prices is heterogeneous among these countries. Long-run ERPT is estimated to be 0.7725 based on the FMOLS and 0.827 based on the DOLS.

Edwards (2006) examined ERPT to the CPI and PPI before and after the adoption of inflation targeting for seven selected countries including South Korea during 1986. Q1 – 2005.Q1. For South Korea, ERPT to the CPI is estimated to be 0.025 before and after the adoption of inflation targeting in the long run, suggesting that ERPT to the CPI does not decline after the adoption of inflation targeting. ERPT to the PPI is estimated to be 0.070 before and after the adoption of inflation targeting in the long run.

Ito and Sato (2008) applied the VAR model to estimate ERPT for five selected Asian countries including South Korea after the Asian financial crisis. ERPT declines along the distribution chain from import prices to producer prices and to consumer prices. ERPT ranges from a low of 0.03 for Malaysia to a high of 0.40 for Indonesia. ERPT is estimated to be 0.07 for South Korea.

Using the VAR technique, Kohlscheen (2010) examined ERPT to consumer prices for eight countries including South Korea with floating exchange rate systems. He found that ERPT is greater for countries trading more homogeneous goods and with higher exchange rate volatility. ERPT after one year ranges from a low of 0.093 for the Philippines to a high of 0.599 for Indonesia. For South Korea, it is estimated to be 0.206.

Prasertnukul, kim andKakinaka (2010) investigated the effect of inflation targeting on ERPT for four selected Asian countries including South Korea. ERPT declines in South Korea and Thailand after adopting inflation targeting whereas Indonesia and the Philippines without adopting inflation targeting show less clear evidence. ERPT ranges from a low of zero for the Philippines to a high of 0.12 for Thailand. ERPT is estimated to be 0.06 for South Korea.

Saha and Zhang (2013) evaluated ERPT for Australia, China and India using the VAR model during 1990-2011. They found that ERPT to consumer prices is less in China and India than in Australia, that the depreciation of the yuan and rupee causes domestic price inflation, and that external variables have little impact on domestic prices in China and India, but interest rates, producer prices and industrial production effect their domestic prices.

Using the VARX model for six emerging countries including South Korea, Aleem and Lahiani (2014) studied ERPT to domestic prices. ERPT tends to be lower in countries with a more credible monetary policy, in Asian countries than in Latin American countries, and after the adoption of inflation targeting. For South Korea, ERPT is estimated to be 0.16 before the adoption of inflation targeting and 0.01 after the adoption of inflation targeting.

Based on a sample of nineteen high and middle countries including South Korea, Dilla, Achsani and Anggraeni (2017) examined whether the adoption of inflation targeting (IT) would affect ERPT to the consumer price. The results are mixed. For South Korea, before the adoption of IT, ERPT to consumer prices is estimated to be 0.041 and 0.099 in the short and long run; and after the adoption of IT, ERPT to consumer prices is found to be 0.022 and 0.035 in the short and long run. Hence, after the adoption of IT, ERPT to prices decline. In addition, ERPT to consumer prices declines for Indonesia and Thailand after the adoption of IT in the short and long run.

Studying ERPT in selected Asian countries including South Korea, Soon, Baharumshah, and Wohar (2018) found that there is evidence of ERPT to the consumer price once inflation volatility is greater than 4.17. The degree of ERPT varies due to low and high inflation volatility in non-inflation and inflation targeting countries.

Using a sample of forty-seven countries including South Korea, Ha, Stocker and Yilmazkuday (2019) revealed that ERPT to inflation differs among countries over time depending on the factors causing exchange rate changes and country characters. Countries pursuing credible inflation targets and flexible exchange rate systems tend to have smaller pass-through ratios. A higher degree of central bank independence helps to stabilize inflation and make the exchange rate as a cushion against external shocks.

Investigating ERPT for selected Asian countries including South Korea during 1995.Q1-2016.Q4 and applying the nonlinear ARDL technique, Kassi, Sun, Ding, Rathnayake and Assamoi (2019) showed that there is an asymmetric ERPT to prices in Asian developing countries in the short run and in Asian emerging countries in the short and long run, that ERPT is higher for appreciation than depreciation in the long run, and that there is evidence of downward rigid price and weak competition. They also indicated that ERPT has not decreased in these Asian countries in the long run. If a currency appreciate (depreciate) 1%, the consumer price would decline0.9% (rise 0.5%) in the long run. ERPT is higher in emerging Asian countries with lower inflation and price volatility than in developing Asian countries.

The Model

Suppose that aggregate expenditures are determined by real income, government taxes, government spending, the real interest rate and the real exchange rate, that real money demand is a function of the nominal interest rate, real income and the nominal exchange rate, and that the price level is representedby an augmented expectations supply function where the price level is influenced by the expected price level, the output gap, the nominal exchange rate, and the energy cost. Extending the IS-LM-AS model (Romer, 2006), we have:

$$Y = z[Y, T, G, R - \pi^{e}, \varepsilon(P^{*} / P)] \quad (1)$$

$$M / P = w(R, Y, \varepsilon) \tag{2}$$

$$P = h(P^e, Y - Y^*, \varepsilon, E) \tag{3}$$

where

Y = real GDP in South Korea,
T = government taxes,
G = government spending,
R = the nominal interest rate,
π^e = the expected inflation rate,
ε = the nominal exchange rate measured as units of the Korean won per U.S. dollar,
P^* = the price level in the U.S.,
P = the price level in South Korea,
M = the money supply,
P^e = the expected price level,
Y^* = potential real GDP, and
E = the energy cost.

Assume that potential real GDP is a constant in the short run. Solving for the endogenous variables (Y, $R - \pi^e$, and P) simultaneously, we can obtain the equilibrium price level as:

$$\bar{P} = \bar{P}(\varepsilon, M, G - T, E, P^*, P^e) \tag{4}$$

The determinant of the Jacobian matrix is given by:

$$|J| = [-(1 - z_Y)w_R - z_R h_Y MP^{-2} + z_P w_R h_Y - z_R w_Y] > 0 \tag{5}$$

The partial derivative of $\bar{P}$ with respect to can be expressed as:

$$\partial \bar{P} / \partial \varepsilon = [-w_R h_\varepsilon (1 - z_Y) - z_\varepsilon w_R h_Y - z_R w_Y h_\varepsilon + z_R w_\varepsilon h_Y] / |J| > 0 \text{ if } w_\varepsilon < 0$$
$$< \text{or} > 0 \text{ if } w_\varepsilon > 0. \tag{6}$$

In equation (6), the sign of the first three terms in the numerator is positive whereas the sign of the last term in the numerat or depends on the sign of w_ε. The exchange rate may affect real money demand through the substitution effect and the wealth effect (Arango and Nadiri, 1981). If the substitution effect dominates the wealth effect, the sign in equation (6) would be positive. On the other hand, if the wealth effect dominates the substitution effect, the sign in equation (6) would be unclear.

Empirical Results

The data were collected from the International Monetary Fund and the World Economic Outlook. The price level is represented by the consumer price index.

The nominal exchange rate is measured as units of the Korean won per U.S. dollar. The money supply is represented byM2 money. G – T is expressed as government borrowing as a percent of GDP. The crude oil price per barrel is selected to represent the energy cost. The U.S. consumer price index is chosen to represent the U.S. price. The expected consumer price index is estimated as the average consumer price index of the past three years.

Figures 1 and 2 present graphical relationships during 1980-2018. Figure 1 shows the scatter diagram between the CPI and the nominal exchange rate (EXR). They seemed to exhibit a positive relationship. Figure 2 presents the scatter diagram between the CPI and M2 money supply. They appeared to have a strong positive relationship.

Table 1 presents the estimated regression and related statistics. The GARCH process is employed in empirical estimation in order to correct for autoregressive conditional heteroskedasticity. The estimated coefficients in the conditional variance equation are significant at the 1% level. Approximately 99.85% of the change in the consumer price index can be explained by the six right-hand side variables. All the estimated coefficients are significant at the 1% level. The consumer price index in South Korea is positively affected by the nominal exchange rate, M2 money, the government borrowing-to-GDP ratio, the crude oil price, the U.S. price level, and the expected price level.

Specifically, if the exchange rate rises 1%, the CPI will increase by 0.0668%. If M2 rises 1%, South Korea's CPI will increase by 0.0394%. A 1 percentage point increase in the government borrowing-to-GDP ratio will cause the log

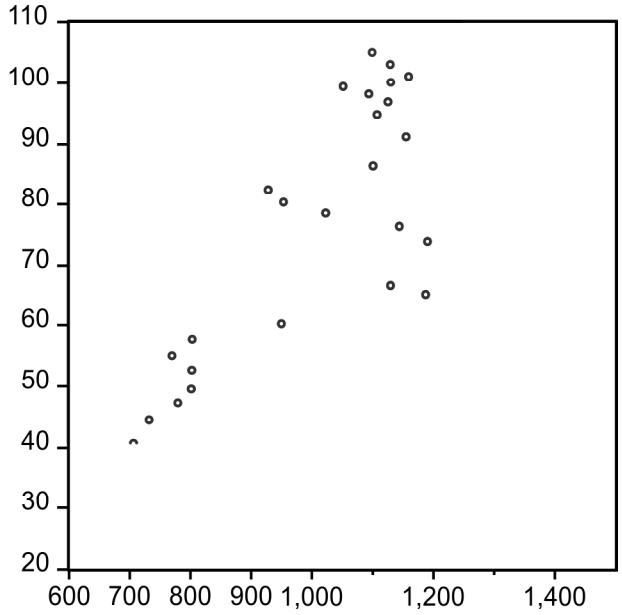

Figure 1: Scatter Diagram between the CPI and the Nominal Exchange Rate (EXR)

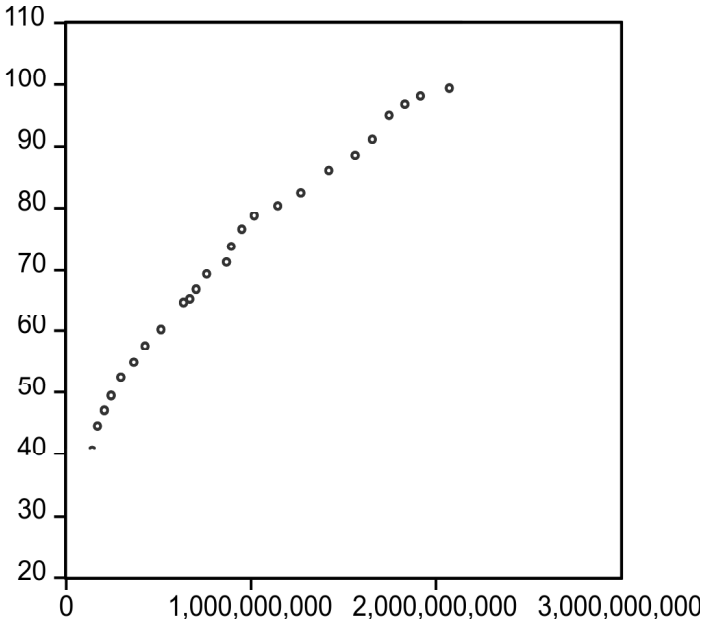

Figure 2: Scatter Diagram between the CPI and the M2 Money

of the CPI to rise by 0.0045. A 1% increase in the crude oil pricewill raisethe CPI by 0.0083%. When U.S. CPI rises 1%, South Korea's CPI will increase by 0.5746%. If the expected price rises 1%, South Korea's CPI will increase by 0.3441%.

Table 1: Estimated Regression of the Log(CPI) in South Korea

Variable	*Coefficient*	*Probability*
Intercept	-1.0126	0.0000
Log(exchange rate)	0.0668	0.0000
Log(M2 money)	0.0394	0.0003
Government borrowing/GDP ratio	0.0045	0.0015
Log(crude oil price)	0.0083	0.0059
Log(U.S.consumer price index)	0.5746	0.0000
Log(expected CPI)	0.3441	0.0000
R-squared	0.9985	
Adjusted R-squared	0.9979	
Akaike information criterion	-6.7460	
Schwarz criterion	-6.3043	
Sample period	1995-2018	
Number of observations	24	

Notes: The CPI is the consumer price index.
The exchange rate is measured as units of the Korean won per U.S. dollar.
Due to lack of data for the government borrowing-to-GDP ratio before 1995, the sample ranges from 1995-2018.

In comparison, the estimated ERPT to the consumer price in this paper is close to the estimates reported by Ito and Sato (2008) and Prasertnukul, kim and Kakinaka (2010), greater than the estimate found by Edwards (2006), and less than the estimate presented by Kohlscheen (2010). The finding that ERPT to the consumer price does not decline after the adoption of inflation targeting is different from the results reported by Aleem and Lahiani (2014) and Dilla, Achsani and Anggraeni (2017), who found a decline in ERPT to prices after the adoption of inflation targeting.

There are several possible reasons for relatively small exchange rate pass-through to consumer prices. Depreciation of the Korean won tends to shift aggregate demand to the right and aggregate supply to the left. It may increase the demand for money due to the wealth effect and raise the interest rate. A higher interest rate tends to hurt consumption and investment spending, shift aggregate demand to the left, and partially cancel out the rightward shift in aggregate demand due to the depreciation of the won. Exporters selling products to South Korea may absorb part of the price increase in order to maintain the market share. Retailers may absorb part of the price increase in order to prevent sales from declining. Consumer spending on imports may constitute a small proportion out of total spending.

If a linear form is estimated, similar results are obtained. The estimated coefficient is the slope. The value of R-squared is 99.82%. All the estimated coefficients are positive and significant at the 1% level. As exchange rate pass-through measures percent change in the price over percent change in the exchange rate, the log-log form would be a better choice.

To determine whether ERPT to the CPI may have declined after the adoption of inflation targeting since 2001, an interactive dummy variable of the exchange rate is included in the estimated regression (Edwards, 2006). The result shows that the coefficient of the interactive dummy variable of the exchange rate is negative but insignificant at the 10% level. Hence, ERPT to the CPI has not declined in South Korea.

Summary and Conclusions

This paper has examined ERPT to consumer prices in South Korea based on an extended IS-LM-AS model. In the simultaneous-equation model, the equilibrium consumer price index is determined by the nominal exchange rate, M2 money supply, government borrowing as a percent of GDP, the crude oil price, the U.S. consumer price index, and the expected consumer priceindex. The depreciation of the Korean won, more M2 money, more government borrowing as a percent of GDP, a higher crude oil price, a higher U.S. consumer price index, and a higher expected consumer price index tend to cause South Korea's consumer price index to rise. Exchange rate pass-through to consumer prices in South Koreais confirmed and is relatively small.

There are several policy implications. First, won depreciation causes the consumer price to rise. Although ERPT to the consumer price is partial,

chronicle depreciation of the won tends to raise the consumer price and reduce household wealth and consumption spending. Second, the consumer price index is also affected by the money supply. Hence, the authorities may need to make sure that the growth rate of the money supply is consistent with the growth rate of real GDP in order to avoid relatively high inflation. The adoption of inflation targeting in 2001 seems to have reduced inflation rates in recent years. Third, external shocks such as the crude oil price and the U.S. consumer prices tend to affectSouth Korean's domestic prices. The government may need to monitor changes in these prices in order to measure their impacts on South Korea's domestic price level.

References

Aleem, A., &Lahiani, A. (2014). Monetary policy credibility and exchange rate pass-through: Some evidence from emerging countries. *Economic Modelling*, 43, 21-29.

Arango, S., &Nadiri, M. I. (1981). Demand for money in open economies. *Journal of Monetary Economics*, 7(1), 69-83.

Dilla, S., Achsani, N. A., &Anggraeni, L. (2017). Do Inflation Targeting Really Reduced Exchange Rate Pass-through?. *International Journal of Economics and Financial Issues*, 7(3), 444-452.

Edwards, S. (2006). The relationship between exchange rates and inflation targeting revisited (No. w12163). National Bureau of Economic Research.

Ha, J., Stocker, M., & Yilmazkuday, H. (2019). Inflation and Exchange Rate Pass-Through. The World Bank.

Ito, T. & Sato, K. (2008). Exchange rate changes and inflation in post-crisis Asian Economies: Vector autoregression analysis of the exchange rate pass-through. *Journal of Money, Credit and Banking*, 40(7), 1407-1438.

Karim, BARHOUMI, (2005). Exchange Rate Pass-Through Into Import Prices In Developing Countries: An Empirical Investigation. *Economics Bulletin*, Vol. 3 no. 26 pp. 1-14.

Kassi, D. F., Sun, G., Ding, N., Rathnayake, D. N., & Assamoi, G. R. (2019). Asymmetry in exchange rate pass-through to consumer prices: Evidence from emerging and developing Asian countries. *Economic Analysis and Policy*, 62, 357-372.

Kohlscheen, E. (2010). Emerging floaters: Pass-throughs and (Some) New commodity currencies. *Journal of International Money and Finance*, 29, 1580–1595.

Prasertnukul, W. Kim, D. &Kakinaka, M. (2010). Exchange rates, price levels, and inflation targeting: Evidence from Asian Countries. *Japan and the World Economy*, 22(3), 173– 182.

Romer, D., (2006). Advanced Macroeconomics, 3rd edition. Boston: McGraw-Hill/Irwin.

Saha, S., & Zhang, Z. (2013). Do exchange rates affect consumer prices? A comparative analysis for Australia, China and India. Mathematics and Computers in Simulation, 93, 128-138.

Soon, S. V., Baharumshah, A. Z., & Wohar, M. E. (2018). Exchange rate pass-through in the Asian countries: does inflation volatility matter?. Applied Economics Letters, 25(5), 309-312.

Tunç, C. (2017). A Survey on Exchange Rate Pass through in Emerging Markets. *Bulletin of Economic Theory and Analysis*, 2(3), 205-233.

Yilmazkuday, H. (2013). Inflation targeting, flexible exchange rates and inflation convergence. *Applied Economics*, 45(5), 593-603.

Yilmazkuday, H. (2015). Pass-through of trade costs to US import prices. *Review of World Economics*, 151(4), 609-633.