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

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Abstract: Applying an extended IS-LM-AS model, this paper finds that a 1% depreciation of the Australian dollar causes the CPI to rise by 0.0537%. In addition, more money supply, a higher crude oil price, a higher U.S. CPI, and a higher expected price will cause Australia's CPI to rise. Inflation targeting has reduced exchange rate pass-through to consumer prices since 1993.Hence, exchange rate pass-through to Australia's 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 Australian dollar per U.S. dollar fluctuated a great deal during some of the time periods. The Australian dollar depreciated 79.14% versus the U.S. dollar from 0.8702 in 1981 to 1.496 in 1986, and the consumer price index (CPI) rose 48.27% during the same time period. Partly due to the Asian financial crisis, the Australian dollar depreciated51.4% versus the U.S. dollar from 1.2770 in 1996 to 1.9334 in 2001, and the consumer price index rose 11.88% during this time period. During the recent global financial crisis, the Australian dollar depreciated 7.55% versus the U.S. dollar from 1.1922 in 2008 to 1.2822 in 2009, and the consumer price index increased 1.77% during the same time period. These three examples suggest that the percent change in CPI responded to percent depreciation of the Australian dollar less proportionally. It is an empirical question as to how much the increase in the consumer price index is attributable to the depreciation of the Australian dollar.

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 Australia. 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 movements would affect the price level.

Literature Survey

Using a panel data consisting of 11 industrialized countries including Australia during 1977-2001, Bailliu and Fujii (2004) found that ERPT to import prices was greater than that to consumer and producer prices. A 1% depreciation led to a 0.75% increase in the import price in the short run and 0.91% increase in the long run. If the exchange rate depreciates 1%, consumer prices would rise by 0.08% in the short run and 0.16% in the long run. A depreciation of 1% caused producer prices to rise 0.2% in the short run and 0.3% in the long run. Furthermore, ERPT decreased following inflation stabilization in the early 1990s mainly due to more credible implementation of monetary policy.

Campa and Goldberg (2005) studied ERPT based on a sample of 24 OECD countries. The coefficient for ERPT to import prices for Australia was 0.55 in the short run and 0.69 in the long run. The coefficient for ERPT to import prices for the whole sample was 0.61 in the short run and 0.77 in the long run. The was a strong evidence of partial ERPT to import prices especially in manufacturing in the short run, thus rejecting the hypotheses of producer currency pricing and local currency pricing. In the long run, producer currency price was more common for many imported goods.Inflation and volatility of exchange rates were weakly correlated with ERPT to import prices. The most significant factors of change in ERPT were industry composition and microeconomic-related variables.

Using the SVAR model and a sample of a disaggregate data during 1990-2011, Saha and Zhang (2016) assessed ERPT for Australia, China and India. They found that there was less impact of ERPT to the rising natural resources and mining prices in Australia and that ERPT to aggregate consumer prices is less in Australia than in China and India.

Using a sample of 17 countries including Australia during 1979.Q1-2015.Q1, Turner and Wood (2017) studies ERPT to import and export prices. The nonlinear adjustment for Australia can be rejected. For Australia, the

coefficient for the import price was estimated to be 0.5952 and was significant at the 1% level, and the hypothesis of a full adjustment can be rejected. The coefficient for the export price for Australia was estimated to be 0.5980 and significant at the 1% level, and the hypothesis of a full adjustment can be rejected.

Using the time-varying parameter Bayesian VAR and a sample of 8 countries including Australia, Alexius and Holmberg (2017) attempted to test the hypothesis that ERPT is lower if the inflation rate is close to the inflation target (Taylor, 1993). They found lack of support for the Taylor hypothesis. It seemed that ERPT did not rise significantly with a lower inflation rate. ERPT seemed to be uncorrelated with inflation persistence. The pass-through of foreign prices was far greater than ERPT.

Dilla, Achsani and Anggraeni (2017) examined the effect of inflation targeting on ERPT for 19 high-income and middle-income countries including Australia. Among high-income countries, except for Norway, the other 7 countries including Australia experienced decline in ERPT in the short run and long run after the adoption of inflation targeting. Among middle-income countries, 7 countries recorded decrease in ERPT whereas 4 countries experienced increase in ERPT in the short run and long run after the adoption of inflation targeting.

Phuc and Duc (2019) examined ERPT for Australia, Japan, New Zealand and South Korea. They found that exchange rate changes affected import prices, producer prices and consumer prices through the distribution chain. After the global financial crisis, the impacts of ERPT to import prices increased in Japan, New Zealand and South Korea and was stable in Australia. The elasticity of ERPT was influenced mostly by macroeconomic variables such as volatility of inflation, interest rates and trade openness.

Buontempo (2019) studied ERPT for 13 industrialized and emerging countries including Australia. For the pooled sample, he showed that inflation targeting caused the effect of ERPT to domestic prices to decline. Inflation targeting also reduced the impact of ERPT by more than 50% in emerging countries. The relationship between decline in REPT and inflation targeting for Australia seemed to be insignificant mainly because the Reserve Bank of Australia was gradual and soft in implementing inflation targeting as it was reluctant to react to short-term deviations from the inflation target and more tolerant than several other countries.

Using the SVAR model and a sample of 47 countries including Australia, Ha, Stocker and Yilmazkuday (2019) revealed that countries with floating exchange rates and credible inflation targets tended to have lower pass-through ratios, that central bank independence could ease the

implementation of inflation stabilization, and that country characteristics, different global and domestic shocks tended to affect the pass-through ratios significantly.

Using the quantile regression to estimate the time-varying ERPT for 16 OECD countries including Australia, Chou (2019) showed that ERPTs were lower since the 1990s and that ERPTs were positively associated with inflation volatility and the inflation rate and negatively associated with the volatility of the exchange rate, the output gap and trade openness. ERPT is not affected by the inflation rate in the deflationary condition and reacted to appreciation and depreciation differently depending upon the magnitude of changes in the exchange rate.

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 represented by 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:

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

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

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

where

- Y = real GDP in Australia,
- 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 Australian dollar per U.S. dollar,
- P^* = the price level in the U.S.,
- P = the price level in Australia,
- 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 -π^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:

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

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

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

In equation (6), the sign of the first three terms in the numerator is positive whereas the sign of the last term in the numerator depends on the sign of 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 Australian dollar per U.S. dollar. The money supply is represented by M3 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.

Figure 1 shows exchange rate movements over time. The Australian dollar depreciated versus the U.S. dollar from 0.87 in 1981 to 1.50 in 1986, appreciated from 1.28 in 1996 to 1.93 in 2001, appreciated from 1.93 in 2001 to 0.97 in 2012, and then depreciated from 0.97 in 2012 to 1.34 in 2018. Figure 2 illustrates seems to suggest a positive relationship between the CPI and M3 money over time.

Figure 1: Exchange Rate Movements over Time

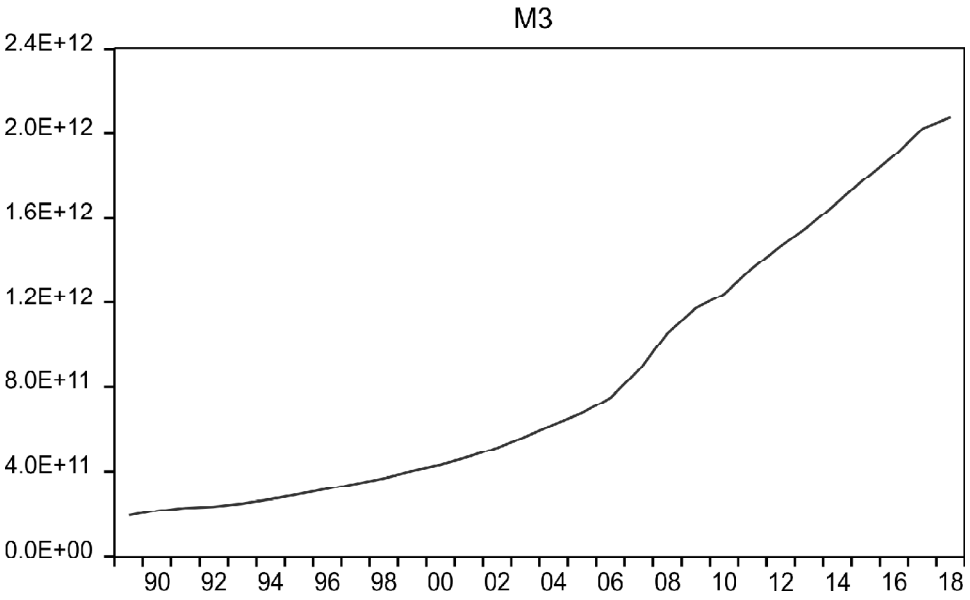

Figure 2: M3 Money Supply over Time

Table 1 presents the estimated regression and related statistics. The GARCH process is employed in order to correct for autoregressive conditional heteroskedasticity. Except for the government borrowing-to-GDP ratio, all coefficients are significant at the 1% level. Approximately 99.75% of the change in the CPI can be explained by the five-right side variables with significant coefficient. Australia's CPI is positively associated with the nominal exchange rate, M3 money, the crude oil price, the U.S. CPI and the expected CPI. The insignificant coefficient of the government borrowing-to-GDP ratio may suggest that the ratio has been less than 3% since 2013 and has not caused the consumer price to rise.

Table 1
Estimated Regression for Log(CPI) in Australia

Variable	*Coefficient*	*Probability*
Constant	0.4864	0.0000
Log(exchange rate)	0.0537	0.0000
Log(M3)	0.3192	0.0000
Government borrowing/GDP ratio	0.00007	0.9291
Log(crude oil price)	0.0386	0.0000
Log(U.S. consumer price index)	0.0833	0.0000
Log(expected CPI)	0.4632	0.0000
R-squared	0.9975	
Adjusted R-squared	0.9969	
Sample	1988-2018	
Methodology	GARCH	

Specifically, a 1% increase in the nominal exchange rate would raise the CPI by 0.0537%. If M3 money rises 1%, the CPI would increase by 0.3192%. When the crude oil price rises 1%, the CPI would increase by 0.0386%. If the U.S. CPIrises by 1%, the Australia's CPI would rise by 0.0833. A 1% increase in the expected CPI would cause the CPI to rise by 0.4632%. These results suggest that exchange rate pass-through is partial and incomplete and that the expected CPI and M3 money have the largest impacts in percent.

To test whether inflation targeting may have changed the CPI, a dummy variable with a value of 0 during 1988-1992 and 1 during 1993-2018 is included in the regression. The result shows that the coefficient is negative and significant at the 1% level, suggesting that the effect of inflation targeting on reducing the CPI is confirmed.

In comparison, the elasticity of ERPT with respect to the CPI found in this study is less than the estimated long-run elasticity reported by

Bailliuand Fujii (2004), is consistent with the result by Dilla,Achsani and Anggraeni (2017) that ERPT declined after the adoption of inflation targeting, and is in contrast with Buontemp (2019) that inflation targeting affected ERPT insignificant.

Summary and Conclusions

This paper has examined ERPT for Australia based on an extended IS-LM model. A theoretical model is presented to determine how the nominal exchange rate and other relevant variables would affect the consumer price index. The results show that depreciation of the Australian dollar, more M3 money supply, a higher crude oil price, a higher U.S. CPI and a higher expected CPI in Australia would cause Australia's CPI to rise. Due to relatively small government borrowing as a percent of GDP, fiscal expansion does not cause the CPI to rise. Inflation targeting adopted by the Reserve Bank of Australia has reduced the magnitude of ERPT to consumer prices.

There may be several policy implications. There are internal and external factors affecting Australia's CPI. The internal factors include M3 money supply, government borrowing-to-GDP ratio and the expected CPI, and the external factors include the exchange rate, the crude oil price and U.S. CPI. Although fiscal expansionary does not affect the CPI, monetary expansion does affect the CPI. The expected CPI has the largest impact in percent. All three external factors are significant. The nominal exchange rate has a larger impact than the crude oil price in percent. However, ERPT to consumer prices is relatively small and partial. Hence, the authorities may need to pay more attention to external factors and estimate potential impacts on the CPI when their values rise. Monetary policy needs to be transparent and credible in order to reduce expectations that consumer prices may rise. The Reserve Bank of Australia may need to monitorincrease in the money supply in order to avoid rapid increase in consumer prices.

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