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Exchange rate pass-through in Korea and Thailand: Trends and determinants

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Abstract

An important but age-old transmission channel of global factors into domestic prices is via exchange rate movements. This paper examines the extent and evolution of exchange rate pass-through (ERPT) into Korea's and Thailand's consumer and import prices at the aggregate level for the period over the last two decades. We find that ERPT appears to be consistently higher for Thailand compared to Korea; while for both nations ERPT of their respective bilateral rates with respect to the US dollar is higher than with respect to the Japanese yen. The paper also investigates if and how ERPT has changed over time, especially during and after the currency crisis period of 1997–1998, as well as its macroeconomic determinants.

JEL classification: E31; F31; F41; O53

Keywords: Exchange rate pass-though (ERPT); Exchange rate volatility; Inflation; Korea; Thailand

1. Introduction

There has been increasing discussion about the role of economic globalization on domestic inflation in various countries (for instance, see Borio and Filardo, 2007; Helbling et al., 2006). An important but age-old transmission channel of global factors into domestic prices is via exchange rate movements. The transmission of exchange rate changes into import (export) prices of goods into the destination-market currency as well as into aggregate domestic prices is referred to as exchange rate pass-through (ERPT). Small and open economies are generally viewed as being relatively more susceptible to ERPT effects in domestic prices. This in turn is a reason often cited for the "fear of floating" among such economies.

Following the financial crisis of 1997–1998, Korea and Thailand have officially moved towards flexible exchange rate regimes while adopting a monetary policy strategy based on inflation targeting (see Table 1 and Cavoli and Rajan, 2007). What has been the extent of ERPT in these two countries and has ERPT changed over time? These are among the set of questions examined in this paper.

In related literature, Ito et al. (2005) examined the extent of ERPT into aggregate import prices and consumer prices in eight East Asian countries over the period 1986–2004. Using a first-differenced model with a lag of the effective exchange rate up to four periods, the authors find ERPT into import prices to be 166 percent (that is more than full pass-through) for Thailand but statistically insignificant pass-through for Korea. ERPT into CPI was estimated at 26 percent for Thailand and 13 percent for Korea.

Sasaki (2005) examined the effects of changes in the US dollar (USD) and Japanese yen on aggregate import prices for selected Asian economies, including Korea and Thailand for 1973–2000. ERPT of the USD into import prices was estimated at 29 percent for Korea and 91 percent for Thailand. ERPT of the yen was found to be insignificant for both nations. Overall, there appears to be preliminary evidence based on these studies that ERPT into Thailand import prices in US dollar and in effective exchange rates to be almost complete, while that into Korean import prices to be partial and highly incomplete.[1]

Kang and Wang (2003) used a VAR analysis to analyze the effect of exchange rate changes on import prices and the

[1] Another notable study on ERPT into Korea is by Fukuda and Ono (2005). The authors investigate the currency invoicing of Korea's exports. Using monthly data from 1998M3 to 2002M12 for 19 commodity categories, the authors surmise that the US dollar is the predominant vehicle currency, not only for Korea's exports to the US, China and Hong Kong but also to destination markets where Japan has large market share and also for commodity categories where shares of local firms were small. We discuss the important of currency invoicing later in the paper (Section 5).

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Table 1
Highlights of inflation targeting regimes in Korea and Thailand

Country	Date	Target price index	Target horizon	Escape clauses	Accountability	Target set by	Publication and accountability
Thailand	April 2000	Core CPI (excluding food and energy)	Indefinite	None	Public explanation of breach and steps taken to address it	Central Bank in consultation with government	Inflation Report, inflation forecasts and publication of models used
Korea	January 1998	Core CPI (excluding non-cereal agricultural products and petroleum products)	Indefinite	Changes caused by major force	None	Central Bank in consultation with government	Inflation report and submission to parliament, publication of monetary policy meetings

Source: Cavoli and Rajan (2007).

consumer prices in Japan, Singapore, Korea and Thailand for the period 1991–2001. Interestingly, the authors find that the transmission of exchange rate changes to import and consumer prices is more in the post-crisis period (1998–2001) than the pre-crisis one (1991–1996). A variance-decomposition analysis also revealed that the contribution of exchange rate shocks in explaining variations in import prices and the CPI is higher for the post-crisis period in Korea and Thailand than in the pre-crisis one.

This paper revisits the issue by estimating exchange rate pass-through (ERPT) into Korea's and Thailand's consumer and import prices at the aggregate level for the period over the last two decades into the US dollar, the Japanese yen and the Nominal effective exchange rate (NEER). The paper also investigates if and how ERPT has changed over time, especially during and after the currency crisis period of 1997–1998, as well as its macroeconomic determinants.

The paper is organized as follows. Section 2 estimates ERPT elasticities for Korea's and Thailand's import prices and consumer prices using both bilateral exchange rates with the US dollar, the Japanese yen, as well as the NEER for the period 1980Q1–2006Q4. Section 3 examines whether the ERPT has changed over time using simple recursive estimates. Section 4 investigates whether ERPT is endogenous to certain macro-variables, including inflation and monetary and exchange rate volatility. We are particularly interested in whether the ERPT is endogenous to the extent of exchange rate variability (Rajan, 2006). The final section concludes the paper.

2. Empirics: point estimates

2.1. The model

We examine ERPT into the aggregate import prices of Korea and Thailand with regard to their bilateral nominal exchange rate with the US dollar (USD) and the Japanese yen (JPY), as well as their nominal effective exchange rates (NEER). To do so we follow Ghosh and Rajan (2007a) by using the following estimating equation in our empirical specification for the bilateral exchange rates and NEER, respectively:

$$\text{bilateral exchange rate}: \quad \ln(P^i)_t = \alpha_0 + \alpha_1 \ln(E^i_j)_t + \alpha_2 \ln(\text{GDP}^i)_t + \alpha_3 \ln(\text{PPI}^j)_t \tag{1}$$

$$\text{NEER}: \quad \ln(P^i)_t = \beta_0 + \beta_1 \ln(\text{NEER})_t + \beta_2 \ln(\text{GDP}^i)_t + \beta_3 \ln(\text{CPI}^w) \tag{2}$$

where i is the Korea or Thailand, j is the US or Japan, p^i denotes either import prices (or CPI) of Korea or Thailand, E^i_j denotes the nominal exchange rate of Korea and Thailand per USD or JPY; *NEER* is the nominal effective exchange rate (NEER) for each nation. A rise in either the bilateral or the NEER denotes a depreciation of the currency of either Korean won or Thai Baht; PPI^j denotes the producer price index (PPI) of the US and Japan, respectively; CPI^w denotes world consumer price index (CPI).

The coefficients of particular interest are the ERPT elasticities, α_1 and β_1. If $\alpha_1 = 0$ there is no ERPT into import prices or CPI, while if $\alpha_1 = 01$ there is complete ERPT. If the coefficient lies anywhere in between 0 and 1 there is partial or incomplete ERPT. In estimating Eqs. (1) and (2) we control for possible shifts in domestic demand and costs changes in the exporting nations. A rise in income implies an increase in demand for imported goods, thereby raising the import price. Thus α_2 and β_2 are generally expected to be positive.[2] While we have data on GDP for the entire time period of interest (1980–2006) for Korea; for Thailand, we use an Industrial Production Index as a proxy for income.[3] The extent of ERPT may also be affected by the marginal costs of the exporters. We proxy foreign exporter's costs by using both the PPI and CPI of the US and Japan. For NEER pass-through, we use the world CPI as a proxy for the costs of all the combined exporters supplying to the two economies.

All data are sourced from the IFS. The data spans the period 1980Q1–2006Q4 with the exception of the NEER which are only available from 1985Q1 onwards.

2.2. Stationarity tests

We conduct tests for stationarity in the variables in Eqs. (1) and (2) using both the augmented Dickey–Fuller (ADF)

[2] However, a rise in output could also imply less demand for imported goods and a decline in the import prices. So it is plausible that α_2 and β_2 might be negative as well.

[3] For Thailand GDP data are available only from 1993, while data on Industrial Production are available from 1987. As such we used the latter as it provided a longer time series.

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Table 2a
Unit root test results

	Korea				Thailand			
	ADF stat. levels	Five percent critical value	ADF stat. first difference	Five percent critical value Levels	ADF stat.	Five percent critical value 1st difference	ADF stat.	Five percent critical value
Null hypothesis: variable has a unit root								
$LIMPR_i$	−3.472	−3.453	−8.613	−3.454	−2.526	−3.453	−8.589	−3.453
$LEXRT_i$/USD	−2.248	−3.452	−12.312	−3.453	−2.156	**−3.452**	−9.839	−3.453
$LEXRT_i$/JPY	−1.942	−3.452	−12.297	−3.453	−1.763	−3.452	−8.998	−3.453
$LNEER_i$	−1.652	−3.462	−7.347	−3.464	−2.868	**−3.463**	−5.284	−3.466
$LGDP_K$	−0.810	−3.456	−5.145	−3.456				
LIP_T					−2.168	−3.474	−2.555	−3.474
$LPPI_{USA}$	−2.659	−3.453	−6.500	−3.453	−2.659	−3.453	−6.500	−3.453
$LCPI_{USA}$	−1.847	−3.454	−4.464	−3.454	−1.847	−3.454	−4.464	−3.454
$LPPI_{JAP}$	−1.243	−3.453	−9.495	−3.453	−1.243	−3.453	−9.495	−3.453
$LCPI_{JAP}$	−0.811	−3.454	−3.510	−3.454	−0.811	−3.454	−3.510	−3.454
$LCPI_i$	−1.658	−3.454	−7.086	−3.453	−1.446	−3.453	−8.385	−3.453
$LCPI_W$	−0.426	−3.457	−2.293	−3.457	−0.426	−3.457	−2.293	−3.457

	Korea				Thailand			
	P–P stat. levels	Five percent critical value	P–P stat. first difference	Five percent critical value Levels	P–P stat.	Five percent critical value 1st difference	P–P stat.	Five percent critical value
Null hypothesis: variable has a unit root								
$LIMPR_i$	−3.684	−3.453	−10.865	−3.453	−2.301	−3.453	−8.513	−3.453
$LEXRT_i$/USD	−2.075	−3.452	−12.318	−3.453	−2.250	−3.452	−9.919	−3.453
$LEXRT_i$/JPY	−1.935	−3.452	−12.355	−3.453	−1.790	−3.452	−9.945	−3.453
LNEER	−1.930	−3.462	−7.809	−3.463	−2.256	−3.462	−6.342	−3.463
$LGDP_K$	−9.736	−3.453	−52.782	−3.454				
LIP_T					−1.808	−3.468	−11.961	−3.468
$LPPI_{USA}$	−2.510	−3.452	−6.385	−3.453	−2.659	−3.453	−6.500	−3.453
$LCPI_{USA}$	−4.295	−3.452	−6.905	−3.453	−1.847	−3.454	−4.464	−3.454
$LPPI_{JAP}$	−3.108	−3.452	−9.157	−3.453	−3.108	−3.452	−9.157	−3.453
$LCPI_{JAP}$	−2.261	−3.452	−13.906	−3.453	−2.261	−3.452	−13.906	−3.453
$LCPI_i$	−3.672	−3.453	−7.035	−3.453	−2.714	−3.452	−8.437	−3.453
$LCPI_W$	0.924	−3.453	−3.954	−3.453	0.924	−3.453	−3.954	−3.453

$LIMPR_i$: import price of Korea or Thailand; $LEXRT_i$/USD: exchange rate of Korea or Thailand per unit of USD; $LEXRT_i$/JPY: exchange rate of Korea or Thailand per unit of JPY; $LNEER_i$: nominal effective exchange rate of Korea or Thailand; $LGDP_K$: GDP of Korea; LIP_T: industrial production index of Thailand; $LPPI_{USA}$: producer price index of USA; $LCPI_{USA}$: consumer price index of USA; $LPPI_{JAP}$: producer price index of Japan; $LCPI_{JAP}$: consumer price index of Japan; $LCPI_i$: consumer price index of either Korea or Thailand; $LCPI_W$: consumer price index of world.

test as well as the Phillip–Perron test (Table 2a). Both tests fail to reject the null hypothesis of unit root in the variables in their level form, suggesting that they are stationary in their first differenced form. Given that the variables are $I(1)$, we next perform co-integration among the variables in Eq. (3) using the methodology developed by Johansen and Juselius (1990). Evidence of co-integration among variables rules out the possibility of the estimated relationship being spurious. The Johansen procedure involves identification of rank of a $m \times m$ matrix Π with the following specification:

$$\Delta X_t = \delta + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-k} + \varepsilon_t \quad (3)$$

X_t is a column vector of the m variables, Γ and Π represent coefficient matrices, Δ is a difference operator, k denotes the lag length and δ is a constant. If Π has zero rank there is no linear combination of the variables, i.e. the variables are non-co-integrated. If the rank r of Π is greater than zero then the variables in Eq. (3) are co-integrated.

The co-integration results for ERPT into import prices for bilateral exchange rates and NEER using the alternate measures of exporter's costs are shown in Table 2b. The results indicate the presence of a co-integrating relationship.

2.3. Methodology

We obtain the long-run exchange rate pass-through elasticities by using a recent methodology developed by Stock and Watson (1993). The dynamic OLS (DOLS) procedure involves regressing any variable with the regressors itself but also the leads and lags of the first differences of the regressors. Stock and Watson (1993) show that it a robust methodology particularly for small samples as it allows for regressing variables integrated of different orders but are co-integrated.

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Table 2b
Co-integration test results

	Trace statistic				Maximum eigenvalue statistic			
	$r = 0$[a]	$r = 1$	$r = 2$	$r = 3$	$r = 0$	$r = 1$	$r = 2$	$r = 3$
Korea								
Import price pass-through								
Spec. 1 (US PPI)	83.866	18.534	4.589	0.522	65.332	13.945	4.066	0.522
Spec. 2 (US CPI)	77.557	23.570	7.566	1.422	53.987	16.003	6.145	1.422
Spec. 1 (JAP PPI)	77.145	31.194	13.894	3.091	45.951	17.300	10.803	3.091
Spec. 2 (JAP CPI)	92.719	30.623	12.880	0.916	62.096	17.742	11.965	0.916
NEER	57.496	29.310	13.465	0.797	28.185	15.845	12.668	0.797
CPI pass-through								
Spec. 1 (US PPI)	88.379	27.576	6.453	0.849	60.803	21.123	5.605	0.849
Spec. 2 (US CPI)	91.107	36.965	13.136	2.032	54.141	23.829	11.104	2.032
Spec. 1 (JAP PPI)	79.730	38.834	20.444	6.665	40.896	18.390	13.779	6.665
Spec. 2 (JAP CPI)	92.495	36.406	15.644	4.296	56.090	20.762	11.348	4.296
NEER	70.211	39.227	12.510	0.344	30.984	26.717	12.166	0.344
Thailand								
Import price pass-through								
Spec. 1 (US PPI)	61.731	19.349	7.199	1.004	42.382	12.150	6.194	1.004
Spec. 2 (US CPI)	50.835	21.234	9.704	1.162	29.601	11.530	8.541	1.162
Spec. 1 (JAP PPI)	62.743	26.010	11.645	2.696	36.734	14.364	8.949	2.696
Spec. 2 (JAP CPI)	90.431	33.527	5.413	0.886	56.904	28.113	4.527	0.886
NEER	89.834	23.442	10.656	0.140	66.391	12.786	10.516	0.140
CPI pass-through								
Spec. 1 (US PPI)	105.522	28.584	13.191	3.156	76.938	15.392	10.035	3.156
Spec. 2 (US CPI)	73.592	40.729	20.441	8.008	32.863	20.288	12.433	8.008
Spec. 1 (JAP PPI)	100.844	28.641	12.605	3.741	72.203	16.037	8.864	3.741
Spec. 2 (JAP CPI)	85.963	30.080	9.165	1.052	55.883	20.915	8.113	1.052
NEER	84.010	26.735	10.108	0.792	57.275	16.627	9.316	0.792

[a] r denotes number of co-integrating vectors.

Moreover, by including the lagged and lead values of the changes in the regressors it corrects for potential simultaneity bias and small sample bias among the regressors.

The empirical estimating version of Eq. (3) is given by:

$$\ln(P^i)_t = B'X_t + \sum_{k=-1}^{k=+1} \eta_k \Delta \ln(E^i_j)_{t-k} + \sum_{k=-1}^{k=+1} \lambda_k \Delta \ln(\mathrm{GDP}^i)_{t-k} + \sum_{k=-1}^{k=+1} \gamma_k \Delta \ln(\mathrm{PPI}^j)_{t-k} + \zeta_t \quad (4)$$

where $B = [\alpha_0, \alpha_1, \alpha_2, \alpha_3]'$, $X = [(1, \ln(E^i_j), \ln(\mathrm{GDP}^i),$ and $\ln(\mathrm{PPI}^j)]$.

The results presented are with one period leads and lags of the regressors.[4] Tables 3a and 3b show the results for import price pass-through of Korea and Thailand while Tables 4a and 4b shows the results for CPI pass-through.[5] In order to capture the impact of the currency crisis the estimations were also run using a dummy with a value of 1 for 1997Q1–1998Q2 and 0 otherwise. The ERPT elasticities were unchanged, while the dummy itself was found to be positive but insignificant.

2.4. Result: ERPT into import prices

With respect to the USD bilateral rate for Korea we find ERPT elasticities of 51 percent when we use the US PPI, and 44 percent when we use the US CPI. The corresponding elasticities for Thailand are 91 and 63 percent, respectively, as shown in Table 3. With respect to the JPY, the ERPT elasticity for import prices of Korea is statistically insignificant when we use Japanese PPI, while it is 24 percent when we use the Japanese CPI. For Thailand the corresponding ERPT elasticities are 53 and 80 percent, respectively. Using NEER we find the ERPT for Korea is 53 percent while for Thailand ERPT seems to be complete. These results are broadly consistent with the findings of Sasaki (2005) and Ito et al. (2005) noted in Section 1.

With regard to the other independent variables, for ERPT with respect to the USD we find the coefficient on Korea's GDP to be negative and significant, while for ERPT the coefficient with respect to the JPY and NEER the Korean GDP is positive. The coefficients on both the US PPI and CPI are positive and significant, while the PPI and CPI of Japan are both negative. For Thailand we find the industrial production index to be positive in all cases. Here again we find the coefficients of the US PPI and CPI to be positive, while those on the Japanese PPI

[4] We also used higher order lags and leads but they were statistically insignificant. As such we restrict our analysis to the most parsimonious model specification.

[5] With one period lag and lead of the regressors the final estimation sample ranged from 1983Q1 to 2006Q1 for bilateral ERPT and from 1985Q3 to 2006Q1 for NEER pass-through.

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Table 3a
Dynamic OLS (DOLS)—import price ERPT for Korea Q3

	Won-USD		Won-JPY		NEER
C	−3.634***	**−3.379*** **	**11.677*** **	**10.690*** **	**5.196*** **
	0.704	0.924	3.899	2.352	0.884
LEXRTK	**0.508*** **	**0.438*** **	0.062	**0.240***	
	0.049	0.065	0.163	0.139	
LNEER					**0.534*** **
					0.138
LGDPK	0.007	**−0.289***	0.169	**0.501*** **	**0.610*** **
	0.044	0.155	0.135	0.132	0.168
$LPPI_j$	**0.992*** **		**−1.754****		
	0.160		0.773		
$LCPI_j$		**1.331*** **		**−1.961*** **	
		0.379		0.589	
$LCPI_W$					**−0.211***
					0.085
ΔLEXRT (1)	0.033	0.031	−0.168	−0.028	
	0.059	0.076	0.108	0.093	
ΔLEXRT (−1)	0.160	0.155	0.152	0.183	
	0.110	0.094	0.161	0.162	
ΔLNEER (1)					**−0.234***
					0.131
ΔLNEER (−1)					0.151
					0.121
$\Delta LGDP_K$ (1)	0.022	−0.134	0.116	**0.309*** **	**0.261****
	0.045	0.083	0.070	0.085	0.099
$\Delta LGDP_K$ (−1)	−0.012	−0.005	−0.031	−0.034	0.011
	0.034	0.030	0.054	0.092	0.065
$\Delta LPPI_j$ (1)	**1.110****		0.969		
	0.486		1.872		
$\Delta LPPI_j$ (−1)	**1.478*** **		1.158		
	0.535		1.642		
$\Delta LCPI_j$ (1)		**4.028*** **		0.753	
		1.044		1.775	
$\Delta LCPI_j$ (−1)		**5.349*** **		**−3.227***	
		1.222		1.915	
$\Delta LCPI_W$ (1)					−0.824
					0.911
$\Delta LCPI_W$ (−1)					−0.912
					0.880
Adj. R^2	0.956	0.939	0.834	0.858	0.908

Terms below co-efficient denote standard errors. *,**,*** indicates significance at the 10 percent, 5 percent and 1 percent levels, respectively. Δ denotes first differenced operator; L denotes log of variables. (−) denotes one period lag of the variables; (1) denotes one period lead of the variables; j denotes either the US or Japan.

and CPI are negative. The world CPI is negative for Korea's NEER pass-through, while it is insignificant for Thailand's NEER pass-through.

2.5. Results: ERPT into CPI

With respect to the USD bilateral rate for Korea we find ERPT elasticities to be 21 percent when we use the US PPI, and 14 percent when we use the US CPI (Table 4a). For Thailand we estimate the ERPT elasticity to be 31 percent using either US PPI, but statistically insignificant in the case of US CPI (Table 4b). With respect to the JPY, we do not find any significant ERPT into CPI for Korea, while for Thailand, ERPT is in the range of 30 percent in both specifications NEER pass-through into CPI for Korea is 14 percent, while it is 29 percent for Thailand.[6]

[6] Instead of Thailand's Industrial Production index when we used its GDP which starts from 1993 the ERPT elasticity into import prices from the USD were 88 and 41 percent, respectively for the two specifications. For the Baht-JPY rates they were 99 and 100 percent. For NEER it was 93 percent. For CPI pass-through of Baht-USD the elasticities were 34 and 11 percent, respectively for the two specifications. For Baht-JPY they were 37 and 35 percent. NEER pass-through into CPI of Thailand using its GDP was insignificant. Detailed results are available upon request.

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Table 3b
Dynamic OLS (DOLS)—import price ERPT for Thailand

	Baht-USD		Baht-JPY		NEER
C	**−6.767*****	**−7.526*****	**13.424****	**11.114*****	**8.256*****
	0.585	1.827	5.276	3.606	0.723
LEXRT	**0.909*****	**0.625*****	**0.533*****	**0.796*****	
	0.065	0.113	0.182	0.147	
LNEER					**1.255*****
					0.134
LIP_T	**0.104*****	−0.209	**0.393*****	**0.572*****	**0.370*****
	0.060	0.193	0.082	0.124	0.133
$LPPI_j$	**1.643*****		**−2.188***		
	0.156		1.158		
$LCPI_j$		**2.336*****		**−1.807***	
		0.646		0.887	
$LCPI_W$					0.100
					0.085
ΔLEXRT (1)	**0.228****	0.071	−0.200	0.022	
	0.103	0.106	0.188	0.175	
ΔLEXRT (−1)	**0.247****	**0.331*****	−0.259	−0.258	
	0.106	0.094	0.286	0.279	
ΔLNEER (1)					0.184
					0.126
ΔLNEER (−1)					0.171
					0.111
ΔLIP_T (1)	−0.013	−0.177	−0.240	−0.115	0.081
	0.073	0.154	0.239	0.399	0.112
ΔLIP_T (−1)	−0.061	−0.020	**−0.349***	−0.416	−0.040
	0.054	0.080	0.208	0.357	0.089
$\Delta LPPI_j$ (1)	−0.561		1.642		
	0.380		2.684		
$\Delta LPPI_j$ (−1)	**−1.192*****		5.194		
	0.434		3.298		
$\Delta LCPI_j$ (1)		**3.998***		0.082	
		2.228		3.063	
$\Delta LCPI_j$ (−1)		**6.056****		−1.238	
		2.542		3.049	
$\Delta LCPI_W$ (1)					−0.786
					0.726
$\Delta LCPI_W$ (−1)					**−1.244***
					0.694
Adj. R^2	0.985	0.974	0.896	0.892	0.975

Terms below co-efficient denote standard errors. *·**·*** indicates significance at the 10 percent, 5 percent and 1 percent levels, respectively. Δ denotes first differenced operator; L denotes log of variables. (−) denotes one period lag of the variables; (1) denotes one period lead of the variables, *j* denotes either the US or Japan.

With regard to the other independent variable, the Korean GDP is found to be positive. Here again, as in the case of import price pass-through, the coefficients for both the US PPI and US CPI are positive and significant. For Thailand's CPI pass-through its industrial production index coefficient is positive for specification 1 with respect to the US, while it is negative for the second specification. It is positive for both specifications with respect to Japan. The coefficients on the US and Japanese CPI are both positive, while both he US and Japan's PPI is insignificant. The coefficient for the world CPI is also positive for both Korea and Thailand's NEER pass-through.

3. Has ERPT declined over time?

Recent literature on ERPT has found that it has declined since 1980s for the industrialized countries (see Ghosh and Rajan, 2007b and references cited within). Can the same be said of ERPT in these two Asian economies? To test this we used the recursive estimation methodology to plot the dynamic ERPT

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Table 4a
Dynamic OLS (DOLS)—CPI ERPT for Korea

	Won-USD		Won-JPY		NEER
C	**−2.649*****	**−3.543*****	0.255	1.270	**2.569*****
	0.814	0.522	2.691	1.512	0.316
LEXRT	**0.210*****	**0.135*****	0.066	0.038	
	0.044	0.041	0.083	0.093	
LNEER					**0.144****
					0.058
$LGDP_K$	**0.436*****	−0.085	**0.676*****	**0.666*****	**0.429*****
	0.061	0.092	0.096	0.071	0.069
$LPPI_j$	**0.819*****		0.232		
	0.232		0.515		
$LCPI_j$		**1.644*****		0.036	
		0.192		0.352	
$LCPI_W$					**0.159*****
					0.041
ΔLEXRT (1)	0.043	**0.099*****	−0.040	−0.040	
	0.047	0.036	0.071	0.077	
ΔLEXRT (−1)	**0.076***	0.041	0.056	0.054	
	0.044	0.031	0.076	0.078	
ΔLNEER (1)					−0.035
					0.050
ΔLNEER (−1)					0.070
					0.053
$\Delta LGDP_K$ (1)	**0.250*****	−0.027	**0.361*****	**0.373*****	**0.233*****
	0.039	0.048	0.049	0.051	0.041
$\Delta LGDP_K$ (−1)	**−0.029***	−0.014	−0.028	−0.020	−0.012
	0.018	0.014	0.029	0.054	0.020
$\Delta LPPI_j$ (1)	0.303		1.429		
	0.285		1.209		
$\Delta LPPI_j$ (−1)	**−0.809***		−1.105		
	0.457		0.882		
$\Delta LCPI_j$(1)		1.305		1.075	
		0.858		1.341	
$\Delta LCPI_j$(−1)		1.563		−1.883	
		1.005		1.422	
$\Delta LCPI_W$ (1)					−0.115
					0.282
$\Delta LCPI_W$ (−1)					−0.100
					0.263
Adj. R^2	0.987	0.992	0.971	0.971	0.992

Terms below co-efficient denote standard errors. ****** indicates significance at the 10 percent, 5 percent and 1 percent levels, respectively. Δ denotes first differenced operator; L denotes log of variables. (−) denotes one period lag of the variables; (1) denotes one period lead of the variables; *j* denotes either the US or Japan.

elasticities over time. While the DOLS methodology used in the earlier section provides a point estimate of ERPT elasticities over the entire sample period, the recursive methodology involves adding one data point to the sample in the DOLS model and re-running the regression. A downward trend in the estimated pass-through co-efficient is suggestive of declining ERPT. As such the last data point in the recursive ERPT elasticity plots exactly match the value of the point elasticities reported in Tables 3 and 4, as both are based on the entire sample size. But given the initial recursive estimates for the initial period are based on too few observations, we present the recursive plots for Korea's ERPT from 1992Q1. For Thailand, with the sample size starting from 1987, we begin all the recursive plots from 1996Q1.[7]

Fig. 1(a) and (b) shows the recursive estimates of ERPT for Korea's Won-USD into import prices and CPI, respectively.

[7] For Korea as such we have 57 observations while for Thailand we have 41 observations in the recursive plots.

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Table 4b
Dynamic OLS (DOLS)—CPI ERPT for Thailand

	Baht-USD		Baht-JPY		NEER
C	**2.338*****	−**3.485*****	**3.826****	0.725	**4.411*****
	0.581	0.826	1.827	1.392	0.227
LEXRT	**0.305*****	0.017	**0.300*****	**0.312*****	
	0.050	0.054	0.076	0.054	
LNEER					**0.286*****
					0.040
LIP_T	**0.446*****	−**0.250****	**0.338*****	**0.287*****	0.070
	0.047	0.107	0.034	0.048	0.051
$LPPI_j$	−0.202		−0.105		
	0.175		0.409		
$LCPI_j$		**1.996*****		**0.625***	
		0.318		0.342	
$LCPI_W$					**0.259*****
					0.034
ΔLEXRT (1)	**0.169*****	0.053	**0.129***	0.072	
	0.044	0.043	0.073	0.058	
ΔLEXRT (−1)	−0.028	0.066	−0.120	−0.169	
	0.062	0.059	0.084	0.066	
ΔLNEER (1)					−0.032
					0.036
ΔLNEER (−1)					−0.041
					0.056
ΔLIP_T (1)	**0.174*****	−**0.152****	0.058	0.055	0.049
	0.051	0.071	0.082	0.101	0.032
ΔLIP_T (−1)	−**0.108***	−**0.065***	−**0.165***	−**0.169****	−0.003
	0.055	0.038	0.088	0.105	0.026
$\Delta LPPI_j$ (1)	−**0.839****		−0.405		
	0.346		0.844		
$\Delta LPPI_j$ (−1)	−0.538		−0.887		
	0.388		1.247		
$\Delta LCPI_j$ (1)		−0.472		0.578	
		0.777		1.178	
$\Delta LCPI_j$ (−1)		−**2.572****		−0.840	
		1.107		0.895	
$\Delta LCPI_W$ (1)					−0.169
					0.238
$\Delta LCPI_W$ (−1)					−**0.371***
					0.208
Adj. R^2	0.972	0.985	0.957	0.962	0.991

Terms below co-efficient denote standard errors. *·**·*** indicates significance at the 10 percent, 5 percent and 1 percent levels, respectively. Δ denotes first differenced operator; L denotes log of variables. (−) denotes one period lag of the variables; (1) denotes one period lead of the variables; *j* denotes either the US or Japan.

With regard to import prices, we see evidence of stable ERPT prior to 1996, followed by a spike upwards until the end of the financial crisis and relative stability thereafter at a higher level. In the case of Korean CPI, the upward trend in ERPT began much earlier in 1992 and continued till about the start of the crisis in 1996. There was a further upward spike during the crisis. Since then the ERPT has been fairly stable till the last sample period.

Fig. 1(c) and (d) shows the recursive plots for Won-JPY rate into Korea's import prices and CPI. Trends in this case are somewhat less clear, though there appears to be evidence of rising ERPT just after the crisis period followed by a gradual decline since 2000.

Fig. 1(e) and (f) clearly reveals that the ERPT of NEER was stable in Korea prior to the crisis, followed by a spike upwards during the crisis period. This in turn was followed by a degree of stability in the case of import price ERPT at a higher level till the end of the sample period. In the case of Korea's CPI, the spike following the crisis was followed by a period of rising ERPT till the end of the sample period where the elasticity is 0.14.

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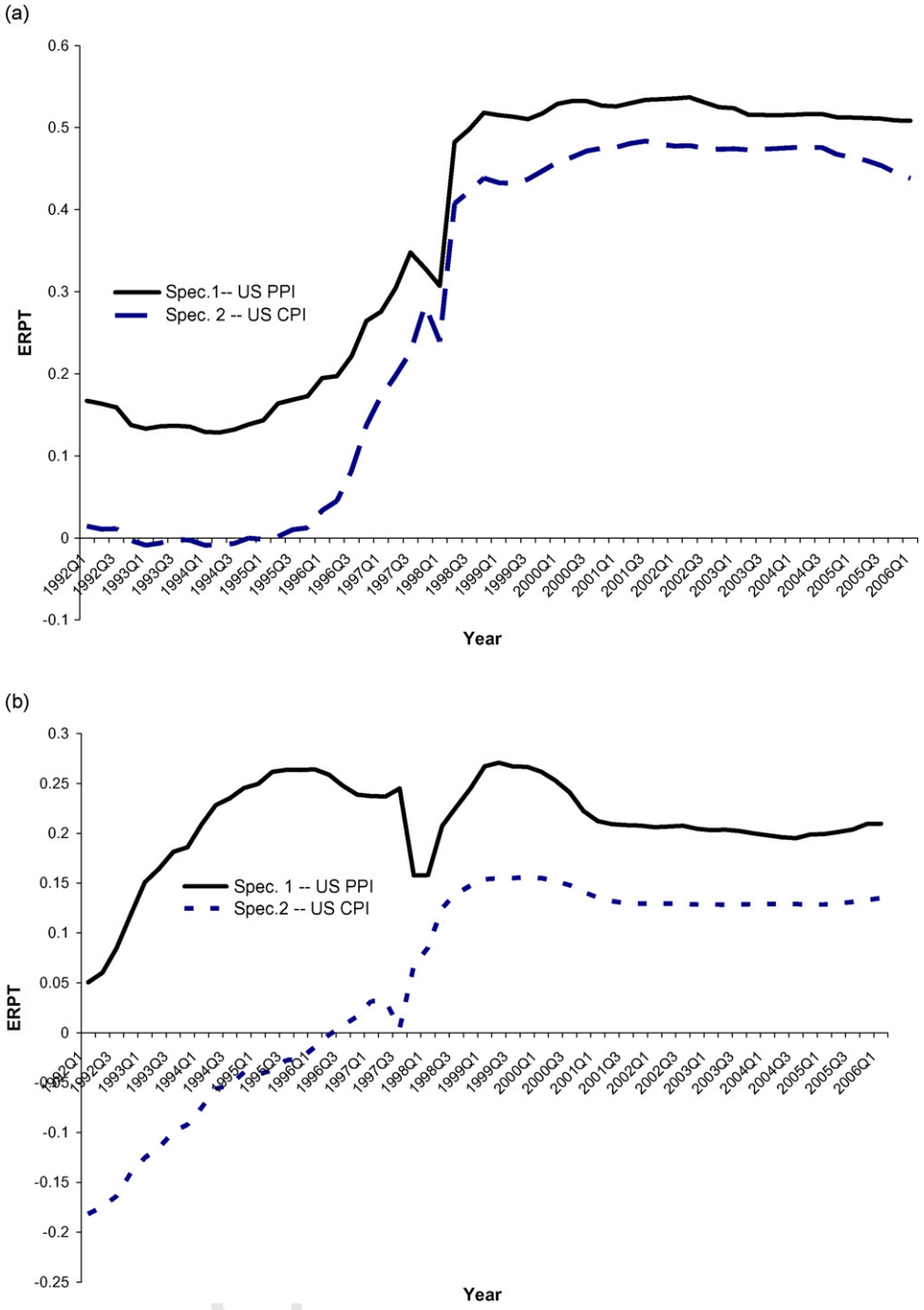

Fig. 1. (a) Recursive estimates of ERPT elasticities of Won-USD into Korea's import prices. (b) Recursive estimates of ERPT elasticities of Won-USD into Korea's CPI. (c) Recursive estimates of ERPT elasticities of Won-Yen into Korea's import prices. (d) Recursive estimates of ERPT elasticities of Won-Yen into Korea's CPI. (e) Recursive estimates of ERPT elasticities of NEER into Korea's import prices. (f) Recursive estimates of ERPT elasticities of NEER into Korea's CPI.

Next we plot the dynamic elasticities for Thailand. Fig. 2(a) and (b) shows the ERPT of the Baht-USD rate into its import prices and CPI, respectively. In all cases there appears a clear spike in ERPT during the crisis and relative stability thereafter. This pattern is even more distinct in Fig. 2(c) and (d) for the Baht-JPY rate. A drop in ERPT just prior to the crisis, is followed by a distinct rise in ERPT and stability at the higher level thereafter. A broadly similar pattern is apparent in the case of ERPT using Thai NEER (Fig. 2(e) and (f)), into both import prices and CPI with the last data points being 1.25 and 0.29, respectively, same as the corresponding point elasticities shown in Tables 3b and 4b.

4. Endogeneity of pass-through rates with macroeconomic variables

Overall the foregoing results suggest that ERPT increased after the currency crisis period and appears to have remained

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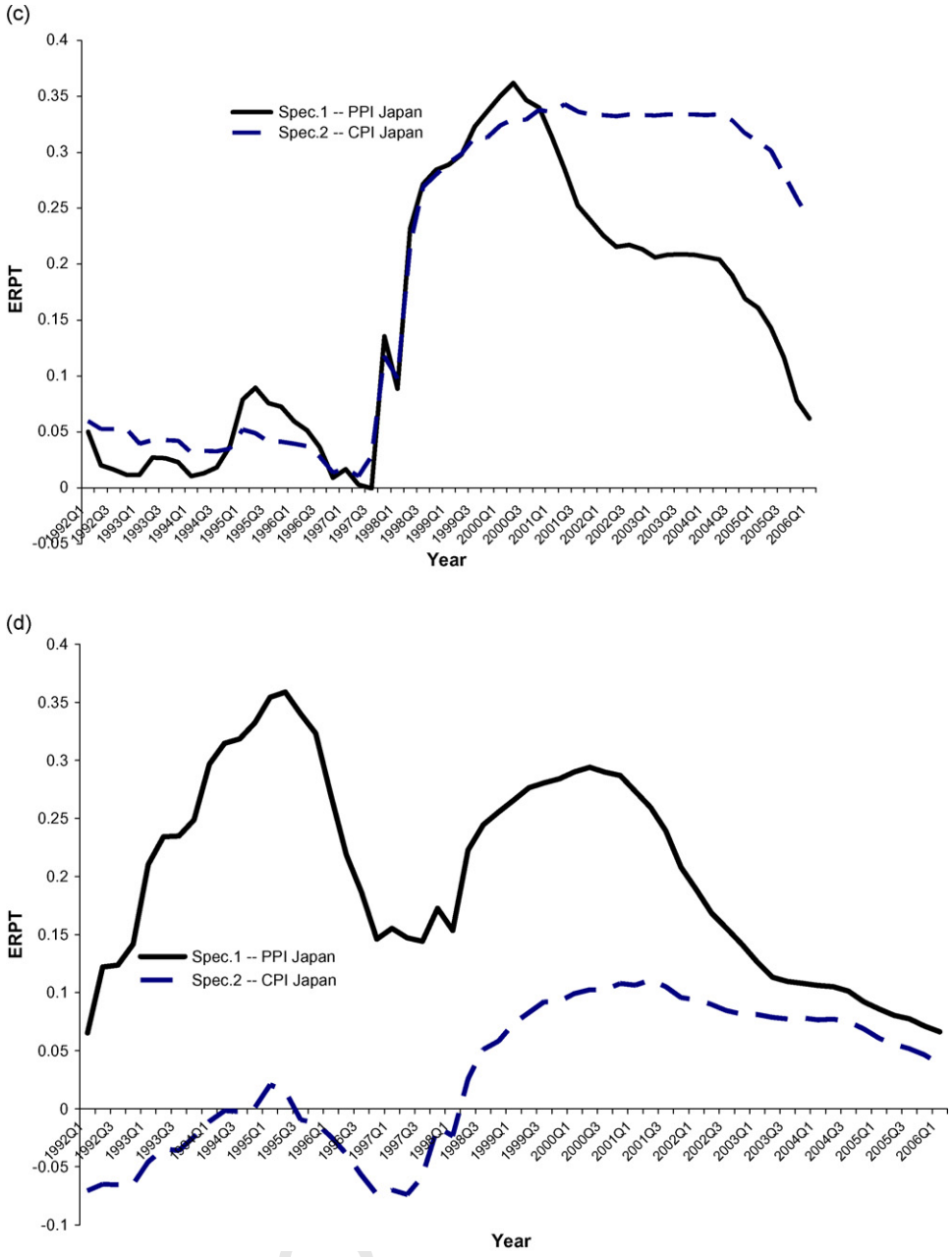

Fig. 1. (*Continued*)

somewhat more stable post crisis at a higher level. But was the rise in the ERPT during the crisis a result of the crisis per se, or because of changes in underlying fundamentals? To answer this question we next turn our attention to the macroeconomic factors that impact ERPT. In particular we are interested in the question as to whether ERPT is endogenous to a country's underlying macroeconomic fundamentals.

Taylor (2000) argues that ERPT is endogenous to a nation's exchange rate and monetary policy. ERPT rates are endogenous to a nation's monetary policy and monetary stability, i.e. the more stable is a country's monetary policy and the lower its inflation the lower will be the extent of ERPT. Some empirical evidence of this has been reported by Gagnon and Ihrig (2004), Choudri and Hakura (2001) and Frankel et al. (2005) using macro-level data for industrial countries.

Another important macro-variable that may affect the ERPT elasticities is exchange rate volatility. Devereux and Engel (2001) argue that if exporters set their prices in the currency of the country that has stable monetary policy (i.e. local currency pricing as opposed to producer currency pricing) then ERPT into import prices in local currency terms will be low for countries with low monetary and exchange rate variability.[8] In contrast, Froot and Klemperer (1989) contend that ERPT is low when nominal exchange rate volatility is high as exporters try to preserve market share. They view exchange rate volatility as

[8] We also tried the variability in monetary growth but this is consistently statistically and economically insignificant so we dropped it. Results are available on request.

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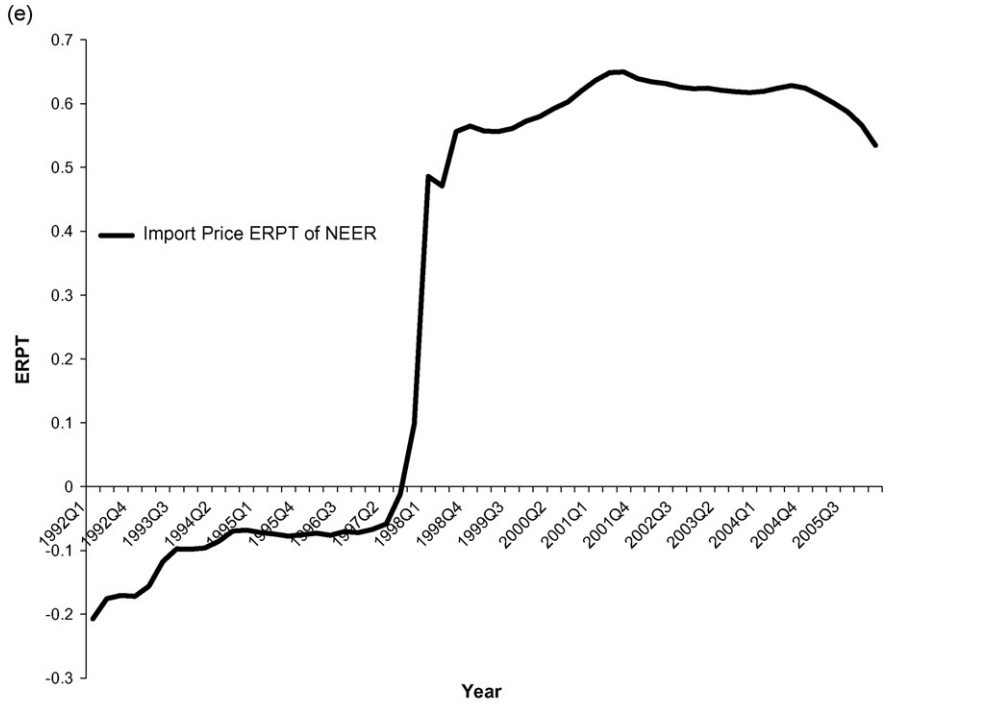

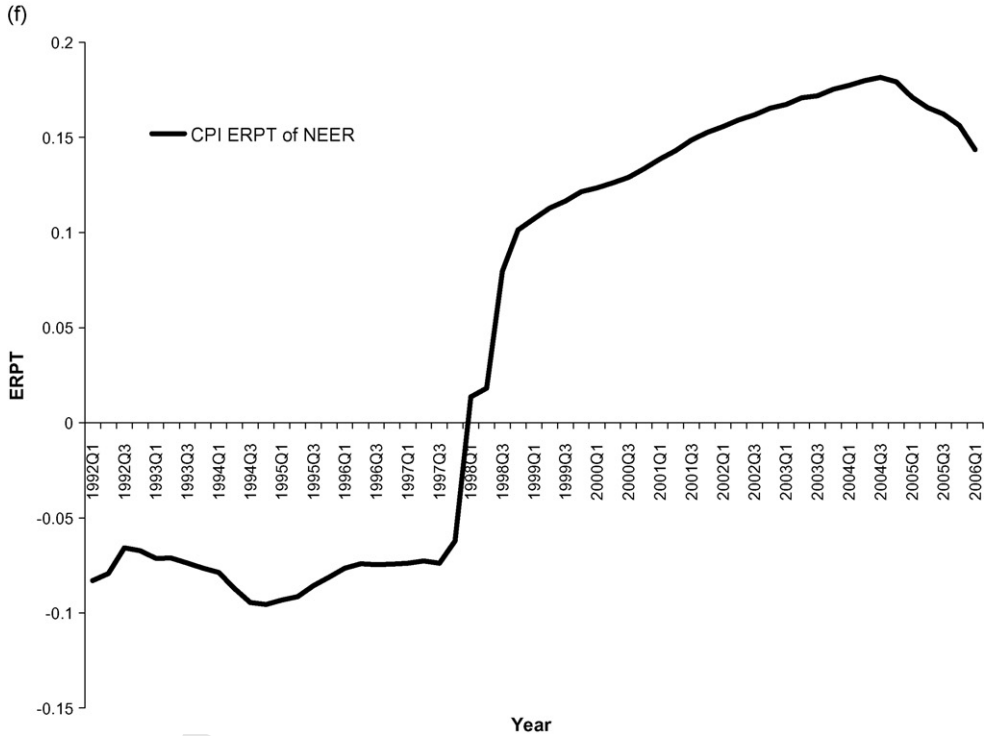

Fig. 1. (*Continued*).

temporary fluctuations in exchange rates in any one direction, leading exporters absorb these shocks in their mark-ups and profit margins. We also examine whether the extent of trade openness impacts ERPT. On the other hand, greater openness ought to imply that domestic prices are more directly and significantly impacted by exchange rate changes. Thus, one would expect ERPT to be higher. On the other hand, greater openness may also imply higher degree of competition for market share, thus implying lower ERPT.

We test for the role of these macroeconomic variables by regressing the time varying ERPT elasticities obtained from the recursive estimations on lagged inflation rate, lagged exchange rate volatility and trade openness.[9] Moreover we use a dummy that has a value of 1 for 1997Q2–1998Q2 and 0

[9] For both Korea and Thailand's ERPT of their bilateral rates with the USD and JPY we use the specification 1 using either US or Japanese PPI.

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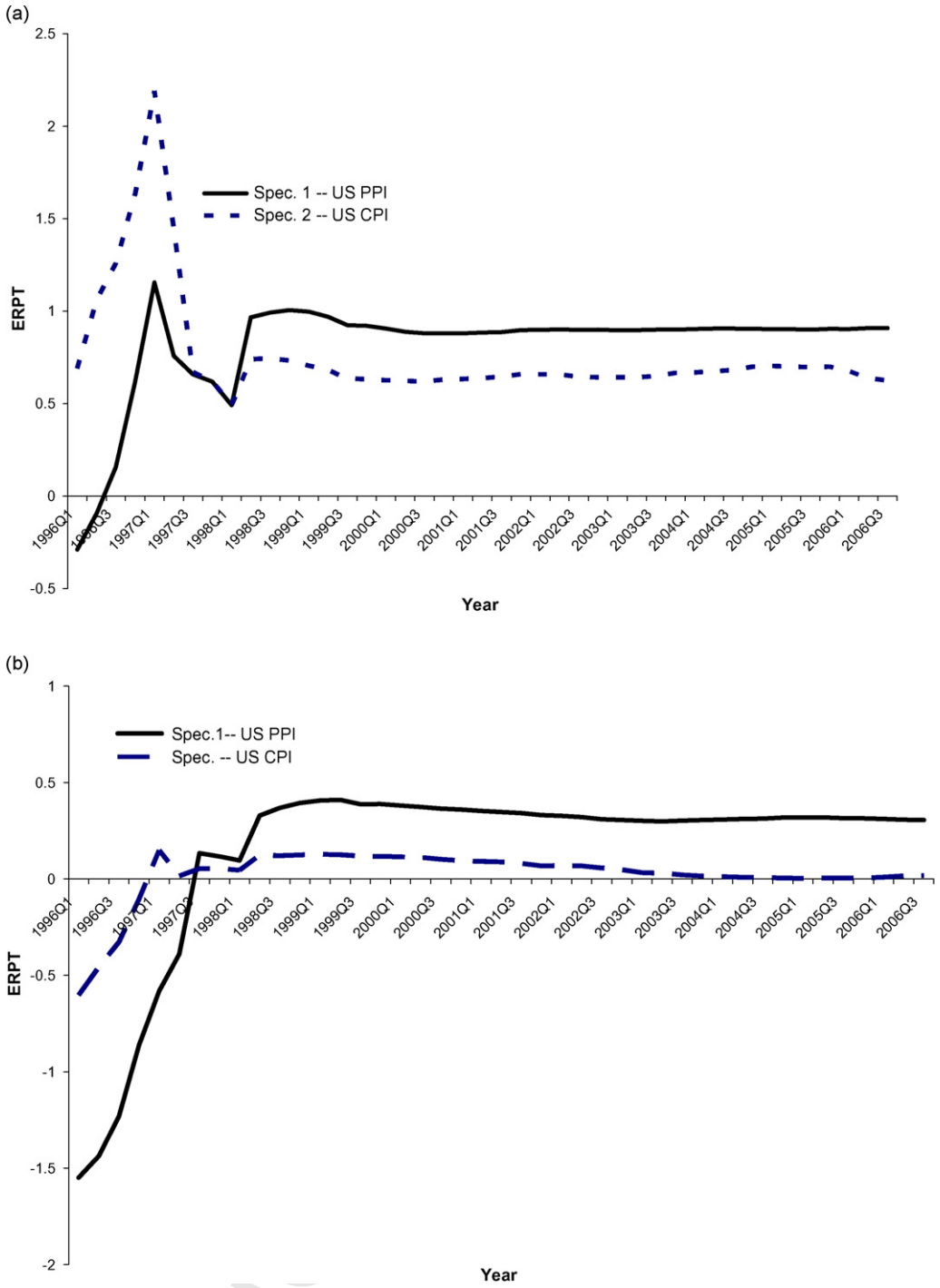

Fig. 2. (a) Recursive estimates of ERPT elasticities of Baht-USD into Thailand's import prices. (b) Recursive estimates of ERPT elasticities of Baht-USD into Thailand's CPI. (c) Recursive estimates of ERPT elasticities of Baht-Yen into Thailand's import prices. (d) Recursive estimates of ERPT elasticities of Baht-Yen into Thailand's CPI. (e) Recursive estimates of ERPT elasticities of NEER into Thailand's import prices. (f) Recursive estimates of ERPT elasticities of NEER into Thailand's CPI.

otherwise to capture any impact of the specific period of the currency crisis:

$$\hat{\alpha}_1^i = \delta' x_t \tag{5}$$

where $\delta = [\delta_0, \delta_1, \delta_2, \delta_3]$, x_t = [lagged inflation rate, lagged exchange rate volatility, trade openness, crisis dummy]. For inflation rate we use percentage change of CPI for both Korea and Thailand. For ERPT elasticities into both import prices and CPI of the bilateral rate with the USD, the JPY as well as the NEER we use the corresponding exchange rate series to obtain the measure of volatility. We capture exchange rate volatility by using a moving average standard deviation of the exchange rate series:

$$V = \left[\left(\frac{1}{m} \right) \sum_{i=1}^{m} (\log E_{t+i-1} - \log E_{t+i-2})^2 \right]^{1/2} \tag{6}$$

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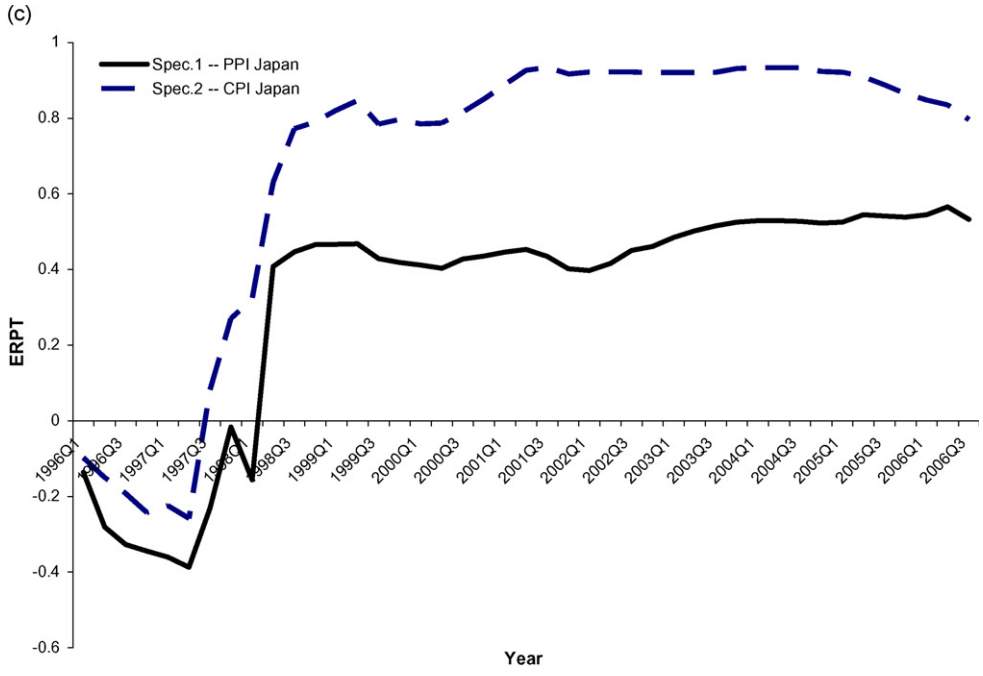

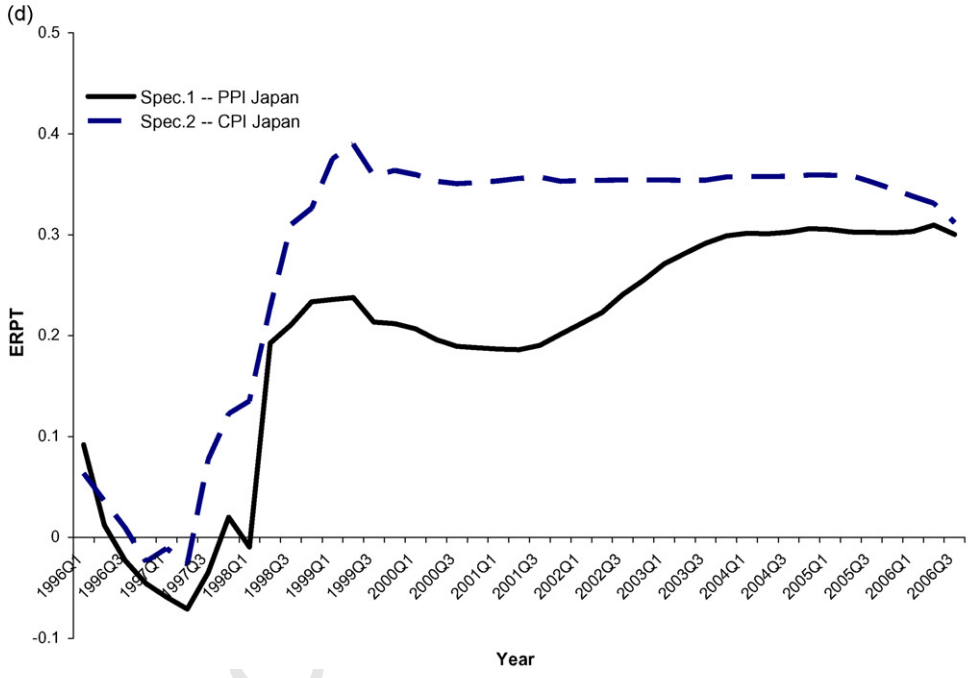

Fig. 2. (*Continued*)

with $m = 4$ is the number of lags and E is the exchange rate (either bilateral or effective). We measure openness by the ratio of the volume of exports and imports to GDP.

The results for the impact of macro-variables on import price and CPI ERPT elasticities are shown in Tables 5a and 5b.[10]

Focusing on the case of import prices, we find that exchange rate volatility has a positive impact on ERPT elasticities. This holds both for Korea and Thailand's bilateral rate with the USD and JPY as well as for their NEERs. The effect of volatility is much stronger for Thailand. This finding seems to argue in favor of the endogeneity thesis of Devereux and Engel (2001) that ERPT is positively related to exchange rate volatility. Higher openness leads to higher ERPT in both nations and consistently so in the case of import price pass-through. Higher lagged inflation rates tend to lower ERPT elasticities though

[10] To be consistent with our graphical illustration of the time-varying elasticities, for Korea we run the impact of macro variables on ERPT elasticities starting from 1992, while for Thailand we start from 1996.

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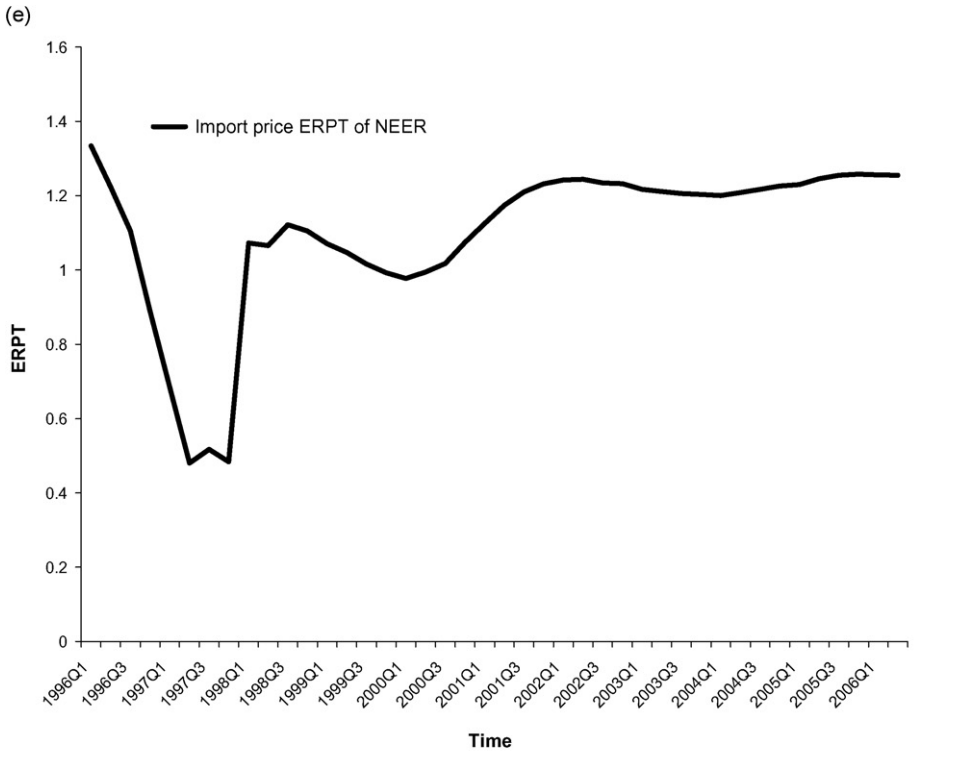

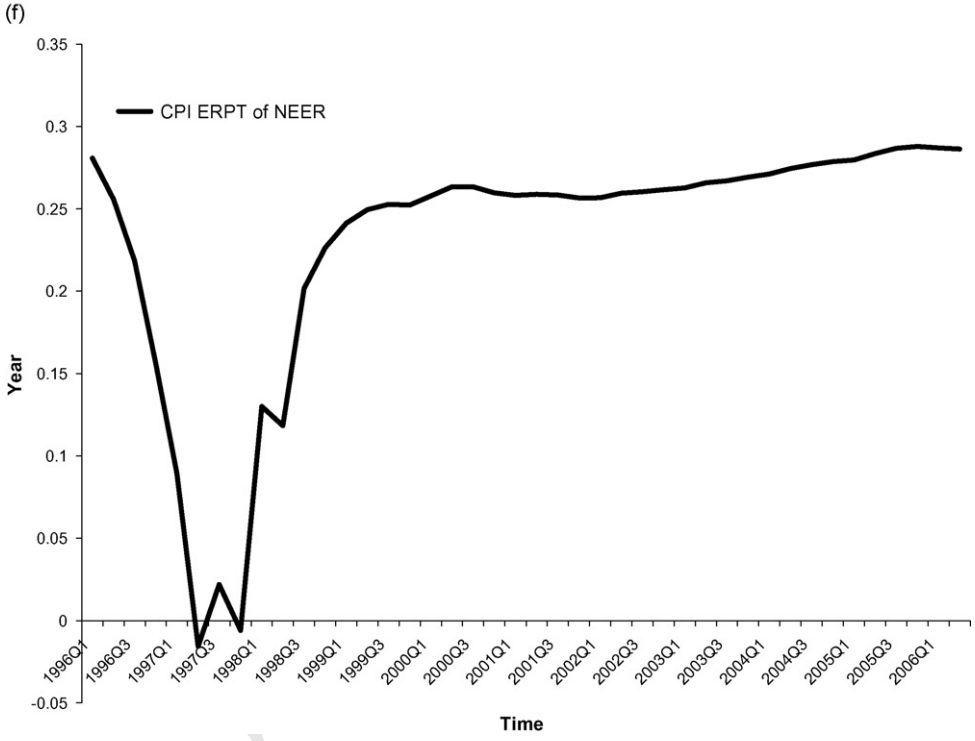

Fig. 2. (*Continued*).

this variable is only statistically significant in the case of Thailand for import price pass-through. This is a rather odd finding as one would have expected lower inflation rates in both economies to reduce rather than increase the extent of ERPT. A possible reason behind this is that higher inflation may lead an inflation targeting regime to undertake contractionary monetary policy measures to curb inflation, which in turn leads to lower ERPT.[11] The Asian currency crisis dummy is negative for Korea, suggesting that the general rise in ERPT during the crisis as discussed previously may have been more due to

[11] Of course, the implicit assumption here is that the policies do not directly impact any of the controls variables in Eq. (3) such as output or costs.

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Table 5a
Effect of macro-variables on ERPT elasticities into import prices

	Korea			Thailand		
	Won-USD	Won-Yen	NEER	Baht-USD	Baht-Yen	NEER
Constant	**−0.351****	**−0.303*****	**−0.396****	0.049	**−1.194*****	−0.009
	0.151	0.107	0.156	0.497	0.287	0.542
Inflation rate$_{(t-1)}$	−0.024	−0.013	−0.023	**−0.144***	**−0.116*****	**−0.142***
	0.016	0.015	0.014	0.077	0.038	0.079
Exchange rate volatility$_{(t-1)}$	**0.617*****	**0.572*****	**0.862*****	**1.882***	**2.534*****	2.616
	0.157	0.129	0.208	1.047	**0.851**	1.61
Trade openness	**1.255*****	**0.755*****	**1.327*****	**0.658***	**1.246*****	**0.709***
	0.239	0.202	0.255	0.383	0.22	0.422
Crisis_dummy	**−0.159***	**−0.148*****	**−0.129***	0.021	**−0.231*****	0.052
	0.081	0.04	0.069	0.145	0.079	0.161
Adj. R^2	0.614	0.445	0.6	0.342	0.775	0.31

*,**,*** indicates significance at the 10 percent, 5 percent and 1 percent, respectively.

Table 5b
Effect of macro-variables on ERPT elasticities into CPI

	Korea			Thailand		
	Won-USD	Won-Yen	NEER	Baht-USD	Baht-Yen	NEER
Constant	**0.226*****	**0.374*****	**0.22*****	**−2.031*****	**−0.327*****	**−2.209*****
	0.067	0.117	0.069	0.494	0.11	0.556
Inflation rate$_{(t-1)}$	−0.011	−0.002	−0.011	**−0.321*****	**−0.029***	**−0.320*****
	0.008	0.011	0.008	0.087	0.015	0.091
Exchange rate volatility$_{(t-1)}$	0.069	**0.346****	0.12	**4.668*****	**0.608***	**6.973*****
	0.055	0.145	0.092	1.075	0.355	1.558
Trade openness	−0.014	−0.331	−0.007	**1.803*****	**0.438**	**1.949*****
	0.101	0.206	0.108	0.389	0.085	0.44
Crisis_dummy	−0.004	−0.031	−0.001	0.284	**−0.116***	**0.349***
	0.02	0.032	0.02	0.195	0.027	0.198
Adj. R^2	−0.028	0.138	−0.025	0.735	0.76	0.708

*,**,*** indicates significance at the 10 percent, 5 percent and 1 percent, respectively.

changes in other macroeconomic factors such as higher exchange rate volatility. The crisis itself appears to have imparted a contractionary-cum-deflationary effect on the Korean economy (see Burstein et al., 2002; Shen and Rajan, 2006). The same is true when we consider Thai ERPT using the Baht-JPY exchange rate. However, the crisis does not appear to have had a separate direct impact on ERPT in Thailand when using the Thai Baht-USD rate or the Thai NEER.

While the foregoing results broadly hold for the case of CPI in Thailand, most of the variables are insignificant in the case if Korea. A priori this is not surprising as Thailand is a much smaller and open economy with a relatively smaller nontradables sector and greater dependence on imports. Thus, factors impacting import prices may also feed directly into CPI.

5. Conclusion

This paper has estimated ERPT elasticities for two Asian economies, Korea and Thailand, both of which have moved towards greater exchange rate flexibility since the currency crisis of 1997–1998. We considered ERPT for three exchange rates, viz. bilateral nominal exchange rate per unit of the USD, the Japanese yen, as well as for their Nominal effective exchange rate (NEER). We also examined the dynamics of ERPT over time and the possible impact of macro-fundamentals on these time varying ERPT elasticities. Certain results warrant summarizing.

First, the ERPT into Thailand is higher than in Korea in all cases under consideration. Given that Thailand is a relatively small and open economy compared to Korea, this is consistent with one's priors in that it is generally acknowledged that ERPT tends to be greater in lower income economies and relatively smaller and more open ones where there is a high share of traded goods, high import content, limited domestic substitutes (thus limiting the extent of "flight from quality" *a la* Burstein et al., 2002), and high degree of integration with the global trading system.

Second, it is apparent that ERPT is much larger into import prices than CPI for both countries. This is also consistent with priors in that typically CPI ERPT is less sensitive to changes in

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exchange rate changes as CPI includes nontradables and is also impacted by other factors such as distribution channel and market structure of retail chains. Therefore, the impact of exchange rate changes on CPI is much more indirect than it is on import prices (i.e. ''prices at the border'') only.

Third, we find that for both Korea and Thailand, pass-through of the bilateral rate vis-à-vis the USD is higher than their bilateral exchange rate with respect to the yen. This may be partly explained by the fact that much of Japan's trade with Asia tends to invoiced in US dollar, which automatically implies lower ERPT (for details, see Sato, 1999, 2003; Fukuda and Ono, 2005).

Fourth, unlike studies on the US and some other industrialized nations, we find no evidence that pass-through has been declining over time for Korea and Thailand. In fact we find ERPT to have risen during the crisis period. The question that follows is whether the rise was because of the crisis per se, or due to changes in the underlying macroeconomic factors. On analyzing the macro-determinants of ERPT into import prices, we find evidence that higher trade openness and greater exchange rate volatility raise ERPT for import prices into both Korea and Thailand. Independent of the macroeconomic variables the currency crisis dummy itself appears in general to have imparted a deflationary impact on import prices into the Korean economy, though the evidence for Thailand's ERPT is mixed.

Given our results, the next stage of research on exchange rate pass-through, especially in the context of Asian economies needs to pay more attention to the impact of different exchange rate regimes on the extent of ERPT.

Q2 Uncited reference

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Acknowledgements

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