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STRUCTURAL BREAKS AND BILATERAL EXCHANGE RATE PASS-THROUGH: AN EMPIRICAL CASE OF INDONESIA–UNITED STATES

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Abstract: *This study estimates the exchange rate pass-through into domestic prices in Indonesia in the two-stage approach. The study focuses on first step pass-through, i.e. ERPT into import prices and second step pass-through, i.e. into consumer prices, using cointegration and error-correction mechanism (ECM) model. This research uses a Zivot-Andrews technique to test for structural breaks and Gregory-Hansen models to tests. The results show that the long run ERPT to import prices with structural breaks is relatively low compared to the results without them. The absolut error correction term values resulted from cointegration are decreased and the error-correction models need period lagged longer than one-period if the estimation included the estimated structural breaks. The main finding is that allowing for possible breaks around the crises in Indonesia, and a shift of the exchange rate management from managed to free floating in 1997 helps to restore a long run cointegration relationship estimation.*

Keywords: *exchange rate pass-trough, structural breaks, cointegration, error-correction mechanism*

Abstrak: *Penelitian ini mengestimasi pass-through kurs ke dalam harga-harga domestik di Indonesia dalam dua tahap pendekatan. Perhatian utama penelitian ini, pertama pada pass-through kurs ke dalam harga-harga impor dan kedua pada pass-through kurs ke dalam harga-harga konsumen, dengan menggunakan model kointegrasi dan error-correction mechanism (ECM). Penelitian ini menggunakan teknik Zivot-Andrews untuk menguji structural breaks dan model-model Gregory-Hansen untuk menguji kointegrasi dengan kemungkinan adanya structural break. Hasil menunjukkan bahwa koefisien pass-through kurs jangka panjang ke dalam harga-harga impor dengan structural break relatif rendah dibandingkan dengan hasil tanpa structural break. Nilai-nilai absolut error correction yang dihasilkan dari kointegrasi menurun dan model-model error-correction memerlukan periode lag yang lebih panjang dari satu periode untuk proses penyesuaian jika estimasi memasukkan structural break. Temuan utamanya adalah bahwa dengan adanya structural break di seputar krisis di Indonesia, dan pergeseran pengelolaan kurs dari mengambang terkendali ke mengambang bebas pada tahun 1997 membantu memperbaiki estimasi hubungan kointegrasi jangka panjang.*

Kata kunci: *pass-through kurs, structural breaks, kointegrasi, error-correction mechanism*

INTRODUCTION

In a small open economy model, openness has an impact on the domestic economy of a country through trade and capital flows from overseas. The countries' openness in the international trade can be closely related to their exchange rate and prices. Both these variables can have effects on broader aspects relating to the welfare. These effects can be triggered by ERPT into domestic prices, especially those of imports. The issue of ERPT is critical since its de-

gree has important implications for the transmission of shocks and optimal monetary policy in open economies (Bashce, 2006). In addition, according to Kreinin (2002), ERPT is one of important factors in determining the response of trade balance besides the J-Curve effect and hysteresis, which contributes to a delayed response from the balance of trade against the dollar depreciation.

The issue of ERPT gets much attention in the literature of new open economy macroeconomics (NOEM). ERPT is closely related to the law of one price (LOP) and purchasing power parity (PPP). Both are associated with the argument of market efficiency on price dynamics. Both are so because the basis of PPP is the LOP. In general literature, the law states that in an efficient market all identical goods have only one price. In such market, one price convergence is instantaneous. The process of convergence into one price can occur through arbitrage between different markets. However, the LOP does not invariably apply in practice. The reason is that most of the trades incur transaction costs and trade barriers, especially for the two markets between the two countries. Study by Frankel *et al.* (2005) supports the theory of low or imperfect pass-through of exchange rates on import prices because of the obstacles to international trade such as tariffs and transportation costs as well as local costs of distribution and retail. These obstacles impede the power of the LOP. It is added also, in Kostov (2006), that the transaction costs become the majority of explanatory sources for empirical rejection of the LOP and PPP. The LOP and PPP that does not apply is related to the low ERPT to import prices. Lower pass-through affects the current account and domestic inflation, which in turn affects the long-term economic growth.

A number of studies found evidence of a decline in foreign exchange effects via pass-through on import prices in a number of industrialized countries. Olivei (2002) and Marazzi *et al.* (2005) examined the sensitivity of exchange rates on import prices in the United States; Otani *et al.* (2003, 2005) view that there is ERPT into import prices in Japan. Meanwhile, Campa and Goldberg (2002, 2005), Frankel *et al.* (2005), Sekine (2006), and Ihrig *et al.* (2006), and Ca'Zorzi *et al.* (2007) estimate ERPT to import prices for a number of countries. Despite its lack of solidity, the empirical evidence showed that ERPT into import prices declined in both the US and in a number of industrialized countries. However, how much and what triggers the decrease in pass-through is remain not fully known with clear evidence.

Recent studies on the pass-through are those of Liu and Tsang (2008), Frimpong and Adam (2010), Devereux and Yetman (2010), and Coulibaly and Kempf (2010). Liu and Tsang in their study found that Hong Kong ERPT to import prices are relatively high compared to those of average OECD countries. However, Frimpong and Adam found that in Ghana the ERPT to inflation is not perfect and tends to decrease. Meanwhile, Devereux and Yetman (2010) build models that can be used to calculate the determinant of ERPT to consumer prices. A determinant of this low pass-through is a slow price adjustment. Coulibaly and Kempf's study found that inflation targeting in emerging countries sustain the decline in ERPT to the various price index from higher to lower levels.

This study aims to examine empirically the ERPT into domestic prices in Indonesia and the speed of its adjustment by the estimated cointegration model and error correction mechanism (ECM). It takes the case of Indonesia and the US because of their close international trade relations and of the US dollar as a hard currency, convertible and widely used in international transactions by Indonesia. This research that use time series data emphasized the period of floating exchange rate regime. It was motivated by the relatively few researches on ERPT to import prices both in narrower and broader definition of domestic prices in Indonesia. In addition, the ERPT analysis that takes into account the existence of structural breaks, such research e.g. Campa *et al.* (2005) and de Bandt *et al.* (2008), remain few. Their study estimates the ERPT into import prices of short and long term related to the structural breaks in European countries at around the EMU and Euro appreciation that began in 2001. In general, their study indicates a structural break and some cases of unstable estimates.

This paper begins with an introduction that put accross the reason why this research is necessary. The next section is theoretical study, followed by the research method that explains the method of estimation with cointegration model and ECM with its prerequisites, which include integration and cointegration. However, prior to the estimation of the model, unit root test with structural breaks was also conducted. In the next section presented results and discussion which ended with the closing of the summaries and conclusions.

RESEARCH METHODS

Basic Model of Exchange Rate Pass-Through

According to Goldberg and Knetter (1997), formally ERPT is the percentage change in import prices (in local currency) generated from one percent change in exchange rates among exporting and importing countries. These import prices are subsequetly determine the retail and consumer prices. The pass-through can lead to inflation if the import price changes cause changes in domestic prices.

The basic model of micro-based theory can be formulated to estimate change in nominal exchange rate reflected in the prices of imports of the so-called ERPT, depending on various factors such as product differentiation and competitiveness. In establishing the model of the theory of ERPT, exporters set their prices (P^X) in profit margin (λ) on production costs (C). Import prices (P^M) can be defined as follows:

$$P^M = P^X \cdot e = (1+\lambda)C \cdot e \quad (1)$$

where **e** is exchange rate. By determining $(1+\lambda) = \rho$, where ***p*** is the price mark-up profit. The condition is based on the hypothesis that the exporter pricing decisions is based on competitive pricing pressures in the domestic market which can be proxied by the gap between domestic prices of import competing goods (P^D) and the cost of exporters in local currency.

Profit mark-up can be modeled as follow:

$$\rho = \left\{P^D /(C \cdot e)\right\}^{\alpha} \quad (2)$$

Substituting ρ in equation (2) for (1+λ) into equation (1), and made in the logarithm, the import equation can then be reduced to:

$$P^M = \alpha P^D + (1-\alpha)C + (1-\alpha)e \quad (3)$$

ERPT in the above equation is (1-α), and expected to $0 < (1-\alpha) < 1$.

Based on Campa, Goldberg and Gonzalez-Minguez (2005), import prices for several commodities j, MP_t^j is the transformation of the export prices of trading partner country XP_t^j that use the bilateral exchange rate ER_t and by omitting the notation j for the model clarity, the import price equation becomes:

$$MP_t = ER_t \cdot XP_t \quad (4)$$

Equation (4) in the logarithm stated:

$$mp_t = er_t + xp_t \quad (5)$$

Where the export price consisted of the marginal costs of exporters and a mark-up:

$$XP_t = FMC_t \cdot FMKUP_t \quad (6)$$

In the logarithm it becomes:

$$xp_t = fmc_t + fmkup_t \quad (7)$$

Substituting xp_t into equation (5) yields:

$$mp_t = er_t + fmkup_t + fmc_t \quad (8)$$

Industrial organization literature provides insight into why the effect of er_t on mp_t change is inequal to one, namely that the determinants of mark-up such as competitiveness confronting the exporters in the destination market. Thus the elasticity of the estimated pass-through is the sum of three effects: (1) Unity translation effect of exchange rate movements; (2) Mark-up response in order to offset the unity translation effect; and (3) Changes in marginal costs associated with exchange rate movements, such as input price sensitivity to exchange rates.

Mark-up is determined by the market share of domestic producers, competition in the industry market, and expansion of price discrimination. In general, the larger the market share of imports in total industry supply, the greater the degree of price discrimination or the greater the share of imported goods in production activities in the destination country the higher the prediction of pass-through. ERPT might be higher if the ratio of exports relative to local competitors is higher (such as commodities or oil), and lower if the exporters compete for market share (such as manufactured products), even if the nominal exchange rate variability was high. Another factor affecting the pass-through is the currency denomination of exports, and the structure and importance of market of intermediary goods.

Campa, Goldberg and Gonzalez-Minguez (CGM) model is empirically based on equation (8) which assumes unity translation of exchange rate movement. The exporters of given products may decide to absorb some changes in exchange rates rather than passing-through to prices in local currency in the importing country. When the pass-through is complete (producer-currency pricing), their mark-up will not respond to exchange rate fluctuations, therefore led to the pure currency translation. At the other extreme, they may decide not to change prices in the destination country currency (local-currency pricing or pricing to market) and to absorb fluctuations in mark-up. Thus, mark-up in the industry is assumed to consist of components specific to the type of goods, exchange rate independence and reaction to exchange rate movements:

$$fmkup_t = \alpha + \Phi er_t \quad (9)$$

In addition, the effect of the workings of the marginal cost is also important to consider in the model. With the function of demand in the importing country, the marginal cost of production (wage) in the exporting country and commodity prices denominated by foreign currency in the model, the equation becomes:

$$fmc_t = \eta_0 \cdot y_t + \eta_1 \cdot fw_t + \eta_2 \cdot er_t + \eta_3 \cdot fcp_t \quad (10)$$

Substituting equation (10) and (9) into equation (8) yields:

$$mp_t = \alpha + (1 + \Phi + \eta_2) er_t + \eta_0 \cdot y_t + \eta_1 \cdot fw_t + \eta_3 \cdot fcp_t + \varepsilon_t \quad (11)$$

where $(1 + \Phi + \eta_2) = \beta$ is elasticity coefficient of the ERPT.

However, in a simple approach through a reduced form representation, where the identification of Φ of η_2 not included, the specification model of "integrated world market" CGM, the term $\eta_0 \cdot y_t + \eta_1 \cdot fw_t + \eta_3 \cdot fcp_t$, the independence of the exchange rate, was considered as the opportunity cost of the allocation of the same goods to other consumers and is reflected in the world price of fp_t products in world currency (i.e. USD). Therefore, the final equation can be rewritten as:

$$mp_t = \beta \cdot er_t + \gamma \cdot fp_t + \varepsilon_t \quad (12)$$

which is a long-term equation between the price of imports, exchange rate and foreign price.

Two critical issues are emphasized in the two main streams of literature focusing on the first stage, ERPT into import prices, and the second stage, ERPT into consumer prices. Both issues will be examined in this study without and with structural breaks. In addition, in this study, equation (12) of CGM will be treated as the basic model both in the form of equation cointegration and ECM models.

Variables and Data

This study uses quarterly data by time period 1990:I – 2009:IV. The period of study began in 1990 as the earliest days of enactment of the floating exchange rate regime in Indonesia. The variables include the prices of imports as measured by the import price index, prices in the United States proxied with the US producer price index, the nominal bilateral exchange rate and consumer price index (CPI). The price index is based on the constant prices of 2000. The data of rupiah exchange rate against the US dollar, the import and consumer price indexes are obtained from Indonesian Financial Statis-

tics published by Bank Indonesia in various editions, Statistical Yearbook of Indonesia published by Badan Pusat Statistik (BPS) in various editions, while the price index in the US can be obtained from Central Bank United States: http://research.stlousfed.org/fred/data.

With regard to the data, this study, overall, applies estimation methods with cointegration model and ECM along with certain prerequisite tests, which include integration and cointegration. However, prior to model estimation, unit root test with structural breaks was conducted as well.

Research Model

The basic model estimated in this study is the ECM model in the equation:

$$\Delta y_t = \alpha_0 - \alpha_y \hat{e}_{t-1} + \sum_{i=1} \alpha_1(i)\Delta y_{t-i} + \sum \alpha_2(i)\Delta z_{t-i} + \varepsilon_{yt} \quad (13)$$

with the matrix for Δy_{t-i} equals zero and i = 0 on Δz_{t-i}, where the variable y is the p^{imp} and the variable z is s and p^{exp}, respectively, the price of imports, the nominal exchange rate and export prices as in Frankel, Parsley and Wei (2005) study. The equation of the ECM model can be written as:

$$\Delta p_t^{imp} = \beta_0 + \beta_1 \Delta s_t + \beta_2 \Delta p_t^{\exp} + \gamma ecm_{t-1} + \varepsilon_t \quad (14)$$

Where p_t^{imp} is log price of import good in local currency proxied by import price index, s_t is log bilateral exchange rate (Rp per $US), $p_t^{\exp}$ is log price of exporting country proxied by producer price index in US, and ecm_{t-1} is *error correction term* (ECT) obtained from cointegration estimation $(p_{t-1}^{imp} - \hat{\alpha}_0 - \alpha_1 \hat{s}_{t-1} - \alpha_2 \hat{p}_{t-1}^{\exp})$ on equation (15)

Estimation of cointegration was also reported for the long-term ERPT either with or without structural breaks. Cointegration equation without structural break using the method and equation of Engle and Granger (1987) was written into:

$$p_t^{imp} = \alpha + \beta s_t + \gamma p_t^{\exp} + e_t \quad (15)$$

On the other hand, the cointegration equation with structural breaks to applied the cointegration equation of Gregory and Hansen (1996). Based on the Engle-Granger model, with the break in constant in the estimation, the equation is written as follows:

$$p_t^{imp} = \hat{\alpha}_0 + \hat{\alpha}_1 * d_s + \hat{\beta} s_t + \hat{\gamma} p_t^{\exp} + \varepsilon_t \quad (16)$$

Subsequently, the slope changes (i.e. changes in the long-term exchange rate pass-through elasticity) is added into:

$$p_t^{imp} = \hat{\alpha}_0 + \hat{\alpha}_1 * d_s + \hat{\beta} s_t + \hat{\beta}_1 s_t * d_s + \hat{\gamma} p_t^{\exp} + \hat{\gamma}_1 p_t^{\exp} * d_s + \nu_t \quad (17)$$

where in both cases above the d_s is dummy variable that equals 0 if t < s and equals 1 if otherwise and s is the break point. In this study, the break points were estimated by the model of Zivot and Andrews (1992). Hypothesis testing of cointegration that includes structural breaks was made through the Dickey-Fuller test against the error term from the second estimate of the above Engle-Granger cointegration model. Additionally, one-period lagged of its error term is use as ECT in the ECM equation.

The pass-through estimation of the cointegration equation and ECM without and with structural breaks was carried out in two stages. First, to estimate ERPT of import prices (the variable y in the model is p^{imp}) the estimation model of which is shown as equation (15) and (14) without integrating structural breaks. Meanwhile, equation (16) and (17) as cointegration equations with structural breaks. Second, to estimate ERPT to consumer prices (y variable in the model is the CPI) for the cointegration equation and ECM without structural breaks, the equation of which was written as:

$$cpi_t = \alpha + \beta s_t + \gamma p_t^{\exp} + e_t \quad (18)$$

$$\Delta cpi_t = \beta_0 + \beta_1 \Delta s_t + \beta_2 \Delta p_t^{\exp} + \gamma ecm_{t-1} + \varepsilon_t \quad (19)$$

Furthermore, the structural break was in-

Table 1. Unit Roots Test Results without Structural Break

Series	ADF tests			
	Level		*First Defference*	
	No Trend	*With Trend*	*No Trend*	*With Trend*
Import price	-1.1263	-2.1174	-4.4144***	-4.4136***
Consumer price	-0.7608	-2.1028	-3.7890***	-3.7826**
Exchange rate	-1.4480	-2.0143	-5.2447***	-5.2510***
US producer price	-0.3725	-2.4091	-7.2364***	-7.2712***
Series	**PP tests**			
	Level		*First Defference*	
	No Trend	*With Trend*	*No Trend*	*With Trend*
Import price	-1.0313	-1.8066	-6.0620***	-6.0528***
Consumer price	-0.7493	-1.7614	-5.4136***	-5.4008***
Exchange rate	-1.3542	-1.8018	-6.5679***	-6.5573***
US producer price	-0.1151	-2.0593	-7.0937***	-7.0801***

*** significant at the 1 percent significance level

cluded in equation (18) either without or with the break in constant, and slope is written as:

$$cpi_t = \hat{\alpha}_0 + \hat{\alpha}_1 * d_s + \hat{\beta} s_t + \hat{\gamma} p_t^{\exp} + \varepsilon_t \qquad (20)$$

$$cpi_t = \hat{\alpha}_0 + \hat{\alpha}_1 * d_s + \hat{\beta} s_t + \hat{\beta}_1 s_t * d_s + \hat{\gamma} p_t^{\exp} + \hat{\gamma}_1 p_t^{\exp} * d_s + \nu_t \qquad (21)$$

RESULTS AND DISCUSSION

Integration

The test results without structural breaks through the Augmented Dickey-Fuller (ADF) and Phillips-Peron (PP) test are reported in *Table 1*. The upper part of *Table 1* presents the results of testing of all the variables included in the model estimates of ERPT with both the ADF test either without trend or with trend for respective data on the level and first difference. All test results on levels either without or with the trend did not reject the unit-root null hypothesis which means that all variables are not stationary at the level form. There are indications that the variables are stationary at first difference. This is evidenced by test results that entirely reject the unit-root null hypothesis either without or with trend.

Indications that all the variables are stationary at first difference are supported by PP test results. The test results presented in lower part of *Table 1* show that all the PP tests either without or with trend did not reject the unit-root null hypothesis for the data on level. Conversely, PP test on all variables reject the unit-root null hypothesis which means that these variables are stationary at first difference.

However, conclusions of the two previous trials have not provided the satisfactory unit root test results when confronted with an estimate of the structural breaks that occur in the study period, i.e. at the time of the Asian economic crisis that began with a currency crisis that also hit Indonesia with a relatively long period of recovery. Zivot-Andrews test, especially for model C for reasons presented earlier, incorporate these structural breaks (Zivot and Andrews, 1992: 253). Zivot-Andrews test results are presented in *Table 2*.

Table 2. The Results of Zivot-Andrews Model Test with One-Break

Series[a]	t-statistics[b]	Break-Points[c]
Import price	-6.7245***	1997:IV
Consumer price	-12.3512***	1997:IV
Exchange rate	-7.7110***	1997:III
US producer price	-4.6095	2001:II

[a] all series at the level form and in natural logarithm (ln)
[b] estimated by model C of Zivot-Andrews with *k = 1*
[c] determined based on the minimum t-statistics from test simulation within λ range between 2/T and T-1/T, where T is sample size
*** significant at the 1 percent level
Critical values of Zivot-Andrews are -5.57, -5.08 and -4.82 respectively for 1 , 5 and 10 percent significance level

The results of unit roots test using the Zivot-Andrews model of four variables as reported in *Table 2* indicate that three variables reject the unit-root null hypothesis. The three variables are import price, consumer price, and exchange rate. The point in time of the structural breaks is the fourth quarter of 1997 for import and consumer prices and third quarter of 1997 for the exchange rate. The time point was consistent with the early notion that structural breaks occur around the period of the economic crisis in Indonesia, which is in tandem with the shift in the management of exchange rate from managed to free floating.

The results of Zivot-Andrews unit root test that incorporate structural breaks give different results with the conclusions of the ADF and PP test results. Thus the results of Zivot-Andrews test will be taken into consideration in estimating the cointegration and ECM models. The results of this test also underlie the stability test on the model estimated based on the obtained break points.

Cointegration

Engle-Granger cointegration test carried out on three groups of samples. The first group is the full sample which includes the break point, while the second and third is a subsample separated by break points. *Table 3* reports the results of tests on three groups of samples for the regression models A and B. The value reported is the result of cointegrating regression Durbin-Watson (CRDW) test or d and the value of τ. CRDW test is an alternative method and is faster to find out whether two or more variables were cointegrated (Gujarati and Porter, 2009: 824) It uses Durbin-Watson d obtained from its cointegration regression. Meanwhile τ value is the value of t-statistic of the its residual regression in which the dependent variable is $\Delta\hat{u}_t$ and the independent variable is u_{t-1}.

Table 3 lists the test results CDRW that demonstrate significant value of d and τ at the 1 percent significance level to estimate the full sample. With the same significance level in the first subsample (the period 1990:I - 1997:III) the value of d and τ is qually significant except in the regression of model B, i.e. the estimated ERPT to consumer prices. Meanwhile, the value of d and τ in the second subsample estimation (the period 1997: IV - 2009: IV) is significant at the 1 percent significance level unless the value of d of the estimated model B that is significant at the 10 percent signicance level for its d value. Overall, it is indicated that that the d test result accept null-hypothesis of cointegration since its value is higher than its critical value. In addition, the overall test results demonstrated lower (negative) τ value than the critival Engle-Granger value demonstrating that the residue of the cointegration regression is I(0) which support cointegration, except in the result of model B estimation for the first subsample.

The result of cointegration test with the approach of Johansen in *Table 4* is presented based on a sample group consisting of the full sample (T), the first subsample (T_1) in the period 1990:1 to 1997:3, and the second subsample (T_2) in the period 1997:4 to 2009:4. The tested cointegration model is the same with the one tested in *Table 3*, with two lags for each.

Table 3. Results of Engle-Granger Cointegration Test

Model	Period of 1990:I – 2009:IV		Period of 1990:I – 1997:III		Period of 1997:IV – 2009:IV	
	d	τ	d	τ	d	τ
Model A	0.6967***	-3.8926***	0.8307***	-2.8107***	0.6501***	-5.0257***
Model B	0.5281***	-3.5030***	0.6117***	-1.9092	0.3857*	-3.4274***

*** significant at the 1 percent significance level; * significant at the 10 percent significance level

Critical values of d are 0.511 , 0.386 , and 0.322 respectively for 1 , 5 , and 10 percent significance level

Critical value of τ at the 1% Engle-Granger is -2,5899

Model A is based on equation $p_t^{imp} = \alpha_0 + \alpha_1 s_t + \alpha_2 p_t^{\exp}$

Model B is based on equation $cpi_t = \beta_0 + \beta_1 s_t + \beta_2 p_t^{\exp}$

Table 4. Results of Johansen Cointegration Test

Variable Series	*Lag*	*Likelihood Ratio*					
		T		*T1*		*T2*	
		r = 0	r ≤ 1	r = 0	r ≤ 1	r = 0	r ≤ 1
p^{imp} *s* p^{exp}	1	59.2145**	17.9574	34.9672	11.8546	76.8397**	35.7837**
	2	47.0642*	15.8984	36.2698	11.6847	69.8571**	29.1485*
cpi s p^{exp}	1	64.0902**	17.8818	24.2423	10.8838	80.5472**	40.7427**
	2	41.6457	13.3021	27.1062	11.2508	61.4656**	24.4621

Assumption : H*(r): $\Pi y_{t-1} + \mathrm{B}x_t = \alpha(\beta' y_{t-1} + \rho_0 + \rho_1 t) + \alpha_\perp \gamma_0$

T: full sample; T_1:first subsample; and T_2: second subsample
Critical values of 1% and 5% (r = 0) are 48.45 and 42.44; critical values of 1% and 5% (r ≤ 1) are 30.45 and 25.32
** significant at the 1 percent significance level and * significant at the 5 percent significance level to reject *$H_0(r)$: no cointegration*; and/or to reject *$H_0(r)$: at most one cointegration*

According to Johansen (1995), assuming that the data series has a linear trend and cointegrating equations have intercept and trend, which is expressed as:

$H_1(r)$: $\Pi y_{t-1} + \mathrm{B}x_t = \alpha(\beta' y_{t-1} + \rho_0 + \rho_1 t) + \alpha_\perp \gamma_0$

these cointegration results are not satisfactory because it does not incorporate structural breaks. At the end of this discussion, cointegration test result will also be presented for estimation that take into account the structural breaks which are expected to improve the cointegration of estimation models.

Table 5. Results of Chow Stability Test

Model	Breakpoint Test (1997:III)	Forecast Test (1997:III – 2009:IV)
Cointegration[A]	1.9874 (0.1232)	97.9611*** (0.0000)
ECM[A]	0.5946 (0.6677)	32.8399*** (0.0000)
Cointegration[B]	3.5415** (0.0186)	62.0346*** (0.0000)
ECM[B]	2.0453* (0.0972)	5.1344*** (0.0000)

[A] dependent variable: p^{imp}; independent variables: s and p^{exp}

[B] dependent variable: cpi; independent variables: s and p^{exp}

The estimated values in the table are F-statistic and *p*-value in parentheses
*** significant at the 1 percent significance level; ** significant at the 5 percent significance level; * significant at the 10 percent significance level

Table 6. The Results of Pass-Through into Import Prices using Basic Model of ECM (Dependent Variable: Δp^{imp})

Variable	Period of 1990:I – 2009:IV	Period of 1990:I – 1997:III	Period of 1997:IV – 2009:IV
Constant	0.0074	0.0031	0.0129
	(0.0074)	(0.0021)	(0.0096)
Δs	0.3813***	0.3348***	0.3492***
	(0.0664)	(0.0369)	(0.0606)
Δp^{exp}	1.2335***	0.8543***	1.2648***
	(0.2701)	(0.1953)	(0.3144)
ECT	-0.3590***	-0.4449***	-0.5185***
	(0.1318)	(0.1449)	(0.0935)

*** significant at the 1 percent significance level
The estimated values in parentheses are standard error; *Newey-West standard error* for full sample and *White standard error* for subsample
ECT used one-period lagged values of cointegration regression error
All variables in natural logarithm (ln)

ERPT model. Meanwhile, the result of break-point test of model estimation, i.e. of estimation of model B for cointegration and ECM only, rejected the same null hypothesis. In general, the test results in this study concluded that the estimated model for the full sample indicates structural breaks. Therefore, the estimation of cointegration and ECM models for long- and short-term pass-through is conducted in two phases, which is estimation without and with taking into account the structural break. The results of whichs are reported in the next section.

Estimation of the Error-Correction Model

The estimation results of ERPT into import prices through the ECM model are reported in *Table 6*. ECT values used in the estimation of the ECM model represent one-period lagged value of their residual cointegration equation in each sample group.

Table 6 shows that the ECT coefficient of the three estimates from each sample group is significant and negative as expected. The explanatory variables, namely exchange rate and export price, are significant effect the import price in the short term with a coefficient term in accordance with the theoretical predictions. Without taking the structural breaks into account for the full sample, the estimated ERPT into import prices in the short run is 0.3813. Meanwhile, if the estimate was made to subsample, each of which was separated by a break point, then each of the estimated ERPT into import prices is 0.3348 and 0.3492, respectively. The higher estimated ERPT into import prices for the short term from the estimates on the second subsample shows that ERPT is higher for a more flexible exchange rate period. Second subsample represents a free floating exchange rate period, while the first subsample represents the period of managed floating exchange rate.

These results indicate that a relatively flexible exchange rate system may be preferred because it provides greater estimates of pass-through. The higher coefficient of ERPT into import prices implies a greater effect on the effectiveness of expenditure-switching policy and the monetary policy through the existing exchange rate management.

Furthermore, *Table 7* reports the estimated ERPT to consumer prices. By grouping the sample into three groups similar to those in the estimation of ERPT into import prices, the significant ECT value is the estimated ECT on the full sample and the second subsample. The estimation coefficient of ERPT to significant consumer prices is only in these two sample groups.

Table 7 shows that the coefficient of ERPT to consumer prices is much lower than that of pass-through into import prices. In the full sample estimate, the coefficient of ERPT to consumer prices is only 0.0907 and the coefficient of pass-through in the second subsample esti-

Table 7. The Results of Pass-Through into Consumer Prices using Basic Model of ECM (Dependent Variable: Δcpi)

Variable	Period of 1990:I – 2009:IV	Period of 1990:I – 1997:III	Period of 1997:IV – 2009:IV
Constant	0.0233***	0.0194***	0.0271***
	(0.0038)	(0.0028)	(0.0043)
Δs	0.0907**	0.0324	0.0576**
	(0.0346)	(0.0482)	(0.0276)
Δp^{exp}	0.2015	0.2121	0.2066
	(0.1275)	(0.2769)	(0.1453)
ECT	-0.2060***	-0.0216	-0.2523***
	(0.0677)	(0.0565)	(0.0335)

*** significant at the 1 percent significance level; ** significant at the 5 percent significance level
The estimated values in parentheses are standard error; *Newey-West standard error* for full sample and *White standard error* for subsample
ECT used one-period lagged values of cointegration regression error
All variables in natural logarithm (ln)

mation is only 0,0576. The lower coefficient of pass-through is because the consumer price index calculates also the non-tradable goods prices so that the coefficient is smaller compared to that of import prices. ERPT into consumer prices reflected also ERPT into domestic inflation. If the pass-through coefficient is very small, direct contribution of the change in nominal exchange rate to CPI inflation will also very small in the short term, but significant as in the estimates for the full sample and second subsample (period after the economic crisis).

Cointegration Estimation

In the previous section, when the estimated model is not stable for the full sample, the alternative measure will be that the estimation is divided into two subsamples separated by structural breaks. In the following stage estimation for full sample by considering the structural breaks, then the results were compared to those of estimation without taking into account structural breaks. Estimations carried out for cointegration regression and the ECM, respectively. Estimation of cointegration model began with the regression model of ERPT into import prices is presented in *Table 8*.

Results of standard model estimation as presented in *Table 8* indicated that by considering structural break, coefficient of ERPT into import prices become smaller. The coefficient of the long-run ERPT into import prices is 0.6989 without taking the structural breaks into consideration. However, pass-through coefficient is decreased to 0.2251 and 0.1743 when structural breaks were considered, respectively, for a break in the constant and in the constant and slope. Thus, structural breaks decrease the coefficient of ERPT into import prices estimated in the long run.

Based on the estimated model as reported in *Table 9*, the structural break decrease also the coefficient of pass-through into consumer prices estimated in long term. Coefficient of pass-through into consumer prices in the long term is 0.5917 when structural break was not considered. It reduced to 0.2946 and 0.3730 when it does considered the structural breaks for a break in the constant and in the constant and slope, respectively. The considered structural break in the estimation model reduced the estimation coefficient of ERPT either into import or consumer prices. Therefore, coefficient of real ERPT is lower than the ordinary estimate due to the structural break during the observation period.

Table 10 indicated that the model B is the only model that cointegrated, assuming that no structural breaks were occured. Taking the structural break into account, both models were cointegrated. The result demonstrated that ta-

Table 8. The Results of Cointegration Estimation of Pass-Through into Import Prices without and with Structural Break using Gregory-Hansen Model (Dependent Variable: p^{imp})

Variable	Without Break (T = 80)	Break in Constant (T = 80)	Break in Constant and Slope (T = 80)
Constant	-9.6822***	-6.2306***	-5.4972***
	(0.7225)	(0.6372)	(0.7640)
Constant*d_s		-0.0725***	-0.0662***
		(0.0072)	(0.0045)
s	0.6989***	0.2251***	0.1743**
	(0.0336)	(0.0538)	(0.0725)
s*d_s			0.0136**
			(0.0059)
p^{exp}	1.7378***	1.7773***	1.7007***
	(0.2039)	(0.1481)	(0.1896)
p^{exp}*d_s			0.0083**
			(0.0066)

*** significant at the 1 percent significance level; ** significant at the 5 percent significance level
The estimated values in parentheses are *Newey-West standard error*

king the structural break into account might lead to different conclusion. The results of cointegration test that integrated the structural break might assist in improving cointegration in the estimation models.

Error Correction Model Estimation with Structural Break

In the current study, the results of cointegration estimation that take structural break into account based on Gregory and Hansen (1996) were used to estimate ECM model through the residual one-period lagged as the ECT. For the standard models of ERPT into import prices and of ERPT into consumer prices, the results of ECM estimation that taske structural break into account are presented in *Table 11*.

Statistically, equilibrium error term or ECT on estimation models presented in *Table 11* is not significant in its one-period lagged, except in estimation model of pass-through into consumer prices. The results indicate that the estimated model of pass-through into import prices in the short term through the ECM model requires a longer lag period to obtain significant

Table 9. The Results of Cointegration Estimation of Pass-through into Consumer Prices without and with Structural Break using Gregory-Hansen Model (Dependent Variable: cpi)

Variable	Without Break (T = 80)	Break in Constant (T = 80)	Break in Constant and Slope (T = 80)
Constant	-9.0049***	-6.8412***	-5.4519***
	(0.8565)	(1.0202)	(1.6498)
Constant*d_s		-0.0489**	-0.0400**
		(0.0201)	(0.0158)
s	0.5917***	0.2946*	0.3730*
	(0.0560)	(0.1527)	(0.2253)
s*d_s			-0.0097
			(0.0204)
p^{exp}	2.0986***	2.1234***	1.6830***
	(0.2708)	(0.2510)	(0.1976)
p^{exp}*d_s			0.0416**
			(0.0115)

*** significant at the 1 percent significance level; ** significant at the 5 percent significance level;
* significant at the 10 percent significance level

The estimated values in parentheses are *Newey-West standard error*

Table 10. ADF Test Results on Residual Estimation of Cointegration Pass-Through without and with Structural Break using Gregory-Hansen Model

Model	without Break	Break in Constant	Break in Constant and Slope
Model A	-2.5560	-3.1102**	-2.8473*
Model B	-3.8907***	-4.4412***	-4.4205***

[A] dependen variable: p^{imp} ; independent variables: s and $p^{\exp}$

[B] dependen variable: cpi ; independent variables: s and $p^{\exp}$

*** significant at the 1 percent significance level; ** significant at the 5 percent significance level; * significant at the 10 percent significance level

ECT when incorporating a structural break. Estimates in this case show that Indonesia's import prices adjust to changes in exchange rate of Rupiah against the US dollar and export prices in the US in different periods with a longer lag period when structural breaks were incorporated. With the structural break, import price adjustment to change in exchange rate and other variables require more than one period lagged compare to that without structural break.

Generally, the adjustment towards equilibrium requires more than one-period lagged but not more than four-periods lagged. Estimation of the standard model of ERPT into import prices with Newey-West standard errors in *Table 11*, on the left side, requires a four-periods lagged or one year for adjustment when entering the break in constant, and three-periods lagged when incorporating the break in constant and slope in its cointegration estimates, and ECT value of each estimation is -0.3176 and -0.3480, respectively for 5 and 10 percent significance level.

CONCLUSION

Taking into account the structural breaks, the results of unit root Zivot-Andrews test rejected the unit-root null hypothesis for the variables of import price, consumer price, and exchange rate, while the ADF and PP tests do not reject the unit-root null hypothesis for these variables on the level. Point in time of the structural breaks is around the economic crisis that occurred simultaneously with changes in the management from managed to free floating exchange rate. Cointegration test results that in-

Table 11. Basic ECM Model Estimation Results of Pass-Through with Structural Break (T = 79)

Variable	Pass-Through into Import Prices		Pass-Through into Consumer Prices	
	ECT with Break in Constant	ECT with Break in Constant and Slope	ECT with Break in Constant	ECT with Break in Constant and Slope
Constant	0.0076	0.0081	0.0238***	0.0237***
	(0.0081)	(0.0081)	(0.0046)	(0.0046)
Δs	0.3976***	0.3924***	0.0991*	0.1090*
	(0.1144)	(0.1163)	(0.0553)	(0.0557)
Δp^{exp}	1.0767***	1.0515***	0.0812	0.0616
	(0.4022)	(0.3945)	(0.1760)	(0.1811)
ECT	-0.1634	-0.2744	-0.1531**	-0.1837**
	(0.2199)	(0.1857)	(0.0680)	(0.0724)

*** significant at the 1 percent significance level; ** significant at the 5 percent significance level;
* significant at the 10 percent significance level
The estimated values in parentheses are *Newey-West standard error*
ECT used one-period lagged values of cointegration regression error
All variables in natural logarithm (ln)

corporate structural breaks could help improve the cointegration and ECM on the estimation model. The consequences of the estimated structural breaks are as follow: (i) stability test should be done on the full sample estimate without taking into account the structural breaks for both cointegration and ECM models and the test results showed that the model is not stable, (ii) because the model was not stable, the alternative is that the estimated model was devided into two subsample and the results of the estimated coefficient of ERPT differ between the two periods, (iii) when the structural breaks considered in the full sample model estimation, the estimated coefficient of long-term ERPT is lower compared to that without structural break, thus the estimated ERPT without taking into account the structural breaks are too high (over estimate) compared to that with structural break consideration, and (iv) for the estimated ECM model, when considering structural breaks, ECT coefficient in absolute value is lower compared to that which consider them, which means that smaller adjustment is necessary to lead back to the long-term relationship, however the adjustment time require more than one period lag.

Concerning the different price index used in the estimation, the estimation coefficient of ERPT to consumer prices is lower than that of import prices. This is due to the wider calculation concept of consumer prices that incorporate nontradable goods' prices compared to that of import prices that calculate all tradable goods.

The ECM model estimation results show that the estimated ERPT into import prices is a relatively higher, for short term, than the estimates in the second subsample. This indicate that the ERPT is higher for a more flexible exchange rate period, where the second subsample represents a period of free floating exchange rate while the first subsample represents a period of managed floating exchange rate. It can be argued from the results, that the relatively flexible exchange rate system may be preferred because it provides more precise estimates of ERPT. Higher coefficient of ERPT into import prices imply larger effect on the effectiveness of expenditure-switching policy and monetary policy through the existing exchange rate management.

Since the estimate coefficient of ERPT is significant in the estimation model, changes in exchange rate have an effect on import price. Although the pass-through is only partial or incomplete because it is smaller than one, the coefficient of pass-through is very significant in determining the effect of exchange rate changes on the changes in domestic prices; import and consumer prices.

In the bilateral case of Indonesia and the US, the lower coefficient of ERPT may be caused by the companies that insist in market pricing in order to maintain their market share. It is possible that when faced with the depreciation of the domestic currency (the rupiah against the US dollar), foreign exporters (the US) that sell goods to Indonesia will lower their price mark-ups to keep their market share. It is quite possible because Indonesia is very profitable and potential as a major destination market for US products, especially manufactured products.

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