EXCHANGE RATE PASS-THROUGH, IMPORT PRICES AND INFLATION UNDER STRUCTURAL BREAKS

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Abstract

This research estimates the exchange rate pass-through (ERPT) into import prices by applying an extension of the basic model of ERPT on Indonesia. It estimates models of cointegration and error-correction mechanism (ECM), with and without structural breaks. It uses the techniques of Zivot-Andrews and of Gregory-Hansen to test for structural breaks and cointegration with the structural breaks, respectively. The results show that with the control variables, inflation affects import prices and lower the pass-through for short term, in a condition of free floating exchange rate. In the short term, with the inclusion of structural breaks, significant inflation affects import prices and lowers the ERPT coefficient.

Keywords: Exchange rate pass-through, inflation, structural breaks, cointegration, error-correction mechanism
JEL classificatiomumbers : C22, C32, E31, F41

Abstrak

Penelitian ini mengestimasi *exchange rate pass-through* (ERPT) atas harga impor dengan menerapkan ekstensi dari model dasar ERPT di Indonesia. Penelitian ini mengestimasi model mekanisme kointegrasi dan koreksi kesalahan (ECM), dengan dan tanpa *structural breaks*. penelitian ini menggunakan teknik Zivot-Andrews dan Gregory-Hansen untuk menguji *structural break* dan kointegrasi dengan *structural break* tersebut. Hasil estimasi dan proses uji menunjukkan bahwa dengan variabel kontrol, inflasi mempengaruhi harga impor dan mengurangi *pass-through* untuk jangka pendek, dalam kondisi nilai tukar mengambang bebas. Dalam jangka pendek, dengan masuknya *structural breaks*, inflasi yang signifikan mempengaruhi harga impor dan menurunkan koefisien ERPT.

Keywords: Exchange rate pass-through, inflasi, structural breaks, kointegrasi, model koreksi kesalahan
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INTRODUCTION

The issue of exchange rate pass-through (*ERPT*) gets an increasing attention in the literature of the new open economy macroeconomics (*NOEM*). The economic literature on *ERPT* has been growing for more than two decades.

It is a critical issue since the degree of *ERPT* has important implications for the transmission of shocks and optimal monetary policy in open economies (Bashce, 2006). Furthermore, according to Kreinin (2002), *ERPT* is one important factor in determining the response of trade balance in addition to the J-Curve effect and hysteresis, which contributes to a delayed response from the balance of trade against the dollar depreciation.

The definition of *ERPT*, according Goldberg and Knetter (1997), is the percentage change in import prices (in local

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currency) generated from one percent change in exchange rates among countries exporting and importing countries. The import prices are then set retail and consumer prices. Pass-through can lead to inflation if the import price changes cause changes in domestic prices.

In the literature, *ERPT* is closely related to the law of one price (*LOP*) and purchasing power parity (*PPP*). Both are associated with the market efficiency argument of price dynamics. They were rightly so because the basis of PPP is the *LOP*. In the general literature the *LOP* states that all identical goods have only one price in an efficient market. In an efficient market, a price convergence is instantaneous. The process of convergence to one price can occur through arbitrage between different markets. However, the law of one price does not always apply in practice. The reason is that most trade 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 constraints to international trade such as tariffs and transportation costs as well as local costs of distribution and retail. These constraints hinder the force of *LOP*. Furthermore, in Kostov (2006), it is stated that the transaction costs become the major explanation consideration for the empirical objection to the *LOP* and *PPP*. No enforcement of the LOP and *PPP* is related to the lower *ERPT* into import prices. The lower *ERPT* has an effect on the current account and domestic inflation, which in turn affect the long-term economic growth.

Lower *ERPT*, according to the extant empirical studies, may be caused by inflation and the implementation of exchange rate system. Studies by Taylor (2000) and Gagnon and Ihrig (2004) found that conditions of low inflation reduce the *ERPT* into the price index in the 1990s. Goldfajn and Werlang (2000) in their study found a low pass-through of a large devaluation in developing countries. Saiki (2004) also reported a decrease in the coefficient of pass-through in a country that switched from monetary regime to inflation-targeting regime. As to the short- and long-term effects, study by Campa and Goldberg (2005) estimates the *ERPT* into import prices in 23 OECD countries. This study found evidence that the pass-through is partially, in the short term, refused the producers' and the local pricing as a representation of aggregate behaviour. In the long run, the producers' pricing will be more evenly distributed for several imported items. In addition to finding high volatility of exchange rates, the study also found higher pass-through elasticity. These results conclude that macroeconomic variables play only a minor role in the evolution of *ERPT* in OECD countries.

Studies on the pass-through are generally found evidence that prices in the local currency are not fully responsive to changes in exchange rates. Therefore, determining the effects of selection and use of the index rate and symmetric or asymmetric effect is quite important in estimating *ERPT* precisely. Coughlin and Pollard (2000) do so since there are only few studies that addressed the question of appropriate exchange rate index and the effect of symmetry or asymmetry. The pass-through estimation can be sensitive to the selection of exchange rate index. The use of a more inclusive index of exchange rate resulted in higher pass-through estimation. The study by Bussiere (2007) confirms that non-linearity and asymmetries in *ERPT* can not be ignored, particularly on the export side.

As to the *ERPT* differences between groups of countries, Ca'Zorzi et al. (2007) examine the degree of *ERPT* into prices in 12 emerging market countries in Asia, Latin America, Central and Eastern Europe. Based on autoregressive models (VAR), *ERPT* into import prices and *CPI* is always higher in emerging market countries than developed countries. The study also found strong evidence of a positive relationship between the degree of pass-through and inflation, in line with Taylor's hypothesis, excluding Argentina and Turkey. This study showed only insignificant empirical evidence to support the theory of positive relationship between import openness and pass-through.

Recent studies on the pass-through are those by Liu and Tsang (2008) and Devereux and Yetman (2010), Coulibaly and Kempf (2010), Xing (2010) and Auer (2011). Those studies are particularly associated with empirical studies in the countries of East Asia, except that of Devereux and Yetman. Liu and Tsang, in their study, found that *ERPT* into import prices for Hong Kong is relatively high compared to that of average OECD countries, although Hong Kong also experienced a decline in pass-through after 1991. In relation to the *ERPT* into domestic prices, they found that a 10% US dollar depreciation against all other currencies except Hong Kong dollar will be followed by an increase in domestic prices by 0.82 and 1.61 percent, respectively, in the short and medium term. The results are consistent with those obtained from the tests estimating *ERPT* into domestic prices through the tradable and non-tradable goods. Furthermore, Xing’s study reported that Japan's import prices are more responsive to changes in bilateral exchange rate between the yuan and the yen, which shows high degree of pass-through effects in the Japanese case associated with China's policy of Yuan peg to the United States (U.S.) dollars. Auer (2011) maintains, in his study, that the pass-through into producer prices in the U.S. is quite high of about 0.7, while the movement of exchange rates of other trading partners has only a smaller effect on import and producer prices. Pass-through into import prices is heterogeneous across sectors with diverse characteristics. Auer's study demonstrated also the inflationary effect of the revaluation of yuan against U.S. PPI inflation. Meanwhile, Devereux and Yetman (2010) build models that can be used to calculate the determinant of *ERPT* to the *CPI*. By holding constant the frequency of price changes, this study shows that the model adapted to data for countries with low inflation can result in re-estimation of very low pass-through for these countries. What determines the low pass-through is a slow price adjustment. Coulibaly and Kempf study find that inflation targeting in emerging countries support the declining *ERPT* into the various price index from higher to lower levels.

With regard to the external balance, Frankel (2005) argues that exchange rate policy concerning devaluation is intended to make adjustments to the external balance without sacrificing internal balance or without causing a recession. Devaluation is deemed to enhance competitiveness, to increase production and exports, to reduce imports, and thereby to promote the trade balance, *GDP*, and employment. However experiences will not be the same between the developing countries, or at least the emerging market countries, and the developed countries. In the era of flexible exchange rate regime in which devaluation is no longer the right solution, changes in exchange rates will affect the import prices through the pass-through, thus affecting domestic demand and prices.

The rupiah exchange rate flexibility since the implementation of floating exchange rate system showed that its movement is more dynamic than the previous period when devaluation policy was imposed on Indonesia. The effect of exchange rate on flexible exchange rate regime can be estimated from the changes due to depreciation or appreciation by estimating pass-through into import prices. In addition to changes in exchange rate regimes, inflation conditions such as in Indonesia are expected to also influence the process of *ERPT*.

This study aims to examine empirically the *ERPT* into import prices in Indonesia and the effect of inflation on the *ERPT* through the estimation of cointegration model and error correction mechanism (ECM). The study takes the case of Indonesia with the United States because strong of international trade relations between them, and considering the U.S. dollar as a strong currency, convertible and widely used in various international transactions by Indonesia.

This research that use time series data emphasized the period of managed and free floating exchange rate regime which in this period may experience a structural break in the transitional phase along with the economic crisis in mid-1997. Structural breaks will be included in the *ERPT* estimation in this study. This study was motivated by the still relatively little researches on *ERPT* in Indonesia, especially those taking into account the controlling factors and structural breaks. This research is important to estimate the influence of *ERPT* on import prices in Indonesia and to analyze the effect of inflation that may have a role to play in the process *ERPT* in Indonesia, given the magnitude *ERPT* is very important in determining the effectiveness of expenditure-switching policy and exchange rate management in relation to monetary and foreign trade policies.

This paper begins with an introduction that is followed by research method explaining the method of estimation with the cointegration model and the ECM and prerequisite tests. The tests include integrated of order and cointegration tests preceded by unit roots, either with or without structural break. The next section presents the results of research and discussion which then ends with conclusions and suggestions.

METHODS

A Model of Exchange Rate Pass-Through

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

$$MP_t = ER_t \cdot XP_t \tag{1}$$

Equation (1) in logarithms states:

$$mp_t = er_t + xp_t \tag{2}$$

Where the export price consists of the marginal costs of exporters and mark-ups:

$$XP_t = FMC_t \cdot FMKUP_t \tag{3}$$

In logarithms it becomes:

$$xp_t = fmc_t + fmkup_t \tag{4}$$

By substituting xp_t into equation (2):

$$mp_t = er_t + fmkup_t + fmc_t \tag{5}$$

Literature on industrial organization provides a view of why the effect of er_t change on mp_t is not equal to one, i.e. the determinants of mark-ups such as the condition of competition confronting the exporters in the destination market. Thus, the estimated pass-through elasticity is the sum of three effects: (i) unity translation effect of the exchange rate movement; (ii) respond to mark-up to offset the unity translation effect; and (iii) changes in marginal costs associated with exchange rate movements, such as input price sensitivity to exchange rates.

Mark-up will depend on market share of domestic producers, forms of competition in the market for the industry, 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, put it another way, greater share of imported goods in production activities in destination countries encourages higher predicted pass-through. The estimation of *ERPT* may be higher if the ratio of exports relative to local competitors is higher (such as commodities or oil), and the lower if the exporters compete for market share (such as manufactured products), even with high nominal exchange rate variability. Another factor affecting the pass-through is the currency denomination of exports, and the structure and importance of markets for intermediate goods.

The CGM model is empirically based on equation (5) which assumes unity translation of foreign exchange movement. The exporters of the given product may decide to absorb some changes in exchange rates rather than in pass-through into prices in local currency in the importing country. When the pass-through is complete (producer-currency pricing), their mark-up will not respond to the exchange rate fluctuation, thus lead to 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 by mark-ups. Therefore, mark-ups in the industry is assumed to consist of components that are specific to the type of goods, exchange rate independence and reaction to exchange rate movements:

$$fmkup_t = \alpha + \Phi er_t \quad (6)$$

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 importing countries, the marginal cost of production (wage) in exporting countries and commodity prices are denominated foreign currency in the model, the equation becomes:

$$fmc_t = \eta_0 \cdot y_t + \eta_1 \cdot fw_t + \eta_2 \cdot er_t + \eta_3 \cdot fcp_t \quad (7)$$

By substituting equation (7) and (6) into equation (5), this process yields:

$$mp_t = \alpha + (1 + \Phi + \eta_2) er_t + \eta_0 \cdot y_t + \eta_1 \cdot fw_t + \eta_3 \cdot fcp_t + \varepsilon_t \quad (8)$$

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

However, in a simple approach through the reduced form representation, where the identification of Φ and η_2 was excluded, in the CGM 'integrated world market' specification, the term $\eta_0 \cdot y_t + \eta_1 \cdot fw_t + \eta_3 \cdot fcp_t$, independence of the exchange rate, were considered as the opportunity costs of the allocation of the same goods to other consumers and is reflected in world prices of products fp_t in world currency (i.e. U.S. dollar). The last equation can therefore be re-written as:

$$mp_t = \alpha + \beta \cdot er_t + \gamma \cdot fp_t + \varepsilon_t \quad (9)$$

which is a long-term equation between import prices, exchange rates and foreign prices. In the next section of estimation models and results, import prices (mp), exchange rate (*er*) and prices of products *(p)* is written as p^{imp}, *s*, and p^{exp}, respectively.

One of the key issues in the two streams of literature concerning the *ERPT* is *ERPT* into import prices besides *ERPT* into consumer prices. In this study, equation (9) of the CGM will be treated as either an equation cointegration model or ECM models added with inflation-import and inflation-*GDP* as control variables in estimating short- and long-term *ERPT* into import prices in Indonesia.

This study uses quarterly data by time period of 1990:I – 2009:IV. As is evident, over the period of the study, the Indonesian exchange rate system experienced a change of exchange rate management from managed to free floating. Variables employed include the prices of imports as measured by the import price index, prices in the United States that proxied by the U.S. producer price index, the nominal bilateral exchange rate, gross domestic product (*GDP*), inflation as calculated from changes in log of *CPI*, and Indonesia's imports from the U.S. *GDP* is based on constant prices of 2000 and price index is based on base year of 2000. The data of rupiah exchange rate against the U.S. dollar, the import price index, *CPI*, import and Indonesia's *GDP*[2] were obtained from Indonesian Financial Statistics published by Bank Indonesia and various editions of Statistical Yearbook of Indonesia published by Indonesia Central Bureau of Statistics, while the price and US *GDP* were obtained from Central Bank of the United States site at http://research.stlousfed.org/fred/data.

Cointegration and Error-Correction Mechanism Model

The principle of cointegrated variables is that the time path of these variables is influenced by the amount of deviation from its long-term equilibrium. If this system leads to long-term equilibrium, the movement of (at least) several variables has to respond to the magnitude of disequilibrium. For example, if the variables *y* and *z* were cointegrated, hence, when the gap between variable *y* and variable *z* is large relative to its long-term equilibrium, the variable *z* must eventually increased relative to the variable *y*. According to Gujarati and Porter (2009) economically speaking, two variables will be cointegrated if they have a long run, or equilibrium, relationship between them. A regression of variable *y* on variable *z* would be meaningful (i.e., not spurious). Although variable *x* and *z* are individually *I*(1), (i.e., not stationary), they have stochastic trends, their linear combination is *I*(0); that is, it is stationary (further discussion on cointegration is in Robinson and Hualde, 2003; and Marmol and Velasco, 2004; among others).

Dynamic model in this system contain error correction. In the ECM model, short-term dynamics of the variables in the system is influenced by the deviation from equilibrium. If it is assumed that the variable y and z is I(1), respectively, then the simple model of the ECM will be:

$$\Delta y_t = -\alpha_y (y_{t-1} - \beta z_{t-1}) + \varepsilon_{yt}, \quad \alpha_y > 0 \quad (10)$$

$$\Delta z_t = \alpha_z (y_{t-1} - \beta z_{t-1}) + \varepsilon_{zt}, \quad \alpha_z > 0 \quad (11)$$

where Δy_t and Δz_t, respectively, represent the growth of y and *z*, while ε_{yt} and ε_{zt} represent the white-noise disturbance terms that are likely to correlate, and α_y and α_z are positive parameters and β can either be positive or negative depending on the proposition theory. In the next section of estimation methods and results, import price in local currency (p^{imp}) is written as variable *y*, and exchange rate (*s*), export price in exporting country (p^{exp}), consumer price (*CPI*), import (*imp*), and ratio of *GDP* (*GDP*) are written as variables *x*.

With reference to one of the equations in the system, namely the equation (10), ECM model can be developed into:

$$\Delta y_t = \alpha_0 - \alpha_y \hat{e}_{t-1} + \sum_{i=1} \alpha_1(i) \Delta y_{t-i} + \sum \alpha_2(i) \Delta z_{t-i} + \varepsilon_{yt} \quad (12)$$

where $\hat{e}_{t-1}$ is the lag of the estimated residuals from the following cointegration equation:

$$y_t = \beta_0 + \beta_1 z_t + e_t \quad (13)$$

[2] Quarterly *GDP* data in Indonesia were available since 1990.

Equation (13) is a long-term equilibrium assuming that the variable *y* and *z* are each *I*(1). Furthermore, based on estimates of equation (13) it may be indicated that the two variables were cointegrated if the residual (e_t) is stationary. If the variable *y* and *z* are, respectively, *I*(1), and the residual is stationary, this means that the series of variables *y* and *z* were cointegrated of order (1,1).

In addition to the above cointegration tests, cointegration test by Johansen's approach was also conducted as in Johansen (1995). In the hypothesis testing with this approach this study employed a statistical value called the Likelihood Ratio (LR) test statistic.

Models

Like the basic model of exchange rate of the expanded CGM, the model estimated in this study is the ECM model in equation (12) with a matrix for Δy_{t-i} is zero and $i = 0$ to Δz_{t-i}, where the variable y is the p^{imp} and the variable *z* is s, p^{exp}, *CPI* and imp which are, respectively, the price of imports, the nominal exchange rate, export prices, inflation, and imports for the first equation. For the second equation, the variable *z* is s, p^{exp}, *CPI* and *GDP*, where *GDP* is the ratio of Indonesia's *GDP* to the U.S. *GDP*. Both of the estimated models are also based on the same basic model used by Frankel et al. (2005). The equation of the ECM model can be written as:

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

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 (IDR/USD), $p_t^{\exp}$ is log price of exporting country proxied by producer price index in US, x_{it} are control variables (i.e., *CPI* and imp, *CPI* and *GDP*, respectively) and ecm_{t-1} is ε_{t-1} obtained from cointegration estimation.

Estimation by cointegration was also reported for long-term *ERPT*, both with and without structural breaks. A common form of cointegration equation used is equation (13). Meanwhile, the equation cointegration with structural break applied cointegration equation of Gregory and Hansen (1996). Initially, the preparation of non-structural break cointegration model uses the model by Engle and Granger (1987). Furthermore, the model estimation is conducted with changes in the constant in order to construct the equation for the estimate. Estimation of the expansion is done in the estimated *ERPT* into import prices, both with and without structural breaks. Estimation is done by entering control variables *CPI* (reflect *CPI* inflation) and Indonesian import (imp) from the United States, and variable *CPI* and the *GDP* (*GDP* ratio of Indonesia to the United States), as control variables into the cointegration equation and ECM. Extended cointegration equation model of *ERPT* into import prices without structural break can be written as:

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

$$p_t^{imp} = \delta + \chi s_t + \varphi p_t^{exp} + \mu cpi_t + \omega gdp_t + \eta_t \quad (16)$$

Furthermore, one-period lagged of error term of equations (15) and (16) is used as error-correction term (ECT) in the ECM equations that include control variables.

$$\Delta p_t^{imp} = \beta_0 + \beta_1 \Delta s_t + \beta_2 \Delta p_t^{exp} + \beta_3 \Delta cpi_t + \beta_4 \Delta imp_t + \gamma ecm_{t-1} + \varepsilon_t \quad (17)$$

$$\Delta p_t^{imp} = \delta_0 + \delta_1 \Delta s_t + \delta_2 \Delta p_t^{exp} + \delta_3 \Delta cpi_t + \delta_4 \Delta gdp_t + \lambda ecm_{t-1} + \quad_t \qquad (18)$$

The extended cointegration equation model incorporates structural breaks, and each slope is written as:

$$p_t^{imp} = \hat{\alpha}_0 + \hat{\alpha}_1 * d_s + \hat{\beta} s_t + \hat{\gamma} p_t^{exp} + \hat{\ } cpi_t + \hat{\psi} imp_t + \varepsilon_t \qquad (19)$$

$$p_t^{imp} = \hat{\delta}_0 + \hat{\delta}_1 * d_s + \hat{\chi} s_t + \hat{\varphi} p_t^{exp} + \hat{\mu} cpi_t + \hat{\omega} gdp_t + \upsilon_t \qquad (20)$$

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

$$p_t^{imp} = \hat{\delta}_0 + \hat{\delta}_1 * d_s + \hat{\chi} s_t + \hat{\chi}_1 s_t * d_s + \hat{\varphi} p_t^{exp} + \hat{\chi}_1 p_t^{exp} * d_s + \hat{\mu} cpi_t + \hat{\mu}_1 cpi_t * d_s + \hat{\omega} gdp_t + \hat{\omega}_1 gdp_t * d_s + \varepsilon_t \qquad (22)$$

where in the above case d_s is a dummy variable that equals 0 if t <s and equal to 1 if otherwise, and s is the break point. In this study, the break points were estimated by Zivot-Andrews model. Hypothesis testing for cointegration by entering structural break was conducted through Dickey-Fuller test against the error term from the estimation of both Engle-Grager cointegration models. From the estimated equation (19) - (22), one-period lagged of the error term is used each as ECT in ECM equations that incorporate structural break when the control variables were used.

Integrated Series

In the application of ECM model, the int egrated of order *d* of time series variables used in the model will determine the accuracy of the selected ECM models to estimate *ERPT* in Indonesia. According to Gujarati and Porter (2009) ECM model requires that the variables used have the same integrated of order *d*, in this case it is assumed I(1) which is then need to be tested. The variables used in the model must be cointegrated and its residual must be stationary, I(0). Stationarity testing of residuals were also done by the ADF test. The value of ECT should be in accordance with theoretical predictions. Based on the ECM equation, the value of ECT should be negative and significant for the ECM model to be valid.

To test the integrated of order *d* of time series variables used, this study will test the unit roots via the Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) as in Gujarati and Porter (2009). However, because during the study period structural breaks were identified, the unit root test also takes into account the structural breaks so that decisions about testing the hypothesis becomes more valid. The unit root testing model as with the structural changes in this study employed a model of Zivot and Andrews (1992). The unit root testing by Zivot and Andrews models is based on regression equations of the following:

$$\Delta y_t = \hat{\mu}^A + \hat{\theta}^A DU_t(\hat{\lambda}) + \hat{\beta}^A t + \hat{\alpha}^A y_{t-1} + \sum_{j=1}^{k} \hat{c}_j^A \Delta y_{t-j} + \hat{e}_t \qquad (23)$$

$$\Delta y_t = \hat{\mu}^B + \hat{\beta}^B t + \hat{\gamma}^B DT_t^*(\hat{\lambda}) + \hat{\alpha}^B y_{t-1} + \sum_{j=1}^{k} \hat{c}_j^B \Delta y_{t-j} + \hat{e}_t \qquad (24)$$

$$\Delta y_t = \hat{\mu}^C + \hat{\theta}^C DU_t(\hat{\lambda}) + \hat{\beta}^C t + \hat{\gamma}^C DT_t^*(\hat{\lambda}) + \hat{\alpha}^C y_{t-1} + \sum_{j=1}^{k} \hat{c}_j^C \Delta y_{t-j} + \hat{e}_t \quad (25)$$

Equation (23), (24) and (25) in the above model is the three-equation model of Zivot-Andrews respectively as models A, B, and C where $DU_t(\lambda) = 1$ if $t > T\lambda$, 0 if otherwise; $DT_t^*(\lambda) = t - T\lambda$ if $t > T\lambda$, 0 if other. $\hat{\lambda}$ on the parameter in equation (23) - (25) correspond with the estimated value of the break fraction. Variable y in the estimation of Zivot-Andrews models is variable estimated for structural breaks individually of the variables in the research models. Furthermore, t-statistics from estimate $\hat{\alpha}$ that exceed the critical t value at break point reject unit-root null hypothesis at the selected level of confidence. In this study, the estimated t-statistics are made to the model C in equation (25) considering that it is superior in its estimating ability. The use of model C is also recommended, as in the study of Sen (2003) and Waheed et al. (2006) compared to model A in equation (23), while Perron (1997) suggested the use of model A or model C.

Stability Test

The consequence of the existence of structural breaks is that the estimation of cointegration and ECM models has to be tested for their stability by taking into account the structural breaks. The stability test of the structural breaks in this study used Chow test. Chow stability testing can be performed using two methods, namely breakpoint tests and forecast test. It is expected that both will give the same convincing conclusion.

Chow breakpoint test is intended to match the estimated equation model separately with each subsample and to see if there are significant differences in the estimates. Significant differences mean that there are indications of structural breaks in the observation period. In addition to breakpoint test, test the forecast needs to be done to match between the previous estimates of the subsample, such as T_1, which is used to predict the value of the dependent variable for the remaining sample, for example T_2. If there are significant differences between the actual and predicted value of sample T_2 then there are indications that the model is not stable due to a structural break.

RESULTS DISCUSSION

Stationarity

In this section, the test results without structural breaks by the ADF and PP tests are reported in Table 1. The upper part of Table 1 presents the results of testing of all the variables included in the *ERPT* estimation model by the ADF test, either without trend or with trend, each for data on levels and in first difference. All test results on the level, both without and with the trend, do not reject the unit-root null hypothesis which means that all variables are not stationary at level. There are indications that the variables were stationary at the first difference. This is evidenced by test results that entirely reject the unit-root null hypothesis, both without and with trend.

The PP test results strengthen the indication that all variables are stationary at first difference. The test results presented in the lower part of Table 1 shows that all the PP test, both without and with trend, also did not reject the unit-root null hypothesis for the data level. In contrast, PP test on all variables reject the unit-root null hypothesis which means that these variables are stationary at first difference.

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***
CPI	-0.7608	-2.1028	-3.7890***	-3.7826**
Exchange rate	-1.4480	-2.0143	-5.2447***	-5.2510***
US PPI	-0.3725	-2.4091	-7.2364***	-7.2712***
Import	-1.4884	-2.0703	-8.4387***	-8.4071***
GDP ratio	-1.6193	-2.0707	-5.2722***	-5.2697***
Series	**PP tests**			
	Level		First Defference	
	No Trend	with Trend	No Trend	with Trend
Import price	-1.0313	-1.8066	-6.0620***	-6.0528***
CPI	-0.7493	-1.7614	-5.4136***	-5.4008***
Exchange rate	-1.3542	-1.8018	-6.5679***	-6.5573***
US PPI	-0.1151	-2.0593	-7.0937***	-7.0801***
Import	-1.5388	-2.2428	-10.7174***	-10.6821***
GDP ratio	-1.5004	-1.8333	-6.4908***	-6.4690***

Notes: *** and ** indicate significant at the 1% and 5% significance level, respectively.
Source: Data estimation.

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

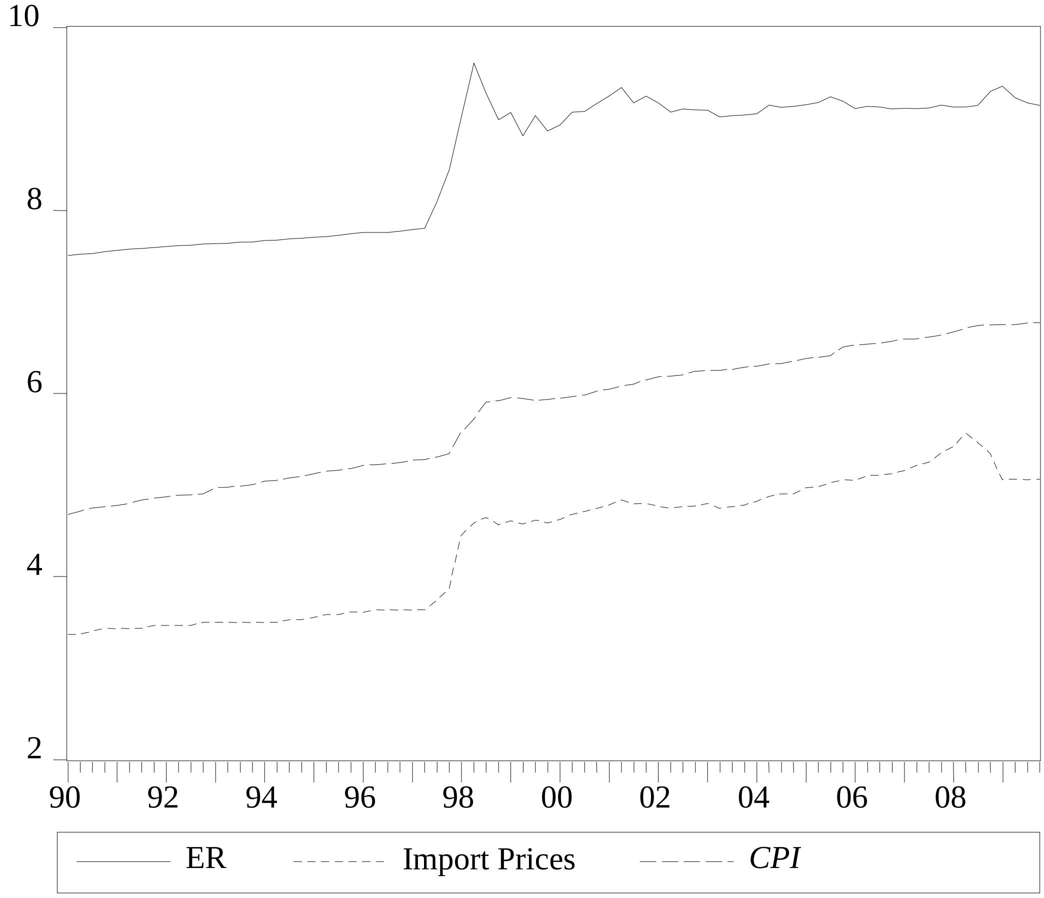
Series[a]	t-statistics[b]	Break-Points[c]
Import price	-6.7245***	1997:IV
CPI	-12.3512***	1997:IV
Exchange rate	-7.7110***	1997:III
US PPI	-4.6095	2001:II
Import	-3.9060	1997:IV
GDP ratio	-8.3969***	1997:III

Notes: (1) [a] indicates all series at the level form and in natural logarithm (ln). (2) [b] estimated by model C of Zivot-Andrews with $k = 1$. (3) [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. (4) *** indicates significant at the 1 percent level. (5) Critical values of Zivot-Andrews are -5.57, -5.08 and -4.82 for 1, 5, and 10 percent significance levels, respectively.
Source: Data estimation.

When confronted with the possibility of structural breaks that occurred during the period of study, the two previous tests give no satisfactory unit root test results. The predicted structural break is the one at the time of the Asian economic crisis that began with the currency crisis that also hit Indonesian currency the recovery of which takes a relatively long time. Through the Zivot-Andrews test, especially for model C with a reason previously stated, the test results include the structural break. Zivot-Andrews test results are presented in Table 2.

Furthermore, Table 2 reported the unit root test using the Zivot-Andrews model of six variables. These results indicate that the test results of four of the six variables reject the unit-root null hypothesis. The four variables are import prices, *CPI*, exchange rate, and the ratio of real *GDP*, while U.S. producer price variable, which is a proxy of export prices, and import variables are not rejected. The timing of the structural break point is 1997 on fourth quarter for import and consumer prices and 1997 on third quarter for exchange rate and the ratio of real *GDP*. The time point was consistent with earlier assertion that the structural break occurred at about the economic crisis in Indonesia, which in tandem with the shift in the management of exchange rate, from the managed floating to the free floating as shown in Figure 1.

Figure 1 shows the simultaneous existence of structural breaks that are consistent between the exchange rate, import prices and the *CPI* at time points surrounding the economic crisis and changes in exchange rate management. The result of the unit root test of Zivot-Andrews that incorporate the structural break gives different results from the conclusions of the ADF and PP test results. Thus the results of Zivot-Andrews test will be taken into account in estimating the cointegration and ECM models. The results of this test underlie the stability test conducted on the model based on the estimation of the obtained break points.



Source: Data processed.

Figure 1: Structural breaks of Exchange Rate, Import Prices and *CPI* in Indonesia, Period of 1990:I - 2009:IV (All Variables are in log)

Cointegration

To distinguish between sample groups based on the period of time, Engle-Granger cointegration test was conducted on three groups of samples. The first group is the full sample where the break point is included, whiles the second and third group is a subsample separated by break points. Table 3 reports the test results on three groups of samples, one for each 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 a faster alternative method to find out whether two or more variables were cointegrated.[3] CRDW use Durbin-Watson *d* obtained from the cointegration regression. Meanwhile τ is the value of t-statistic of the residual regression with $\Delta\hat{u}_t$ and u_{t-1} as the dependent and independent variable, respectively.

The test results of CRDW demonstrate the value of *d* and τ significant at 1% significance level for the estimate on the full sample as reported in Table 3. With the same significance level in the first subsample (the period 1990: I - 1997: III) the *d* value and the value of τ are both significant. Meanwhile, the value of *d* and τ on the estimation of the second subsample (the period 1997: IV - 2009: IV) is significant at 1% significance level. Overall, results show that the *d* tests are generally accepted the null-hypothesis of cointegration since its values are higher than the critical values. In addition, the overall test results show the lower τ values (negative) than the critical values of Engle-Granger which indicated that the residuals of the cointegration regression are I(0) which supports the existence of cointegration.

Moreover, Table 4 presents the results of cointegration test by Johansen approach 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 similar to that tested in Table 3, each with two lags.

Table 4 shows that the model of *ERPT* into import prices with the expansion through the addition of control variables is cointegrated for all sample groups. These results are consistent with those of Engle-Granger cointegration test. However, these cointegration results are not satisfactory because the structural break has not been included. The last part of this discussion will present the estimated cointegration test results that take into account structural breaks which are expected to improve the estimation of cointegration models.

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	0.7695***	-4.1834***	0.9425***	-3.0685***	0.7483***	-4.0326***
Model B	0.8621***	-4.3376***	0.9763***	-3.1344***	0.7804***	-3.6170***

Notes: (1) *** indicates significant at the 1 percent significance level. (2) The critical values of *d* are 0.511, 0.386 , and 0.322 respectively for 1,5, and 10 percent significance level. (3) The Critical value of τ at the 1% Engle-Granger is -2.5899. (4) Model A is based on the equation of $p_t^{imp} = \delta_0 + \delta_1 s_t + \delta_2 p_t^{\exp} + \delta_3 cpi_t + \delta_4 imp_t$. (5) Model *B* is based on the equation of $p_t^{imp} = \gamma_0 + \gamma_1 s_t + \gamma_2 p_t^{\exp} + \gamma_3 cpi_t + \gamma_4 gdp_t$.
Source: Data estimation.

[3] See Gujarati (2003).

Table 4: Results of Johansen Cointegration Test

Variable Series	Lag	*Likelihood Ratio*					
		T		T_1		T_2	
		$r = 0$	$r \leq 1$	$r = 0$	$r \leq 1$	$r = 0$	$r \leq 1$
p^{imp} *s* p^{exp} *cpi imp*	1	99.4199**	50.9571	78.1809	51.6392	114.2555**	62.1782
	2	83.0341	54.1615	96.5929**	64.8180*	104.3201**	58.1632
p^{imp} *s* p^{exp} *cpi gdp*	1	112.6727**	57.1264	90.9494*	54.0474	118.1760**	72.9041**
	2	88.0703*	55.9691	115.4872**	66.9452*	112.5002**	65.1956*

Notes: (1) The assumption is $H^*(r)$: $\Pi y_{t-1} + \mathrm{B}x_t = \alpha(\beta' y_{t-1} + \rho_0 + \rho_1 t) + \alpha_\perp \gamma_0$. (2) *T* indicates full sample; T_1 indicates first subsample; and T_2 indicates second subsample. (3) The critical values of 1% and 5% (r = 0) are 96.58 and 87.31; critical values of 1% and 5% ($r \leq 1$) are 70.05 and 62.99. (4) ** indicates significant at the 1 percent significance level. (5) * indicates 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.
Source: Data estimation.

Table 5: Results of Chow Stability Test

Model	*Breakpoint Test* (1997:III)	*Forecast Test* (1997:III – 2009:IV)
Cointegration[A]	2.7705** (0.0243)	66.8000*** (0.0000)
ECM[A]	0.6516 (0.6886)	22.3146*** (0.0000)
Cointegration[B]	0.8965 (0.4884)	52.4776*** (0.0000)
ECM[B]	0.4083 (0.8710)	21.5583*** (0.0000)

Notes: (1) [A] indicates that the dependent variable: p^{imp}; independent variables: s, $p^{\exp}$, cpi and imp. (2) [B] indicates that the dependent variable: p^{imp}; independent variables: s, $p^{\exp}$, cpi and gdp. (3) The estimated values in the table are *F*-statistic and *p*-value in parentheses. (4) ***ind icates significant at the 1 percent significance level; (5) ** indicates significant at the 5 percent significance level.
Source: Data estimation.

Model Stability

If the estimate of the existence of structural breaks shows significant result, the estimated model will becomes unstable even if the results of cointegration and ECM regression estimates for the full sample show significant results. In that case, the estimate should be tested for stability through a Chow test on the regression results of the estimated model.

Through the forecast test all the test results reject the null hypothesis of no structural break in the estimated model of *ERPT* as shown in Table 5. Meanwhile, with the breakpoint test to estimation, model A for cointegration indicate the results that reject the same null hypothesis. In general, the test results in this study drew the conclusion that the estimated model for the full sample shows indications of structural breaks. Therefore, in the estimation model, both cointegration and ECM, the estimation of long- and short-term pass-through is conducted in two phases; estimation with and without taking into account the structural break, the results of which are reported in the next section.

Estimation of Error-Correction Mechanism Model

In this section, estimation results of *ERPT* model into import prices through the ECM model are reported in Tables 6 and 7. Estimation of *ERPT* into import prices is done by adding the control variables of the basic model. *ECT* values used in the estimation of the ECM model are one-period lagged values of the cointegrated residual equation in each sample group.

Table 6: The Results of Pass-Through into Import Prices using Model of ECM with Control Variables of *CPI* and Import (Dependent Variable: Δp^{imp})

Variable	Period of 1990:I – 2009:IV	Period of 1990:I – 1997:III	Period of 1997:IV – 2009:IV
Constant	-0.0175**	0.0042	-0.0164
	(0.0074)	(0.0037)	(0.0111)
Δs	0.2920***	0.3350***	0.2818***
	(0.0323)	(0.0378)	(0.0600)
Δp^{exp}	1.2545***	0.7862***	1,3439***
	(0.1703)	(0.2025)	(0.3322)
Δcpi	1.0162***	-0.0376	0.9951***
	(0.2068)	(0.1529)	(0.2275)
Δimp	-0.0405	-0.0113	-0.0793
	(0.0359)	(0.0090)	(0.0635)
ECT	-0.2121**	-0.5240***	-0.3094***
	(0.1047)	(0.1629)	(0.1107)
T	79	30	49
Adjusted R-squared	0.6710	0.7805	0.6894
DW-stat	2.2288	2.1348	1.8728
F-stat	32.8102***	21.6275***	21.8683***
	(0.0000)	(0.0000)	(0.0000)

Notes: (1) ***indicates significant at the 1 percent significance level. (2) ** indicates significant at the 5 percent significance level. (3) The estimated values in parentheses are standard error; Newey-West standard error for full sample and White standard error for subsample. (4) *ECT* used one-period lagged values of cointegration regression error. All variables are in natural logarithm (ln).
Source: Data estimation.

Table 7: The Results of Pass-Through into Import Prices using Model of ECM with Control Variables of *CPI* and *GD*P: The Dependent Variable is Δp^{imp}

Variable	Period of 1990:I – 2009:IV	Period of 1990:I – 1997:III	Period of 1997:IV – 2009:IV
Constant	-0.0198**	0.0039	-0.0193
	(0.0080)	(0.0043)	(0.0117)
Δs	0.3738*	0.3317***	0.3651
	(0.1939)	(0.0812)	(0.2377)
Δp^{exp}	1.1062***	0.7722***	1.1177***
	(0.2441)	(0.2078)	(0.3013)
Δcpi	1.0815***	-0.0338	1.0998***
	(0.2394)	(0.1652)	(0.2403)
Δgdp	0.0630	0.0056	0.0655
	(0.1862)	(0.0820)	(0.2375)
ECT	-0.2587**	-0.5088***	-0.3146**
	(0.1006)	(0.1711)	(0.1217)
T	79	30	49
Adjusted R-squared	0.6756	0.7652	0.6794
DW-stat	2.1634	2.0199	1.8735
F-stat	33.4906***	19.9022***	20.9174***
	(0.0000)	(0.0000)	(0.0000)

Notes: (1) *** indicates significant at the 1 percent significance level. (2) ** significant at the 5 percent significance level. * indicates significant at the 10 percent significance level. (3) The estimated values in parentheses are standard error. (4) Newey-West standard error for full sample and White standard error for subsample. (5) *ECT* used one-period lagged values of cointegration regression error; All variables are in natural logarithm (ln).
Source: Data estimation.

Table 6 reports estimation results of *ERPT* into import prices if the estimation model is added with *CPI* and import variables. Meanwhile, Table 9 reports the estimates if the control variables are the change (in log) of *CPI* that reflects inflation and income proxied with *GDP* ratio between Indonesia and the US.

Table 6 reports that for the three groups of samples, the results of *ECT* coefficient estimates show significant and negative value as expected. In this model, with the change in *CPI* (inflation) that influence changes in import prices, the coefficient *ERPT* into import prices for full sample and first subsample become smaller than the coefficient of pass-through into the estimated standard model.[4] The estimation coefficients of pass-through into the three groups of samples were 0.2920, 0.3350, and 0.2818, respectively.

Inflation also influence the model by reducing *ERPT* (directly) into import prices in the short term, particularly to estimate the full sample and second subsample. These results indicate that in the period of more fluctuating exchange rate, that is the period of free floating exchange rate, inflation also influence the coefficient or relatively small *ERPT*. Meanwhile, in the period of relatively stable exchange rate during the period of managed floating exchange rate, inflation has no effect on changes in import prices in the short term.

The estimation results indicate also that the magnitude of Indonesia's imports from the United States does not significantly influence the changes in import prices because the large imports in these variables do not specifically elaborate on the type of goods being traded or market structure of the traded goods. If the elaboration was conducted, these variables may be significant. In addition, the effect of inflation in this model causes *ERPT* into import prices at a relatively flexible exchange rate period (second subsample) becomes lower than the previous period, in contrast to the results of the standard model estimation that take no inflation into account in the previous study by Arintoko (2011).

Table 7 shows that with the control variables of *CPI* and the *GDP*, the model estimation results are not too different from that in Table 6. The values of *ECT* remain significant and this is in line with expectations. The coefficients of *ERPT* into import prices for the third consecutive sample groups were 0.3378, 0.3317 and 0.3651. Inflation that affects the estimation model also causes *ERPT* coefficient (directly) into lower import prices in the short term, particularly to estimate the full sample. On the extreme, in the period a relatively flexible exchange rate, influences of inflation render pass-through even more insignificant in the model. Meanwhile, the magnitude of change of Indonesia's *GDP* relative to the U.S. has no significant effect on changes in import prices. These variables may tend to directly affect the magnitude of imports and not on import prices in the short term.

Cointegration Estimation

In the preceding section, when the estimated model is not stable for the full sample, the alternative is that the estimation is divided into two subsamples separated by structural breaks. In the following stage estimation was conducted for full sample by taking into account the structural break that occurred and the results were compared with those of estimation without taking structural breaks into account. Estimations were each carried out for cointegration regression and the ECM. Estimation results of long-term *ERPT* into import prices model which is extended from the basic model with two pairs of control variables that take into account the structural break are presented in Table 8 and 9.

[4] Estimation results of *ERPT* into import prices using the standard model with same period were 0.3813, 0.3348, and 3.492 respectively in the prior study by Arintoko (2011).

Table 8: The Results of Cointegration Estimation of Pass-Through into Import Prices without and with Structural Break using Gregory-Hansen Model, with Control Variables of *CPI* and Import: The Dependent Variable is p^{imp}

Variable	without Break	Break in Constant	Break in Contant and Slope
Constant	-8.2539***	-6.1006***	-6.4928***
	(1.6846)	(1.0244)	(1.8320)
Constant*d_s		-0.0741***	-0.1409
		(0.0133)	(0.1346)
s	0.5303***	0.2275***	0.1676**
	(0.0774)	(0.0630)	(0.0744)
s*d_s			0.0127**
		1.7302***	(0.0052)
p^{exp}	1.7339***	(0.3086)	1.9090***
	(0.4489)		(0.4924)
$p^{exp}*d_s$		0.0796	0.0026
		(0.1157)	(0.0107)
CPI	0.2139		-0.0052
	(0.1413)		(0.1113)
*CPI**d_s		-0.0498	0.0312
		(0.0494)	(0.1578)
imp	-0.1771***		0.0196
	(0.0575)		(0.0202)
$imp*d_s$			-0.1048
			(0.0932)
T	80	80	80
Adjusted R-squared	0.9884	0.9935	0.9935
DW-stat	0.7695	0.6804	0.7170
F-stat	1682.937***	2415.561***	1354.026***
	(0.0000)	(0.0000)	(0.0000)

Notes: (1) *** significant at the 1 percent significance level. (2) ** significant at the 5 percent significance level. (3) The estimated values in parentheses are Newey-West standard error.
Source: Data estimation.

Table 8 presents the estimation results of extended model with control variables of *CPI* and import, while Table 9 presents the results of the estimated model with control variables of *CPI* and *GDP*. Both tables also present the comparison between the estimation results without and with taking structural breaks into account.

Table 8 shows that the estimation coefficient of long-term *ERPT* into import prices without taking into account the structural break is 0.5303 with the integration of *CPI* and import variables in the model. The result is that the *CPI* is not significant but the magnitude of imports also affects the import prices. A negative coefficient of import reflects that the larger the Indonesian imports from the U.S. the lower the import price will be. However, when structural break was calculated, pass-through coefficient decline and a variable imports magnitude become insignificant. Assuming a break in constant, the coefficient of pass-through feel into 0.2275 and assuming the break in constant and slope, the coefficient fell again into 0.1676.

Table 9 shows that with the control variables of *CPI* and the *GDP* ratio of Indonesia to the U.S., the estimated coefficients of long-term *ERPT* were not obtained in accordance with the theoretical prediction because its value is negative with 10 percent significance level. In addition, the coefficient of pass-through is also not obtained through the estimation by taking the structural breaks into account because it is not significant. Only the export price that is consistently significantly affects the import prices. Overall, export prices consistently positively effect the import prices, which means that the producer marginal cost in the exporting countries is a major contributor in the determination of import prices in trading partner countries.

Structural breaks taken into account in the estimation, addition to showing the coefficient of real pass-through with lower value than estimated indicate also that the cointegration hypothesis testing is more convincing. Table 10 shows that by considering structural breaks with the assumption of break in constant and break in constant and slope in the estimation model, the variables in the model become more cointegrated than without considering them.

With the assumption of no structural break, only model A that is cointegrated. After taking into account structural breaks, the two models were cointegrated. The estimation results confirm that by considering structural breaks, the conclusion can be different. The result of cointegration test by including the structural break could help improve the model estimation.

Table 9: The Results of Cointegration Estimation of Pass-Through into Import Prices without and with Structural Break using Gregory-Hansen Model, with Control Variables of *CPI* and *GDP*: Dependent Variable is *CPI*

Variable	Without Break	Break in constant	Break in Constant and Slope
Constant	-6.7792***	-5.8087***	-5.8095***
	(1.3186)	(1.0485)	(1.5871)
Constant*d_s		-0.0805***	-0.1477
		(0.0131)	(0.1414)
s	-0.2699*	0.0018	0.0041
	(0.1589)	(0.1235)	(0.2041)
$s*d_s$			-0.1006
			(0.1761)
p^{exp}	1.3280***	1.5772***	1.7410***
	(0.3424)	(0.3004)	(0.4242)
$p^{exp}*d_s$			0.0125
			(0.0143)
CPI	0.4769***	0.1818*	0.1432
	(0.1162)	(0.1028)	(0.1262)
*CPI**d_s			-0.0807
			(0.1670)
GDP	-0.7493***	-0.2412*	-0.1351
	(0.1550)	(0.1393)	(0.0240)
*GDP**d_s			-0.1647
			(0.2590)
T	80	80	80
Adjusted R-squared	0.9908	0.9936	0.9937
DW-stat	0.8621	0.5963	0.6652
F-stat	2130.208***	2462.756***	1385.693***
	(0.0000)	(0.0000)	(0.0000)

Notes: (1) ***, **, and * indicate significant at the 1%, 5%, and 10% significant level, respectively. (2) The estimated values in parentheses are Newey-West standard error.
Source: Data estimation.

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	-2.8649*	-2.9750**	-3.0442**
Model B	-2.5000	-2.8507*	-2.6070*

Notes: (1) [A] indicates that the dependent variable: p^{imp}; independent variables: s, $p^{\exp}$, cpi and imp. (2) [B] indicates that the dependent variable: p^{imp}; independent variables: s, $p^{\exp}$, cpi and gdp. (3) *** **, and * indicate significant at 1%, 5% and 10% significant level, respectively.
Source: Data estimation.

Estimation of Error-Correction Mechanism Model with Structural Break

In this study, the results of cointegration estimation which take into account the structural break based on the Gregory and Hansen (1996) were used to estimate the ECM model through the one-period lagged residuals as ECT. The results of the extended ECM model estimation for *ERPT* into import prices by two pairs of control variables that take into account structural breaks are presented in Table 11.

Table 11: Basic ECM Model Estimation Results of Pass-Through with Structural Break and with Control Variables

Variable	Control Variables of *CPI* and Import		Control Variables of *CPI* and *GDP*	
	ECT with Constant Break	ECT with Constant and Slope Break	ECT with Constant Break	ECT with Constant and Slope break
Constant	-0.0213***	-0.0201***	-0.0241**	-0.0231**
	(0.0076)	(0.0071)	(0.0095)	(0.0092)
Δs	0.2789***	0.2744***	0.4188*	0.4180*
	(0.0395)	(0.0407)	(0.2193)	(0.2211)
Δp^{exp}	1.2506***	1.2306***	1.1380***	1.1207***
	(0.1594)	(0.1630)	(0.2028)	(0.2039)
ΔCPI	1.1581***	1.1291***	1.2289***	1.1978***
	(0.2568)	(0.2518)	(0.3070)	(0.3092)
Δimp	-0.0282	-0.0304		
	(0.0271)	(0.0321)		
ΔGDP			0.1417	0.1419
			(0.2297)	(0.2258)
ECT	-0.0986	-0.1935	-0.1137	-0.1750
	(0.2311)	(0.2206)	(0.2160)	(0.2307)
T	79	79	79	79
Adjusted R^2	0.6432	0.6536	0.6458	0.6520
DW-stat	2.4419	2.3873	2.3885	2.3466
F-stat	29.1218***	30.4309	29.4383***	30.2238***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Notes: (1) ***, **, and * indicate significant at the 1%, 5%, and 10% significant level, respectively. (2) The estimated values in parentheses are Newey-West standard error. (3) *ECT* used one-period lagged values of cointegration regression error. All variables are in natural logarithm (ln).
Source: Data estimation.

Statistically, *ECT* on the model estimates presented in Table 11 is not significant at the value of one-period lagged. These results indicate that the estimated model of pass-through into import prices for short term through the ECM model requires a longer lag period to obtain significant *ECT* when including a structural break. Estimation in this case shows that Indonesia's import prices adapted to the exchange rate changes of Rupiah - USD, US export prices, domestic *CPI* and other control variables, namely Indonesia's import from the U.S. or *GDP* ratio of Indonesia to the U.S. in different periods with a longer lag period when structural breaks are included. With the structural break, the adjustment of import prices to changes in exchange rate and other variables may take more than one-period lagged than the estimates that exclude structural breaks.

The adjustment towards the equilibrium requires, on average, more than one-period lagged but not more than four-periods lagged. In the estimation model with control variables, *CPI* and imports were reported in left part of Table 11. The necessary time adjustment is a three-periods lagged, either by entering a break in constant or constant and slope with each *ECT* value of -0.3394 and -0.3166 which are both significant at the 10 percent significance level. To estimate the model of *ERPT* with control variables of *CPI* and *GDP* on the right side of Table 11, it takes an adjustment of import prices to changes in exchange rate and other variables with two and three-periods lagged, respectively, for the break in constant and break in constant and slope. *ECT* values for both are -0.1651 and -0.3603, respectively, with 5 percent significance level.

CONCLUSION

The unit root test by Zivot-Andrews test give different results with those conducted through ADF and PP tests. Taking into account the structural break, Zivot-Andrews unit root test results rejected the unit-root null hypothesis for the variables of import prices, *CPI*, exchange rate and *GDP*, while the ADF and PP tests do not reject the unit-root null hypothesis for the six variables at the level. The point in time of the structural changes is at about the economic crisis along with the change in exchange rate management from managed into free floating exchange rate. The results of cointegration test that include a structural break could help improve the estimation of cointegration and ECM models.

The results showed that with the control variables, inflation also affects import prices and lower the pass-through for short term and this happens in a free floating exchange rate period characterized by volatile exchange rate movements. By entering a structural break, inflation, in the short term, remains significantly affects import prices and the declining *ERPT* coefficient. The different conditions of inflation and exchange rate regime influence the *ERPT* process. In addition, absolute values of *ECT* declined and required more than one period for the adjustment process.

Given the significant coefficient estimates of *ERPT* in the extension of basic estimation model, the change in exchange rate still has a significant effect on import prices, although the coefficient is relatively low when inflation affects the pass-through of exchange rate. Although the pass-through is only partial or incomplete because it is less than one, the coefficient of pass-through is very significant in determining the effect of changes in exchange rate on the changes in domestic prices.

Another factor of low *ERPT* coefficient may be due the company support to the making of pricing to market in order to maintain its market share. The possibility that when faced with the depreciation of the domestic currency (the rupiah against the U.S. dollar), foreign exporters (the U.S.) that sell goods to Indonesia will lower their price mark-ups to maintain their market share. It is very likely considering that Indonesia is very profitable and potential as a major destination market for U.S. products, especially manufactured products.

The results showed that the inflation has effect on the low coefficient of *ERPT* into import prices. In addition, the effect of inflation to *ERPT* was also associated with differences in the period of exchange rate where the inflation affects the *ERPT* in a period of fluctuating exchange rate and its *ERPT* coefficient tend to be lower. From these results it can be suggested that policy makers can make exchange rate management policy and inflation in synergy. Management of inflation within the framework of inflation aimed to a relatively stable inflation target, along with the exchange rate management policy will provides an exchange rate movement space that constantly dynamic and flexible. With *ERPT* that is not too small, the expected changes in exchange rate will affect policy intended to divert spending, the so-called expenditure-switching policy, in order to improve the current account deficit.

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