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Asymmetric effects of the exchange rate on domestic corporate goods prices☆

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ABSTRACT

This paper empirically examines whether there are asymmetric effects of the exchange rate on domestic corporate goods prices when the exchange rate is more volatile. To identify different volatilities in the exchange rate, we employ a threshold regression model. In other words, we define exchange rate volatility as a threshold variable. By using monthly data from Japan, we estimate a threshold parameter and calculate its confidence interval by following Hansen (2000). The results substantiate that the degree of exchange rate pass-through to the aggregated corporate goods price index is higher and more gradually adjusted in a higher exchange rate volatility regime. Furthermore, such asymmetric relationships are clearly found in three disaggregated corporate goods prices: petroleum and coal products, nonferrous metals, and chemicals and related products.

1. Introduction

Exchange rate pass-through (ERPT) has been widely debated in order to explore its implications on the macroeconomy, monetary policies, and international transmission of shocks as well as to investigate whether the law of one price holds. In theories such as the so-called New Open Economy Macroeconomics, Obstfeld and Rogoff (1995) explain that money supply shocks can improve international welfare with the assumption of perfect ERPT. On the other hand, Betts and Devereux (2000) introduce local currency pricing in some exporting firms, which causes imperfect ERPT, and show that monetary policy could be a "beggar-thy-neighbor" instrument in terms of welfare. Other theoretical studies, allowing for price stickiness in both importing and final good sectors, illustrate that the monetary authority faces a trade-off between stabilizing domestic prices and stabilizing output, and analyze the implication of imperfect ERPT on optimal monetary policy.[1] Furthermore, Taylor (2000) investigates the recent decline in the degree of pass-through and states that lower pass-through is caused by low inflation environment.

In terms of empirical studies, Campa and Goldberg (2005) and Otani et al. (2003) estimate the short-run and long-run ERPT into import prices for 23 OECD countries and for Japan respectively. Both studies empirically demonstrate that the degree of ERPT has been declining over time. Campa and Goldberg (2005) account for the pass-through declines in terms of the shift in import composition, while Otani et al. (2003) note that Campa and Goldbergs suggestion is not appropriate for the Japanese data and that ERPT as a whole has been declining. Shioji and Uchino (2009) also examine whether ERPT has been changed by using the Japanese data. They point out a possible correlation of exchange rate fluctuation with that of oil prices, so they re-estimate ERPT by using new import price indexes from which the effects of oil prices are removed. They also conclude that ERPT is declining, although they assert that the degree of ERPT is overestimated in the analysis ignoring the effects of oil prices.

This paper also estimates the degree of ERPT but focuses on the asymmetric relationship between ERPT and exchange rate volatility. While price stickiness is a key element to explain ERPT, we show that the size of shocks is also important. Acknowledging the fact that firms need adjustment costs to change their prices,[2]

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[1] See, for example, Smets and Wouters (2002), Choudhri et al. (2005), Monacelli (2005), Lindé et al. (2004), Bouakez and Rebei (2008), and Galí and Monacelli (2005).

[2] Rotemberg (1982) discusses why firms need adjustment costs and introduces two reasons. The first is the administrative cost of changing price lists. Secondly, an implicit cost comes from the unfavorable reaction of customers. In recent studies, however, administrative costs seem unimportant. In the survey conducted by Abe et al. (2008), 30 percent of the retail store owners said that they changed prices because of the costs of collecting and processing information about demands and purchasing expense rather than because of the traditional menu costs.

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we infer that they are not willing to frequently reset their prices in response to a small movement in the exchange rate. They will not reset their prices until the profits increase when the change in their prices exceeds their adjustment costs. Therefore, they will adjust their prices only when the exchange rate fluctuates wildly. In other words, prices are more passed through when the exchange rate is relatively more volatile. In contrast, prices are less passed through when the exchange rate is relatively stable.

One of the outstanding findings in previous empirical studies is that the degree of ERPT has changed over time. These studies follow the approach of dividing a sample period into the first and latter parts and then estimating the degree of ERPT within single equation models or vector autoregressive models respectively. Our approach, however, introduces threshold regression models in order to specify different regimes like high and low volatility. The purpose of this approach is to clarify the asymmetric relationship between the degree of ERPT and exchange rate volatility and to provide new insights about ERPT.[3]

A threshold regression model is estimated by using the method of conditional least squares. A threshold parameter is determined so as to minimize the sum of squared residuals, and then under its estimate coefficients are estimated by the usual Ordinary Least Squares (OLS). From statistical points of a threshold regression model, Chan (1993) shows that an estimator of a threshold parameter is super-consistent. Furthermore, Hansen (2000) develops an asymptotic theory to conduct hypothesis tests on a threshold parameter. We take advantage of the method of Hansen (2000) since we can have more statistical confidence in estimated split regimes, which cannot be captured by the well-known standard Markov switching model. In addition, estimation is feasible without complicated assumptions. Too many assumptions like parametric and prior distributions need not be imposed.

On the basis of the views of macroeconomics and econometrics, we employ a threshold regression model to empirically examine whether the degree of ERPT is higher when the exchange rate is more volatile. This paper defines exchange rate volatility estimated by a generalized autoregressive conditional heteroskedasticity (GARCH) model as a threshold variable. By using monthly data for the Japanese domestic corporate goods price index (DCGPI), we estimate a threshold parameter and calculate its confidence intervals by using the method of Hansen (2000). Then we divide the exchange rate volatility into two regimes: between high and low exchange rate volatility, and estimate the accumulated responses of prices to a 1 percent appreciation in the exchange rate in each regime. In order to capture the feature of each industrial sector, we also use the disaggregated DCGPI for estimation.

The main result is that the degree of ERPT is higher and prices are more gradually adjusted in a high exchange rate volatility regime by using the aggregated DCGPI. Another finding is that differences in the degree of ERPT can be explained by each industrial sector. Significant results can be obtained in petroleum and oil products, nonferrous metals, and chemicals and related products. These sectors are associated with imports of raw materials. In other sectors such as general machinery and equipment and transportation equipment, significant results are not obtained. This is because inputs in these sectors are more domestically dependent.

The remainder of this paper is organized as follows. Section 2 presents a review of the econometric method developed by Hansen (2000). The data and regression models are explained in Section 3, and the empirical results are discussed in Section 4. Finally, concluding remarks are provided in Section 5.

[3] Examples of application to nonlinear specification are as follows: Hooker (2002) studies oils and inflation. Benhabib and Spiegel (2009) analyze inflation and GDP growth with a panel approach. Shintani et al. (2009), which is similar to our paper, employs a class of smooth transition autoregressive models in order to investigate ERPT, using U.S. data.

2. Econometric method

In order to capture the asymmetry between exchange rate volatility and price changes, we employ a threshold regression model. Following Hansen (2000), we estimate a threshold parameter and construct its asymptotic confidence intervals. By using the estimated parameter, the following model can be divided into two regimes, and we calculate the accumulated response of prices to a 1 percent appreciation of the exchange rate in each regime. This section provides a review on how to estimate a threshold parameter and how to conduct a hypothesis test.

The estimation model is

$$y_t = \theta' x_t + \delta_n' x_t I_{\{q_t \le \gamma\}} + e_t \tag{1}$$

The observed sample is $\{y_t, x_t, q_t\}_{t=1}^{n}$, where q_t is a threshold variable, y_t is a dependent variable, and x_t is a $k \times 1$ vector of the explanatory variables. ϵ_t is a usual regression error term, and $I_{\{\cdot\}}$ is an indicator function. The unknown parameter $(\theta,\ \delta_n,\ \gamma)'$ is a $(2k+1) \times 1$ vector, and γ is a threshold parameter. As argued in Hansen (2000), $\delta_n = cn^{-\alpha}$, where $c \neq 0$ and $0 < \alpha < 1/2$. In the matrix representation, the model (1) can be written as

$$Y = X\theta + X_\gamma \delta_n + e \tag{2}$$

where Y and e are $n \times 1$ vectors by stacking the variables y_t and e_t, and X and X_γ are $n \times k$ matrices by stacking the vectors x_t' and $x_t' I_{\{q_t \le \gamma\}}$ respectively. Let

$$S_n(\theta, \delta, \gamma) = (Y - X\theta - X_\gamma \delta)'(Y - X\theta - X_\gamma \delta) \tag{3}$$

be a function of the sum of squared residuals.

The least squares estimator jointly minimizes $S_n(\theta, \delta, \gamma)$, where γ is restricted to a bounded set $[\boldsymbol{\gamma}, \overline{\gamma}]$. For estimation, however, the conditional least squares method is used. Thus, for a given γ, $\hat{\theta}(\gamma)$ and $\hat{\delta}(\gamma)$ are obtained by OLS. The concentrated sum of squared residuals can be given by

$$\begin{aligned} S_n(\gamma) &= S_n(\hat{\theta}(\gamma), \hat{\delta}(\gamma), \gamma) \\ &= (Y - X\hat{\theta}(\gamma) - X_\gamma \hat{\delta}(\gamma))'(Y - X\hat{\theta}(\gamma) - X_\gamma \hat{\delta}(\gamma)) \end{aligned} \tag{4}$$

An estimate of a threshold parameter is uniquely determined by minimizing $S_n(\gamma)$

$$\hat{\gamma} = \arg \min_{\gamma \in \Gamma_n} S_n(\gamma) \tag{5}$$

where $\Gamma_n = \Gamma \cap \{q_1, \ldots, q_n\}$.

Hansen (2000) has shown that $n^{1-2\alpha}(\hat{\gamma} - \gamma) = O_p(1)$, and that its asymptotic distribution is nonstandard. In addition, to conduct the hypothesis test $H_0 : \gamma = r$, let us assume that the error term is independently, identically, and normally distributed. Then, the likelihood ratio (LR) statistic is defined as

$$LR_n(r) = n \frac{S_n(r) - S_n(\hat{\gamma})}{S_n(\hat{\gamma})} \tag{6}$$

where $S_n(\hat{\gamma})$ is the sum of squared residuals evaluated at the estimate of a threshold parameter and $S_n(r)$ is one evaluated at the threshold value under a null hypothesis. As derived in Hansen (2000), when the disturbance is homoskedastic, the asymptotic distribution of $LR_n(r)$ is nuisance parameter free. The asymptotic p-value for this test statistic is

$$p_n = 1 - \left\{ 1 - \exp\left(-\frac{1}{2} LR_n \right) \right\}^2 \tag{7}$$

and the critical value at the 5 percent significant level is 7.35.