# Exchange rate exposure of sectoral returns and volatilities: Evidence from Japanese industrial sectors

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## Abstract

Most studies of exchange rate exposure of stock returns do not address three relevant aspects simultaneously. They are, namely: sensitivity of stock returns to exchange rate changes; sensitivity of volatility of stock returns to volatility of changes in foreign exchange market; and the correlation between volatilities of stock returns and exchange rate changes. In this paper, we employ a bivariate GJR-GARCH model to examine all such aspects of exchange rate exposure of sectoral indexes in Japanese industries. Based on a sample data of fourteen sectors, we find significant evidence of exposed returns and its asymmetric conditional volatility of exchange rate exposure. In addition, returns in many sectors are correlated with those of exchange rate changes. We also find support for the ''averaged-out exposure and asymmetries'' argument. Our findings have direct implications for practitioners in formulating investment decisions and currency hedging strategies.
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## 1. Introduction

Modeling exchange rate exposure has been an important growing area of research in the last decade. The literature of exchange rate exposure dates back to early 1940s. Initially, a firm's actual rather than future cash flows are used to analyze the exposure. However, such an approach is inappropriate for practical reasons. For instance, realized cash flows do not capture a firm's operating exposure. Changes in exchange rates may also influence the future activities of the

firm. And, it is not operationally easy to obtain a significant amount of firm-specific information, especially when the study is focused on a large number of firms. Adler and Dumas (1984) give a lucid review of the definition and measurement of exposure to currency risk. More recently, Bodnar and Wong (2003) provide an excellent account of issues in estimating exchange rate exposures.

In this paper we propose a unified approach to address the exchange rate exposure of stock returns. To the best of our knowledge, our approach is the first direct investigation that simultaneously captures three relevant aspects exchange rate exposures including time-varying risk of 14 sectoral returns in Japanese industries. Bivariate GJR-GARCH models are employed to achieve such purposes.

We follow the well-documented approach of Adler and Dumas (1984) and others to take a firm's market value as reasonable proxy to its future operating cash flows. Based on the efficient market hypothesis, exchange rate exposure of a firm is defined as ''the sensitivity of [its] economic value, or stock price, to exchange rate changes'' (Hekman, 1983). Adler and Dumas (1984) show that exchange rate exposure can be obtained by regressing a firm's value on exchange rate. The following augmented market model is often used to estimate exposure coefficients:

$$r_{i,t} = \delta_{0,i} + \delta_m r_{m,t} + \delta_x r_{x,t} + \xi_{i,t}, \quad i = 1, 2, \ldots, n \tag{1}$$

and

$$\xi_{i,t} \sim N(0, \sigma^2)$$

where $r_{i,t}$ is the returns on firm $i$'s stock at time $t$; $r_{m,t}$ the returns on market portfolio at time $t$; $r_{x,t}$ is the changes in exchange rate at time $t$. Here exchange rate is expressed as local currency price of foreign currency; $\delta_m$ is the firm $i$'s exposure to market returns; $\delta_x$ the firm $i$'s exchange rate exposure coefficient which measures the sensitivity of a firm's returns to the exchange rate movements; $\xi_{i,t}$ is the regression residual which is assumed to follow a normal distribution with zero mean and constant variance.

Many earlier studies rely heavily on the standard OLS or SUR method of estimation, with emphasis on the sensitivity of stock returns to changes in exchange rate. Among others, such studies include Jorion (1990), Bodnar and Gentry (1993), Chamberlain et al. (1997), Chow and Chen (1998), Dominguez (1998), He and Ng (1998), and Dominguez and Tesar (2001a, 2001b, 2006), respectively. Among many studies that focus on Japan, Bodnar and Gentry (1993)[1] obtain OLS estimates of monthly exchange rate exposure of industry portfolios,[2] and find that 5 out of 20 Japanese industries are significantly exposed to exchange rate changes. They find that an appreciation in the yen affects favourably on both non-traded goods sector producers and importers, and adversely on exporters and the value of their foreign operations. Dominguez (1998) classifies a sample of 275 Japanese firms into 18 portfolios distinguished by industry type, firm size and degree of internationalization. She finds that 7 out of 18 portfolios are significantly exposed to weekly exchange rate changes. At the firm level, He and Ng (1998) find that most of the 171 firm-returns are positively exposed to depreciation of the yen. They observe that significantly exposed firms are mostly concentrated in three sectors: electric machinery; precision instruments; and transport equipment. Contrary to the findings of He and Ng (1998),

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[1] Besides Japan, they focus on industrial sectors in the US and Canada as well.
[2] The industries are selected from the two-digit level of the Standard Industrial Classification (SIC).