EXPOSURE TO PERMANENT AND TEMPORARY EXCHANGE-RATE SHOCKS OF INDUSTRIES IN THAILAND

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ABSTRACT

The study proposes an alternative approach for testing exposure of firms to foreign exchange risk. It allows asymmetric response of firms to permanent and transitory shocks in the exchange rate in a positive or negative direction. It is motivated by the fact that firms may respond to permanent and temporary shocks in the exchange rate in a different way and that firms may devise business strategies to benefit from currency appreciation and depreciation.

Using monthly, real returns from December 1984 to June 1997 on industries classified by the Stock exchange of Thailand, the study finds that the industries responded to both permanent and transitory shocks and that the response was asymmetric to the shocks in a positive and negative direction. The finding supports the fact that the industries devised strategies to cope with both currency appreciation and depreciation. Moreover, the test proposed by this study can detect significant exposure for many more cases than the conventional tests can. The asymmetric response may help to explain why the conventional tests cannot detect the exposure of firms to foreign exchange risk.

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I. INTRODUCTION

Thailand has an open economy. The exchange rate for the Thai baht had been determined by a basket of currencies since November 1984 before it was switched to a managed floating system in July 1997. The fluctuation of the Thai baht *vis a vis* foreign currencies has important implications to all Thai firms. In the theory, previous studies, e.g., Heckerman (1972), Hekman (1985), Booth and Rotenberg (1990), showed that the value of purely domestic, importing and exporting, and multinational firms could be altered by movement in the exchange rate through resulting changes of future cash flows from operations and accounting translations. However, the studies using data on Thai firms and industries found that the movement of the Thai baht had little impacts on the firms' value (Wattanapronprom et al (1994)). These findings are similar to those for more developed markets such as Australia (1994), Canada (Abeysekera and Mossman (1996)), Germany (Prasad and Rajan (1995)), Japan (Bodnar and Gentry (1993)), the U.K. (Prasad and Rajan (1995)) and the U.S. (Jorion (1990, 1991)).

Alternative explanations as to why significant relationship could not be detected were offered in the literature. Choi and Prasad (1995) proposed that the insignificant relationship was due to the success of hedging strategies of firms. Even though this explanation is convincing for cases in the more developed markets, its application for the Thai case should be limited because hedging instruments are expensive or inexistent in Thailand. Bartov and Bodnar (1994) and Chow et al (1997a) provided evidence for the U.S. and other countries, suggesting that the insignificant relationship was due to lagged adjustment of the firms' value to current change in the exchange rate. Since the Bartov-Bodnar study limited its sample firms to those with significant gain from foreign exchange and the Chow et al study focused only on stock and bond market portfolios, it is not clear whether their results can be generalized to firms which are seemingly exposed but report small or no foreign exchange gain.

This study proposes an alternative explanation based on two observations in the literature. First, shocks from foreign exchange can be decomposed into permanent and temporary shocks. Chow et al (1997b) suggested that only permanent shocks affected the firms' value. However, previous studies, for example, Jorion (1991) and Abeysekera and Mossman

(1996), did not consider the composition of the shocks. So, if Chow et al is correct, it would be difficult for these studies to find significant exposure because the exchange rates being employed were contaminated by transitory shocks.

Second, Srinivasulu (1981) recommended various strategies to firms for coping with currency depreciation and appreciation. So, firms which gained from currency appreciation might not necessarily lose from currency depreciation. They could adjust their investment strategies to gain from currency depreciation as well. If the firms could gain from both currency depreciation and appreciation, the tests proposed by previous studies which imposed symmetric response of the firms' value to the change in the exchange rate would have low power because the effects canceled.

In this study, both the composition and the sign of the shocks are considered. First, shocks in the exchange rate are decomposed into permanent and transitory shocks by the Lastrape (1992) technique. Then, these shocks are grouped based on their signs. This procedure creates four series of the foreign exchange shocks, appropriate for examining how the firms' value responds to positive and negative transitory and permanent shocks.

The study focuses on the exposure of Thai firms to the baht exchange rate. Thailand's stock market is one of the most important market on the Pacific Rim in terms of its growth and size, although its visibility is diminishing due to the country's recent economic turmoil. The economic success of the country predominantly relies on foreign trades and investment. So, it is likely that Thai firms are exposed to changes in the exchange rate. Moreover, the baht exchange rate had been determined by a basket of currency for almost thirteen years, before the system was changed to a managed floating system. Since the baht was determined by the currency basket, its fluctuation was small and artificial. This fact makes the Thai sample during the currency-basket period even more interesting because previous studies employed the data from countries whose exchange systems are managed floating. Using monthly, real returns from December 1984 to June 1997 on industries classified by the Stock exchange of Thailand, the study finds that the industries responded to permanent and transitory shocks in the exchange rate and that the response was asymmetric to positive and negative shocks. It suggests that the industries devised strategies to cope with both currency appreciation and depreciation. Moreover, the approach proposed by this study can detect significant exposure for many more cases that the conventional tests can. So, the asymmetric response may help to explain why the conventional tests cannot detect the exposure of firms to foreign exchange risk.

The organization of this study is the following. Section II reviews previous literature on foreign exchange exposure. Section III proposes a new approach for investigating the exposure. Section III discusses the data to be employed. Section IV reports and analyzes the results. Section V concludes and suggests directions for further research.

II. LITERATURE REVIEW

II.1 Foreign Exchange Exposure

Firms which operate in an open economy are exposed to foreign exchange risk. Some theories suggested that the risk was not important because the system would adjust to neutralize the effect, the investors could manage the risk by themselves, or the market did not price the risk. But Dufey and Srinivasulu (1983) argued that firms should manage the exposure because the certain conditions to obtain the results might not hold true in reality, it was less expensive if the risk was managed by firms, or lower capital cost and less financial distress could be achieved.

Wihlborg (1980) and others classified foreign exchange exposure into transaction, translation and economic exposure. Transaction exposure is defined as an uncertain domestic currency value of open position denominated in a foreign currency with respect to a known transaction, while translation exposure is defined as an uncertain domestic value of a net accounting position denominated in a foreign currency at a certain future date. Economic exposure is the exposure that previous studies were interested in. It is the uncertain value of the firm in domestic currency resulting from the impact of changing exchange rate on the firm's current and future cash flows. The three types of exposure are not independent. Choi (1986) pointed out that transaction and translation exposure could affect cash flows and economic exposure due to tax treatments and other inefficiencies in the market.

II.2 Measuring Foreign Exchange Exposure

Ang and Ghallab (1976) studied the effect of dollar devaluation in 1971 on U.S. multinational firms. Their approach to examining foreign exchange exposure was unique. The authors proposed that if the devaluation had any effect on the firms' value, there had to be significant abnormal returns on the firms' stocks around the announcement of the devaluation. Using monthly returns from January 1969 to December 1973 on the U.S. multinational firms whose foreign sales were greater than 50 percent of total sales in 1970, Ang and Ghallab found

that the cumulative abnormal returns had been declining before the dollar devaluation was announced. But after the announcement, the abnormal return jumped immediately to reflect net gain from the devaluation.

Adler and Dumas (1984) proposed that the firm's value could be decomposed into an exposed and unexposed parts and only the exposed part was the only part that could be hedged. Adler and Dumas then suggested that the exposure could be measured by regression coefficients of the firm's value on interesting exchange rates. Their approach to measuring foreign exchange exposure is now common in the literature.

II.3 Theories on Foreign Exchange Exposure

Researcher proposed alternative explanations as to how foreign exchange could affect the firm's value. Hekerman (1972) noticed that the firm's value was the domestic and foreign assets net of domestic and foreign liabilities plus the present value of the firm's future income from local and foreign operations. Since the change in exchange rate affected the translation values of assets and liabilities as well as the income in the in the future, the firm's value had to change accordingly.

Shapiro (1975) modeled the structure of profit made by a multinational firm as a function of production, prices, costs, and taxes in the local and foreign markets. A change in foreign exchange rate could affect the firm's value through a change in profit, resulting from the price and cost structure and the production strategy of the firm. Shapiro's analysis was interesting in that it considered the firm's profit maximizing behavior explicitly by allowing the firm to modify its production in response to the exchange rate change.

Dumas (1978) considered a three-period model of a firm which produced and exported its goods for foreign currency in the first and second periods. But it could collect money in the following periods. Dumas showed that this exporting firm had transaction exposure from the goods that were already sold and economic exposure for an uncertain amount of goods to be sold in the future at an uncertain level of exchange rate. Dumas analyzed further if the firm's value could be maximized by a hedging strategy. He found that if the forward market was perfect and the forward rate was an unbiased predictor of the future exchange rate, forward hedging could not increase the firm's value. In his model, hedging was useful only when the firm had bankruptcy costs because hedging minimized the probability of bankruptcy.

The analysis of Hodder (1982) was similar to that of Hekerman (1972). It considered the firm's value as composing of assets, liabilities and future earnings. In order to relate the movement in the exchange rate with the firm's value, Hodder noticed that the firm's value moved randomly with local and foreign inflation, the exchange rate, and the firm's distribution of assets and liabilities. Since the exchange rate was correlated with the inflation and itself, the firm's value and the exchange rate had to move together. And, the size of the correlation was determined by the firm's allocation of its assets and liabilities in the domestic and local countries.

Hekman (1985) decomposed the firm's value into the value of unlevered equity plus the value of debt and the value of hedged transactions. She then modeled these values as the corresponding present values of expected cash flows in the future, which in turn were affected by the current and future exchange rates. Since the expectations of future exchange rates were formed, conditioned on the current exchange rate, a change in current exchange rate led the market to revise its expectations on the future exchange rate. Hence, the firm's value had to change. This analysis was very important because it related the firm's value to a changing exchange rate through revised expectations.

Foreign exchange exposure was analyzed for a firm in a discount cash flow framework by Choi (1986). In that study, the firm's value was the present value of net cash flows generated from the firm's local and foreign sales. Choi showed that the exposure of the firm resulted from the sensitivity of production, output price, and input cost to the exchange rate. Choi also expressed that even a pure domestic firm could be exposed because the production, price, and cost of the firm was not insensitive to the exchange rate.

Like Hodder (1982), Booth and Rotenberg (1990) recognized that there could be deviations from the purchasing power parity. These deviations could persist if their sizes were not greater than the arbitrage band. But the deviations from the purchasing power parity caused the real exchange rate to change. The change in the real exchange rate resulted in the firm's competitive ability in the international markets.

Finally, Choi et al (1992) proposed a model for analyzing the exposure of bank to interest-rate risk, exchange-rate risk and default risk. In their model, the bank allocated its deposits and loans in the domestic and foreign markets in order to maximize profit. The degree of foreign exchange exposure depended on the gap between deposits and loans in the foreign markets and the correlation of foreign exchange risk with interest and default risk.

In sum, the previous literature pointed to the fact that all firms ranging from pure domestic firms to multinational firms were exposed to foreign exchange risk by the sensitivity of the production, price, cost and, as the result, future cash flows to the exchange rate. The following section reviews empirical evidence on the exposure of firms in developed and emerging markets.

II.4 Empirical Evidence on Foreign Exchange Exposure

Previous studies examined foreign exchange exposure for firms in developed and emerging markets. It is surprising that only a few studies could find significant exposure, even though the sample firms had high degree of foreignness.

II.4.1 Significance of Exposure

In an early study, Ang and Ghallab (1976) examined the effects of the 1971 dollar devaluation on U.S. multinational firms by an event-study approach. Using monthly returns from January 1969 to December 1973 on fifteen firms whose foreign sales in 1970 exceeded fifty percent of the total sales, Ang and Ghallab found the cumulative abnormal returns were declining before the devaluation, but they jumped immediately after the devaluation was announced. This finding suggested that these multinational firms were exposed to foreign exchange. The declining cumulative abnormal returns reflected the impact of the expectations of possible devaluation on the firms' value. Once the devaluation was announced, the returns jumped to reflect the resulting gain.

In a study of exposure of U.S. firms in aggregate, Aggrawal (1981) followed the Adler-Dumas (1984) approach in regressing the returns on NYSE, S&P500 and DC500 market portfolios on the trade-weighted average dollar value with the U.S.' 42 largest trading partners. The sample period was from July 1974 to December 1978, during which the dollar exchange rate was floating. Aggrawal found that the coefficients for all the market returns were positive and significant. So, he concluded that the U.S. firms were exposed positively to the exchange rate.

Later studies found significant exposure for only a few U.S. firms and industries. Jorion (1990) studied exposure of 287 U.S. multinational firms from January 1971 to December 1987 with the MERM trade-weighted dollar exchange rate. It was found that most of the exposure coefficients were small and not significant. Jorion argued that the insignificant

coefficients might not necessarily imply that the true coefficients were zero, but that the coefficients were estimated imprecisely.

Jorion (1991) examined foreign exchange exposure of U.S. firms by a multi-factor model. The study considered the impact of six shocks from the market, industrial production, inflation, default-risk premium, term structure, and exchange rate. Using monthly returns from January 1971 to December 1987 on twenty 2-digit SIC portfolios, Jorion found that the exposure coefficients were significant only for four portfolios when the shocks from the market and from exchange rate were considered and only for seven portfolios when all the six shocks were considered. Jorion also found that the foreign exchange risk was not priced by the market.

Bodnar and Gentry (1993) studied foreign exchange exposure of U.S. firms at an industry level from January 1979 to 1988. Their sample period was shorter than but overlapping with that of Jorion (1991). More industries were examined by this studies. However, the results were similar. Using monthly returns on thirty-nine 2-digit SIC portfolios, Bodnar and Gentry found that the exposure coefficients were significant only for eleven industries.

The study of Jorion (1991) was repeated by Prasad and Rajan (1995) for the U.S. industries, but with a different sample period from January 1981 to December 1989. Again, the results were unchanged. Prasad and Rajan reported that only five out of twenty 2-digit SIC portfolios had significant exposure coefficients.

Insignificant exchange rate exposure was found for other countries. Bodnar and Gentry (1993) studied exposure at an industry level for Canada and Japan. The portfolios being considered were nineteen Canadian and twenty Japanese 2-digit SIC portfolios. The Canadian sample was monthly returns from January 1979 to December 1988 and the Japanese sample was monthly returns from August 1983 to December 1988. Bodnar and Gentry found that only four Canadian portfolios and seven Japanese portfolios had significant exposure coefficients.

Foreign exchange exposure from January 1981 to December 1989 was examined by Prasad and Rajan (1995) for Germany, Japan and the U.K. The authors employed monthly returns on twelve German, twenty five Japanese, and seventeen U.K. 2-digit SIC portfolios. They found that only two German, one Japanese, and two U.K. portfolios had significant exposure.

For Thailand, foreign exchange exposure was examined at an industry level by Wattanapronprom et al (1994). In its tests, that study used monthly returns on the market and

five major sectorial portfolio constructed by the Stock Exchange of Thailand. The sample period was from January 1986 to December 1991. It was found that the Thai market and industries did not have significant exposure coefficient with the shocks from the baht-U.S. dollar exchange rate.

It could be argued that foreign exchange exposure was not significant for markets and industries because exposure of individual firms was different in size and direction. So, the effect canceled when firms were aggregated into portfolios. However, the results in previous studies which employed stock returns on individual firms did not support this argument. Khoo (1994) examined exposure of seventy seven mining firms in Australia from January 1980 to March 1987 and found that only twenty firms reported significant exposure coefficients.

Abeysekera and Mossman (1996) studied exposure of Canadian firms to the trade-weighted exchange rate from January 1980 to December 1992. The authors reported that among 1,476 firms on the Toronto Stock Exchange, only 126 firms had significant coefficients. Abeysekera and Mossman also considered sixteen Canadian multinational firms in their sample separately. They found a similar result that the coefficients were small when compared with the standard errors.

II.4.2 Possible Explanations for Insignificant Exposure

A. Degree of foreignness. Shapiro (1975), Choi (1986) and others proposed that changes in the exchange rate affected the firm's value directly through future cash flows from foreign operations. So, one may expect large exposure for firms whose cash flows are predominantly foreign in nature. A popular reference of the research along this argument is Jorion (1990). In that study, Jorion examined exposure of U.S. multinational firms from January 1971 to December 1987. Jorion found only a few firms with significant exposure. However, in the cross-sectional regression of the exposure coefficients on the firms' foreign sales, it was found that the foreign sales could explain the degree of exposure. This finding implied that the insignificant exposure was due to insignificant cash flows in foreign currencies.

In a study of foreign exchange exposure of Canadian firms, Booth and Rotenberg (1990) limited their sample to those firms on the Toronto Stock Exchange, which reported material foreign transactions and/or operations in 1979. They had 156 firms in their sample. Using monthly returns from January 1979 to December 1983, Booth and Rotenberg found a striking results that one hundred and thirteen of these sample firms had significant exposure

coefficients. This finding was consistent with Jorion (1990) in that firms with a high degree of foreignness had significant exposure.

Bodnar and Gentry (1993) followed Jorion (1990) in using variables which indicated degree of foreignness to explain the exposure of firms in Canada, Japan and the U.S. But they considered more explanatory variables, including the dummy for non-traded goods industries, the export-to-total domestic production ratio, the import-to-total domestic production ratio, the foreign-asset-to-total-asset ratio, and the percentage of final product value spent on internationally priced inputs. In their tests, they could not reject the hypotheses that these variables explained the exposure jointly.

Choi and Prasad (1995) proposed a model which related the degree of exposure with the degree of foreignness through the sizes of foreign sales, assets, and profits. This model helped to justify the proceeding tests performed by Jorion (1991) and Bodnar and Gentry (1994). Choi and Prasad also offered empirical justification for their model. They examined the relationship of the exposure coefficients of 409 U.S. multinational firms with the sizes of foreign sales, assets, and profits. Their sample was from January 1978 to December 1989. They found that these explanatory variables varied positively with the exposure coefficients, thereby justifying the argument of degree of foreignness.

Nevertheless, in a recent study, Bartov and Bodnar (1994) hypothesized that the reason why firms with foreign operations did not have significant exposure was due to the small size of their gain or loss from the exchange rate. To test their hypothesis, Bartov and Bodnar focused only on U.S. firms with significant foreign exchange gain or loss (greater than 5 percent of pre-tax income in three or more out of five years). There were 208 qualified firms for the sample period from 1978 to 1989. Their finding was opposite to those in the previous studies. When Bartov and Bodnar regressed the firms' abnormal returns on the change in exchange rate, they found no response of the firms' value to the change.

B. Success of hedging strategies. Bodnar and Gentry (1993) noted that the exposure measured by the previous studies was the net exposure after firms had hedged their positions. The hedging strategies might be so successful such that the net exposure was very small and standard tests could not detect it. This argument was supported by Eun and Resnick (1988) who showed that performance of international investment could be improved if foreign exchange risk was hedged fully.

In reality, firms used financial instruments to hedge against exchange rate risk. A recent survey by Bodnar et al (1996) reported that U.S. firms preferred forward coverage to manage their exchange risk and they seemed to concern more on the anticipated foreign transactions and contractual commitments. Although firms answered that they used forward contracts to manage their exchange risk, Fieleke (1981) found that the position in forward contracts might not be explained by the firms' positions in foreign currencies. In his study of the behavior of U.S. bank and non-bank firms from March 1975 to March 1978, only positions in the Japanese yen and U.K. pound but not the Canadian dollar could explain the positions in forward contracts of the sample firms. And, although the positions in the Japanese yen and Canadian dollar had explanatory power, the signs of the coefficients were wrong. The study also found that bank firms tended to cover their positions more than non-bank firms.

Even though firms hedged their positions in foreign currency, the hedging might or might not be successful. Grammatikos et al (1986) studies management of foreign exchange risk by U.S. banks from December 1975 to November 1981. They found that these banks managed their asset and liability gaps in the U.S. dollar and foreign currencies and hedged the gaps by forward contracts. Despite active management, the resulting volatility was much higher than what was expected if the risk was managed optimally. This finding pointed to a failure of the management of foreign exchange exposure.

Nance et al (1993) proposed that only large firms tended to manage their foreign exchange exposure while smaller firms tended not to. So, if these researchers were correct, one would expect that larger firms would have smaller exposure and smaller firms would have larger exposure. Chow et al (1997b) tested the Nance et al (1993) proposition, using the exposure of 213 U.S. multinational firms from March 1977 to December 1991. In their cross-sectional regressions of the exposure coefficients on asset sizes and foreign sales, it was found that the asset sizes were negatively related with the coefficients. This result supported the proposition of Nance et al. Moreover, it was interesting to find that once the asset sizes were included, the foreign sales could not explain the coefficients in any but one regression.

C. Lagged adjustment to foreign exchange shocks. Bartov and Bodnar (1994) and Chow et al (1997a) noticed the insignificant exposure of seemingly exposed firms found by previous studies. These researchers proposed that the insignificant exposure could result from lagged, not contemporaneous, adjustment of the firm's value to the foreign exchange shocks. In order to test this proposition, Bartov and Bodnar collected a sample of 208 U.S. firms with

significant exchange gain or loss. This sample selection was intended to ensure that the sample firms were exposed firms. Then Bartov and Bodnar regressed abnormal returns of these firm on the contemporaneous and lagged exchange rates. If lagged adjustment explained the insignificant exposure, the regression coefficients of lagged exchange rates had to be significant and that of the contemporaneous exchange rate had to be zero. Bartov and Bodnar reported that their tests could not reject this hypothesis.

The finding of Bartov and Bodnar (1994) was supported by Roll (1992) who examined the explanatory power of local currency-U.S. dollar exchange rates on returns on twenty four national market portfolios. Roll regressed the national market returns on contemporaneous, leading, and lagging exchange rates as well as other variables which described industry characteristics. He reported that these exchange rate variables could jointly explain the returns in twenty two countries.

Chow et al (1997a) proposed an alternative test of the lagged adjustment hypothesis. They argued that if the exchange rate contained information on the interest and cash flow effects to firms for more than one period, short-horizon data would not have enough information to detect the exposure. So, they recommended long-horizon data be used. Chow et al considered long-horizon excess returns on value- and equal-weighted U.S. stock-market portfolios during March 1977 and December 1989. They found that the exposure coefficients were not significant for one- and three-month returns. However, when the horizon was lengthened to six months or longer, the coefficients became highly significant. The significant exposure for long-horizon returns supported the lagged adjustment proposition.

D. Time-varying exposure. Booth and Rotenbreg (1990) developed a discount cash flow model to explain foreign exchange exposure of firms. In their model, the exchange rate affected the firms' value because the firms lost or gained international competitiveness, resulting from deviations from the PPP's no-arbitrage bands. Since the band could vary over time, the firms' exposure had to vary over time as well.

In their test of foreign exchange exposure for U.S. banks, Choi et al (1992) took the time-varying nature of the exposure into consideration, although their reason was fundamentally different from that of Booth and Rotenberg. Choi et al noticed that there was an upward shift in the volatility of interest rate after October 1979. So, their regression incorporated the October-1979 dummy in order to examine the exposure before and after October 1979 separately. The data were monthly returns from January 1975 to December 1987 on 48 largest

U.S. commercial banks. It was found that the two exposure coefficients were highly significant. However, when the sample period was broken in a different way, the results were not so strong. In a separate test, Choi et al also found that the exposure could be different for money-center banks and other banks.

E. Exchange-rate shocks. Adler and Dumas (1984) defined economic exposure to foreign currency risk as the exposure of the firm's value to unexpected exchange rate variation. Choi et al (1992) expressed that a study of foreign-exchange exposure had to consider only the unexpected part of the exchange-rate change, not the realization of the change. This was because the firm's value might have had adjusted to the expected change and only the unexpected change affected the current change in value. Chow et al were successful in detecting significant exposure in their tests.

It should be noted that there were studies which considered unexpected changes in the exchange rate, but did not find significant exposure, for example, Jorion (1991)[1] and Wattanapronprom et al (1994). The difference in the findings might be due to different data sets or different approaches to obtain the unexpected exchange-rate change.

Lastrape (1992) showed that shocks in the exchange rates could be decomposed into permanent and transitory shocks. And Chow et al (1997b) suggested that only the permanent shocks should affect the firm's value. Following Choi et al (1992), this study proposes that, if Chow et al was correct, it would be difficult for tests which considered the permanent and transitory shocks in aggregate to detect the exposure. However, none of the previous studies had explicitly considered the firm's exposure to permanent shocks and transitory shocks. In Section III, a model to examine the firm's exposure to permanent and transitory shocks is proposed. In that model, permanent and transitory shocks in the real exchange rate will be recovered by the Lastrape (1992) procedure before their relationship with the firm's value is analyzed.

III. METHODOLOGY

This study analyzes exposure of a firm to permanent and temporary shocks in the real exchange rate. Let R_{it} be the real rate of return on firm i realized at time t. R_{it} can be

[1] Jorion (1990) pointed out that actual variation in the spot rate could not be explained by the forward premium or an ARIMA model. Hence, most of the variation in the spot rate should be unanticipated.

decomposed into the expected return $E(R_{it} | \Omega_{t-1})$ conditioned on the information Ω_{t-1} and the unexpected return ξ_{it}. That is,

$$R_{it} = E(R_{it} | \Omega_{t-1}) + \xi_{it}. \quad (1)$$

According to Adler and Dumas (1984), if firm i is exposed to foreign exchange risk, ξ_{it} must be explained by unanticipated changes in the real exchange rate. Lastrape (1992) noticed that the real exchange rate was integrated of order 1. So, its shocks had to consist of permanent and transitory shocks. Let ϖ_{Pt} and ϖ_{Tt} be permanent and transitory shocks in the real exchange rate, respectively. ϖ_{Pt} and ϖ_{Tt} are orthogonal by construction. Firm i's exposure to ϖ_{Pt} and ϖ_{Tt} is measured by the coefficients α_{iP} and α_{iT} in the following model.

$$\xi_{it} = \alpha_{iP}\varpi_{Pt} + \alpha_{iT}\varpi_{Tt} + \alpha_{iM}\varpi_{Mt} + \eta_{it} \quad (2)$$

where ϖ_{Mt} is the market shock and α_{iM} measured the exposure of firm i to ϖ_{Mt}. η_{it} is the part of ξ_{it} which cannot be explained by ϖ_{Pt}, ϖ_{Tt}, and ϖ_{Mt}. ϖ_{Mt} is orthogonal to ϖ_{Pt} and ϖ_{Tt}. It is considered because previous studies, for example, Jorion (1990), noted that variation of the firm's return could be due to the market shock.

Since the shocks ϖ_{Pt}, ϖ_{Tt}, and ϖ_{Mt} are not observed, this study will have to extract them from the data. Let $X_t = \begin{pmatrix} Z_t \\ S_t \\ R_{Mt} \end{pmatrix}$ be a (3×1) vector, where Z_t is the rate of change of real exchange rate, S_t is the rate of change of nominal exchange rate. and R_{Mt} is the real return on the market portfolio. All the elements in X_t are de-meaned. If the variable vector X_t is stationary, its motion can be described by a structural vector autoregression (VAR) model of order q. That is,

$$X_t = A_0X_t + A_1X_{t-1} + \ldots + A_qX_{t-q} + \omega_t \quad (3)$$

where $\omega_t = \begin{pmatrix} \varpi_{Pt} \\ \varpi_{Tt} \\ \varpi_{Mt} \end{pmatrix}$ is a (3×1) vector of the structural shocks. A_j is the coefficient matrix corresponding to X_{t-j} and j=0,1,...,q. The diagonal elements of A_0 must be zero to avoid the trivial case. It is assumed that ω_t is distributed as a multivariate normal variable with a zero mean vector and a diagonal covariance matrix $\sum$.

At this state, since the parameters have not been restricted, ϖ_{Pt}, ϖ_{Tt} and ϖ_{Mt} cannot be interpreted as being a permanent shock, temporary shock, and market shock just yet. In order to obtain ϖ_{Pt} and ϖ_{Tt} as the permanent and transitory shock, this study follows Lastrape (1992) in noticing that the structural VAR in eq. (3) implies a standard VAR of order q.

$$X_t = \prod_1 X_{t-1} + \prod_2 X_{t-2} + \ldots + \prod_q X_{t-q} + \varepsilon_t \qquad (4)$$

where $\prod_k = (I-A_0)^{-1}A_k$, where k=1,2,..., q. $\varepsilon_t = (I-A_0)^{-1}\omega_t$, whose mean vector is zero and covariance matrix is $\Psi = (I-A_0)^{-1}\sum((I-A_0)^{-1})^T$. X_{t-j}, where j=1,2,...,q, can be interpreted as the conditioning information to form the expectation of X_t. So, in eq. (4), $\prod_1 X_{t-1} + \prod_2 X_{t-2} + \ldots + \prod_q X_{t-q}$ is the part of X_t that is anticipated and ε_t is unanticipated.

Lastrape pointed out that the long-run effects of ω_t on $\mathbf{x}_t$ is

$$\lim_{k\to\infty} \frac{\partial x_t}{\partial \omega_{t-k}} = B = \prod_1 (I-A_0)^{-1}, \qquad (5)$$

where x_t is the matrix of the logged indices of real exchange rate, nominal exchange rate, and market portfolio, corresponding to the elements of X_t. This study imposes restrictions on B as in eq. (6).

$$B = \begin{pmatrix} b_{11} & 0 & 0 \\ b_{12} & b_{22} & 0 \\ b_{31} & b_{32} & b_{33} \end{pmatrix}. \qquad (6)$$

The restriction in the first row follows Lastrape (1992). It implies that persistence of Z comes from the permanent effect of ϖ_P alone. By the restriction, since ϖ_T and ϖ_M do not have a permanent effect, they are temporary shocks to the real exchange rate by definition. The

restriction in the second row allows persistence of S to come from either ϖ_P or ϖ_T but not from ϖ_M. Finally, the restriction in the third row suggests that persistence in the return on the market portfolio can come from ϖ_P, ϖ_T or ϖ_M. The restrictions in the second and third rows on S and R_M are not rigid. If ϖ_P, ϖ_T or ϖ_M do not have permanent effects on S or R_M, their corresponding coefficients in B will be zero.

From eq. (4), the matrix $C=(I-A)^{-1}$ governs the correlation among the unexpected changes in Z_t, S_t and R_{Mt}. Previous studies, e.g., Jorion (1990) and Abeysekera and Mossman (1996), considered only the part in the exchange rate shock that was uncorrelated with the market movement. This study will follow the previous studies in considering only the uncorrelated part. In this framework, the matrix C will be restricted to

$$C = \begin{pmatrix} c_{11} & c_{12} & c_{13} \\ c_{21} & c_{22} & c_{23} \\ 0 & 0 & c_{33} \end{pmatrix}. \qquad (7)$$

This restriction imposes that ϖ_{Mt} is the pure market shock because it can explain the unanticipated movement in R_{Mt} completely. Furthermore, ϖ_{Pt}, ϖ_{Tt} and ϖ_{Mt} together explain the unanticipated movement of Z_t and S_t. So, under this restriction, one can interpret ϖ_P and ϖ_T as being the shocks that explain the portions of the unanticipated changes in Z_t and S_t, unexplained by ϖ_M.

To extract the structural shocks ϖ_{Pt}, ϖ_{Tt} and ϖ_{Mt} with the desired properties, this study will use maximum likelihood to estimate the standard VAR in eq. (4) with the restrictions in eqs. (5), (6) and (7) imposed on the parameter matrices $\prod_1$ and $(I-A_0)$.[2] ϖ_{Pt}, ϖ_{Tt} and ϖ_{Mt} are recovered from the estimated $(I-A_0)$ and ε_t with respect to the relationship $\omega_t = (I-A_0)\varepsilon_t$ in eq. (4).

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[2] To ensure that $(I-A_0)^{-1}$ can be inverted, $(I-A_0)^{-1}$ will be estimated indirectly from the product of its elementary matrices. Note that $(I-A_0)$ must have unit diagonal elements. This property is obtained by scaling the inverse of the estimated matrix $(I-A_0)^{-1}$ by matrix $\beta = \begin{pmatrix} \frac{1}{\beta_{11}} & 0 & 0 \\ 0 & \frac{1}{\beta_{22}} & 0 \\ 0 & 0 & \frac{1}{\beta_{33}} \end{pmatrix}$, where β_{jj} is the diagonal element (j,j) of the estimated $((I-A_0)^{-1})^{-1}$. The inverse of the scaled $((I-A_0)^{-1})^{-1}$ is regarded as $(I-A_0)^{-1}$ in the recovering process of ε_t.

From eq. (4), the conditioning information is $X_{t-1}, X_{t-2}, \ldots, X_{t-q}$. This study will assume that the expected return $E(R_{it} | \Omega_{t-1})$ of firm i is linear in the information. That is,

$$E(R_{it} | \Omega_{t-1}) = \Phi_0 + \Phi_1 X_{t-1} + \ldots + \Phi_q X_{t-q} \tag{8}$$

where Φ_j is a (1×3) coefficient vector corresponding to X_{t-j}. j=1,2,...,q.

The test of exposure to permanent and temporary shocks in the real exchange rate considers the regression in eq. (9). This regression is derived from eqs. (1), (2), and (8).

$$R_{it} = \Phi_0 + \Phi_1 X_{t-1} + \ldots + \Phi_q X_{t-q} + \alpha_{iP} \varpi_{Pt} + \alpha_{iT} \varpi_{Tt} + \alpha_{iM} \varpi_{Mt} + \eta_{it} \tag{9}$$

Following Adler and Dumas (1984), this study will measure the exposure of firm i to permanent and transitory shocks by the coefficients α_{iP} and α_{iT}, respectively.

The structure of α_{iP} and α_{iT} in eq. (9) implies that if firm i gains from exchange-rate appreciation, it will lose from depreciation or vice versa. However, Srinivasulu (1981) suggested various strategies for firms to benefit from both appreciation and depreciation of the exchange rates. If firm i is successful in implementing these strategies, eq. (9) will not be able to describe firm i's exposure.

In order to correct the possible deficiency of eq. (9), this study will separate the exposure into the exposure to positive and negative shocks. Let D^+_{Pt}, D^-_{Pt}, D^+_{Tt} and D^-_{Tt} be dummy variables whose values depend on ϖ_{Pt} and ϖ_{Tt}. D^+_{Pt} is 1 if ϖ_{Pt} is greater than zero. Otherwise, D^+_{Pt} will be set to 0. D^-_{Pt} is set to 1 if ϖ_{Pt} is less than or equal to zero and it is set to 0 if ϖ_{Pt} is greater than zero. D^+_{Tt} and D^-_{Tt} are set in a similar fashion with respect to ϖ_{Tt}. Taking the signs of ϖ_{Pt} and ϖ_{Tt} into account, eq. (9) can be modified to

$$\begin{aligned} R_{it} = {} & \Phi_0 + \Phi_1 X_{t-1} + \ldots + \Phi_q X_{t-q} + \alpha^+_{iP} D^+_{Pt} \varpi_{Pt} + \alpha^-_{iP} D^-_{Pt} \varpi_{Pt} \\ & + \alpha^+_{iT} D^+_{Tt} \varpi_{Tt} + \alpha^-_{iT} D^-_{Tt} \varpi_{Tt} + \alpha_{iM} \varpi_{Mt} + \eta_{it}, \end{aligned} \tag{10}$$

where superscripts + and - over the exposure coefficients α_{iP} and α_{iT} indicate that it is the exposure to positive and negative shocks, respectively.

IV. THE DATA

The data are monthly, real returns on sectorial portfolios of firms listed on the Stock Exchange of Thailand. The sectors are classified by the Stock Exchange of Thailand, based on the firms' major operations. The reason why the exposure is considered at an industry level is that operations of firms in the same sectors are similar and that previous studies did not suggest any gain if the data on individual firms were used. Table I summarizes the sectors to be studied and their corresponding sample period. The sample periods began December 1984--one month after Thailand had switched to a basket-of-currency system, or the first month which the sectors had started, which ever month came later. All the sample period ended June 1997, one month before Thailand had switched from the basket system to a managed floating system.

TABLE 1

The Sample Periods

SECTOR	SAMPLE PERIOD	SECTOR	SAMPLE PERIOD
Agribusiness	12:84-06:97	Insurance	12:84-06:97
Banking	12:84-06:97	Jewelry and Orname.	05:89-06:97
Building and Furni.	12:84:06:97	Machinery and Equip.	08:91-06:97
Chemicals and Plasti.	12:04-06:97	Mining	12:84-06:97
Commerce	12:84-06:97	Packaging	12:84-06:97
Communication	04:91-06:97	Pharmaceutical Prod.	10:88-06:97
Electrical Products	12:84-06:97	Printing and Publish.	01:85-06:97
Electronic Compo.	09:88-06:97	Professional Services	08:87-06:97
Energy	12:84-06:97	Property Develop.	07:88-06:97
Entertainment	10:89-06:97	Pulp and Paper	12:84-06:97
Finance and Secur.	12:84-06:97	Text, Cloth., and Foot.	12:84-06:97
Foods and Beverages	12:84-06:97	Transportation	01:89-06:97
Health Care Services	12:84-06:97	Vehicles and Parts	12:84-06:97
Hotels and Travel S.	12:84-06:97	Warehouse and Silo	12:84-06:97
Household Goods	12:84-06:97	Others	05:91-06:97

The returns are real returns on the SET sectorial portfolios and are equal to the nominal returns minus inflation. The nominal returns are the difference of logged sectorial indices and the rate of inflation is the difference of logged consumer price index. This study obtains the sectorial indices from the Stock exchange of Thailand and the consumer price index from DataStream. The real return on the market portfolio is the nominal return minus inflation, where the nominal market return is the difference of logged SET index.

For the exchange rates, this study considers both real and nominal effective exchange rate, constructed by the Research Institute at Securities One. The effective rates are a trade-weighted indices of the baht real and nominal exchange rates with Thailand's major trading partners (the U.S., the U.K., Germany, Japan, Singapore, Malaysia, and Hong Kong). A positive rate of change suggests that the baht is depreciating.

Permanent shocks in the real exchange rate in the key variable that this study is interested in. Lastrape (1992) noted that the permanent shocks existed only if the real exchange rate was non-stationary in its level. So, this study tested for unit root in the logged real exchange rate and its difference. The test could not reject the unit root hypothesis for the real exchange rate, but it could reject the hypothesis for the difference.[3] The finding suggests that there exist permanent shocks in the baht real exchange rate.

VI. THE RESULTS

Before it begins the tests for industries' exposure to permanent and transitory shocks in the exchange rate, this study repeats the conventional tests for foreign exchange exposure as was suggested by Adler and Dumas (1984), Jorion (1991) and others. Table 2 reports the exposure coefficients from two regression. In the first regression, the real return on the sectorial portfolio is regressed on the rate of change of the baht real exchange rate. According to Adler and Dumas (1984), the coefficient b_i is the exposure coefficient. From column 2 of Table 2, the coefficients are significant only for seven out of thirty sectors. The finding that the coefficients

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[3] The test is a Dickey-Full test of the following form.

$$\Delta y_t = \gamma_0 + \gamma_1 y_{t-1} + \upsilon_t,$$

where y_t is the variable of interest at time t and Δy_t is the difference of y. If y_t has unit root, γ_1 must be zero. The resulting test statistics for the logged real exchange rate is -2.94, while that of its difference is -12.93. For a sample size of 100, the critical value is -3.51 and -2.89 at 99% and 95% confidence levels, respectively.

TABLE 2

Tests for Foreign Exchange Exposure

This table reports tests for foreign exchange exposure. In the tests, the following regressions are considered.

$$R_{it} = a_i + b_i R_{et} + e_{it}$$

$$R_{it} = \alpha_i + \beta_{Mi} R_{Mt} + \beta_{ei} \xi_{et} + \eta_{it}$$

where R_{it} is the real rate of return on sectorial portfolio i, R_{et} is the rate of change of the real baht exchange rate, R_{mt} is the real rate of return on the market portfolio, and ξ_{et} is the regression residual of R_{et} on R_{mt}. e_{it} and η_{it} are regression residuals. Exposure coefficients are b_i and β_{ei}. Superscripts a, b and c indicate significance at 99%, 95% and 90%, respectively.

SECTOR	EXPOSURE COEFFICIENT	
	b_{ei}	β_{ei}
Agribusiness	-0.5321	0.1485
	(-0.9099)	(0.4143)
Banking	-0.2951	0.3215
	(-0.5796)	(1.1126)
Building and Furni.	-0.3785	0.3651
	(-0.6406)	(1.1970)
Chemicals and Plasti.	-0.3439	0.3255
	(-0.4362)	(0.6168)
Commerce	-0.2993	0.2551
	(-0.6278)	(0.8771)
Communication	-1.5315	-0.6612
	(-1.2446)	(-0.8701)
Electrical Products	-1.2188[b]	-0.5972[c]
	(-2.1932)	(-1.6481)
Electronic Compo.	-1.2661	-0.2486
	(-1.3101)	(-0.3419)

TABLE 2

(Continued)

SECTOR	EXPOSURE COEFFICIENT	
	b_{ei}	β_{ei}
Energy	-1.2630[c]	-0.6689
	(-1.6653)	(-1.0331)
Entertainment	-0.7800	0.3994
	(-0.7568)	(0.5281)
Finance and Secur.	-1.2819	-0.1450
	(-1.4787)	(-0.3724)
Foods and Beverages	-0.5478	-0.0289
	(-1.1274)	(-0.0861)
Health Care Services	-0.3815	-0.0246
	(-0.7451)	(-0.0541)
Hotels and Travel S.	-0.3496	0.7264
	(-0.5644)	(0.6105)
Household Goods	-1.2234[c]	-0.8915
	(-1.8404)	(-1.4117)
Insurance	-0.4040	0.0330
	(-0.8973)	(0.0937)
Jewelry and Orname.	-0.0606	1.0598
	(-0.0627)	(1.4471)
Machinery and Equip.	-1.6908[b]	-1.4125[b]
	(-2.1771)	(-1.9475)
Mining	-0.8145	-0.1075
	(-1.1328)	(-0.1998)
Packaging	-0.3506	0.2590
	(-0.6573)	(0.7689)

TABLE 2

(Continued)

SECTOR	EXPOSURE COEFFICIENT	
	b_{ei}	β_{ei}
Pharmaceutical Prod.	-1.6793[c]	-0.9322
	(-1.9246)	(-1.2587)
Printing and Publish.	-0.2200	0.3461
	(-0.3190)	(0.5997)
Professional Services	-0.4395	-0.1232
	(-0.6419)	(-0.1856)
Property Develop.	-2.5502[a]	-1.2875[b]
	(-2.5738)	(-2.1716)
Pulp and Paper	0.2824	0.7112
	(0.4729)	(1.3526)
Text, Cloth., and Foot.	-0.2560	0.3591
	(-0.5254)	(1.4396)
Transportation	-1.4611	-0.1596
	(-1.3461)	(-0.2084)
Vehicles and Parts	-0.3638	0.1777
	(-0.5952)	(0.3615)
Warehouse and Silo	-1.2159[c]	-0.5932
	(-1.7074)	(-1.0277)
Others	-1.3002	-0.8130
	(-1.1096)	(-0.7804)

are significant only for a few industries is similar to what was reported by the previous studies for Thailand, other emerging markets, and more developed market.

Jorion (1991) pointed out that market risk and foreign exchange risk might be correlated. So, b_i in this first regression does not measure the exposure to foreign exchange alone but the exposure to the market as well. In order to measure the exposure to foreign exchange risk which is uncorrelated with the market risk. The second regression is run. In this

regression, the real return on the sectorial portfolio is regressed on the real return on the market portfolio and the residual from the regression of the rate of change in the baht exchange rate on the market return. The residual is considered in order to ensure orthogonality of the exchange risk with the market risk. With respect to Jorion (1991), the coefficient β_{ei} corresponding to the residual is the coefficient of foreign exchange exposure. The coefficient β_{ei} is reported in Column 3 of Table 2. From the table, it is found that the number of sectors whose exposure coefficients are significant reduces to three. This finding suggests that the exposure found by the first regression was due to the risk which overlaps with the market risk.

This study proposes that the insignificant exposure to the exchange rate is due to the fact that firms respond to permanent and transitory shocks in a different ways. Moreover, they can devise strategies to benefit from both exchange rate appreciation and depreciation. The fact that the conventional tests disregarded this behavior of firms may result in the tests having low power.

Table 3 reports the exposure coefficients for permanent and temporary shocks based on the model in eq. (9). This model does not consider the direction of the shocks. But it is considered first because Choi et al (1997b) proposed that only permanent shocks could affect the firm's value. Since conventional tests considered permanent and temporary shocks in aggregate, the data on the exchange rate might be too noisy, resulting in the tests being unable to detect the exposure. If the proposition of Choi et al is correct, the test of eq. (9) should find that the exposure coefficient for the permanent shock (α_{iP}) is significant and the exposure coefficient for the transitory shock (α_{iT}) is not significant.

In the estimation, the permanent and transitory shocks in the exchange rate as well as the shock in the market return has to be recovered from the restricted VAR in eq. (4). The Akaike information criterion sets the lag of the VAR to 1. And the restricted VAR is estimated by the maximum likelihood method. The shocks ϖ_{Pt}, ϖ_{Tt} and ϖ_{Mt} are recovered from the exchange rate and return series, once all the parameters are estimated. The model in eq. (9) is estimated by a multiple regression. To be consistent with the VAR's specification, the information set Ω_{t-1} is the first lags of the real exchange rate, nominal exchange rate and market return.

From the table, it is found that the exposure coefficient for the permanent shock is significant for two sectors--property development and textiles. So, separation of the shocks into permanent and temporary components still cannot explain the insignificance of the exposure.

TABLE 3

Tests for Exposure to Permanent and Transitory Shocks in the Baht Exchange Rate

(Direction of shocks *is not* considered.)

This table reports tests for exposure to permanent and transitory shocks in the baht exchange rate of industries in Thailand. In the test, the following regression is considered.

$$R_{it} = \Phi_0 + \Phi_1 X_{t-1} + \ldots + \Phi_q X_{t-q} + \alpha_{iP}\varpi_{Pt} + \alpha_{iT}\varpi_{Tt} + \alpha_{iM}\varpi_{Mt} + \eta_{it}$$

α_{iP} and α_{iT} are exposure coefficients for permanent shocks and transitory shocks. Superscripts a, b and c indicate significance at 99%, 95% and 90%, respectively.

SECTOR	EXPOSURE COEFFICIENT	
	Permanent (α_{iP})	Transitory (α_{iT})
Agribusiness	0.1205	0.3065
	(0.6717)	(0.1445)
Banking	0.1415	-1.6524
	(0.9726)	(-0.9603)
Building and Furni.	0.1644	-0.9865
	(1.0881)	(-0.5519)
Chemicals and Plasti.	0.1062	-4.2701
	(0.3290)	(-1.1185)
Commerce	0.0626	-2.2492
	(0.4312)	(-1.3090)
Communication	-0.3804	-1.9319
	(-0.9832)	(-0.5086)
Electrical Products	-0.2616	0.9553
	(-1.4310)	(0.4418)
Electronic Compo.	-0.1876	-2.3934
	(-0.5213)	(-0.6293)
Energy	-0.3663	-1.1396
	(-1.1283)	(-0.3637)

TABLE 3

(Continued)

SECTOR	EXPOSURE COEFFICIENT	
	Permanent (α_{iP})	Transitory (α_{iT})
Entertainment	0.3752	5.3560
	(0.9953)	(1.4658)
Finance and Secur.	-0.0445	-0.5108
	(-0.2318)	(-0.2247)
Foods and Beverages	-0.0536	-0.8746
	(-0.3201)	(-0.4410)
Health Care Services	0.0014	0.8479
	(0.0063)	(0.3144)
Hotels and Travel S.	0.2392	5.1490[b]
	(1.0854)	(1.9756)
Household Goods	-0.4658	0.9697
	(-1.4603)	(0.2571)
Insurance	-0.0139	-1.3787
	(-0.0806)	(-0.6721)
Jewelry and Orname.	0.3724	-4.5192
	(1.0099)	(-1.3027)
Machinery and Equip.	-0.5556	4.4238
	(-1.5269)	(1.2289)
Mining	-0.0187	3.0155
	(-0.0689)	(0.9401)
Packaging	0.0744	-2.4448
	(0.4403)	(-1.2223)
Pharmaceutical Prod.	-0.4920	-0.3215
	(-1.3280)	(-0.0835)
Printing and Publish.	0.2907	1.4898
	(1.0107)	(0.4380)

TABLE 3

(Continued)

SECTOR	EXPOSURE COEFFICIENT	
	Permanent (α_{iP})	Transitory (α_{iT})
Professional Services	-0.0836	-0.5379
	(-0.2519)	(-0.1532)
Property Develop.	-0.5446[c]	4.1492
	(-1.8463)	(1.3576)
Pulp and Paper	0.2421	-7.9842[a]
	(0.9289)	(-2.5907)
Text, Cloth., and Foot.	0.2303[c]	1.7991
	(1.8688)	(1.2341)
Transportation	-0.3241	-6.6821[c]
	(-0.8472)	(-1.8700)
Vehicles and Parts	0.0727	-2.7119
	(0.2937)	(-0.9254)
Warehouse and Silo	-0.3023	1.3441
	(-1.0413)	(0.3915)
Others	-0.4340	-1.9939
	(-0.8413)	(-0.3955)

Moreover, the proposition by Choi et al (1997b) is not supported by the data. There is evidence that the firm's value is affected by temporary shocks. Table 3 reports that the exposure coefficient for temporary shocks is significant for the pulp and paper sector and transportation sector.

According to Srinivasulu (1981) and others, firms might respond asymmetrically to positive and negative shocks. Although the test of eq. (9) recognizes the response to permanent and temporary shocks, it disregards the different response to positive and negative shocks. The model in eq. (10) is motivated by this possible difference. Hence, it allows different degrees of exposure to the positive and negative shocks. The estimation and test of eq. (10) is similar to those of eq. (9). Table 4 reports the exposure coefficients to positive and negative shocks of the

TABLE 4

Tests for Exposure to Permanent and Transitory Shocks

in the Baht Exchange Rate

(Direction of shocks *is* considered.)

This table reports tests for exposure to permanent and transitory shocks in the baht exchange rate of industries in Thailand. In the test, the following regression is considered.

$$R_{it} = \Phi_0 + \Phi_1 X_{t-1} + \ldots + \Phi_q X_{t-q} + \alpha_{iP}^{+} D_{Pt}^{+} \varpi_{Pt} + \alpha_{iP}^{-} D_{Pt}^{-} \varpi_{Pt}$$
$$+ \alpha_{iT}^{+} D_{Tt}^{+} \varpi_{Tt} + \alpha_{iT}^{-} D_{Tt}^{-} \varpi_{Tt} + \alpha_{iM} \varpi_{Mt} + \eta_{it}.$$

α_{iP}^{+}, α_{iP}^{-}, α_{iT}^{+} and α_{iT}^{-} are exposure coefficients for positive and negative permanent shocks and positive and negative transitory shocks. Superscripts a, b and c indicate significance at 99%, 95% and 90%, respectively.

SECTOR	EXPOSURE COEFFICIENT			
	Permanent		Transitory	
	α_{iP}^{+}	α_{iP}^{-}	α_{iT}^{+}	α_{iT}^{-}
Agribusiness	0.0561	0.2012	1.4342	-1.0123
	(0.1676)	(0.5431)	(0.3375)	(-0.2344)
Banking	0.2704	-0.0205	-3.9573	1.0376
	(0.9979)	(-0.0685)	(-1.1520)	(0.2971)
Building and Furni.	-0.1659	0.5814[c]	5.1805	-8.1512[b]
	(-0.6027)	(1.9100)	(1.4841)	(-2.2972)
Chemicals and Plasti.	-0.7364	1.0721	-5.8762	-4.5288
	(-1.2323)	(1.6226)	(-0.7756)	(-0.5880)
Commerce	0.0266	0.1040	-2.3009	-2.2779
	(0.0981)	(0.3464)	(-0.6681)	(-0.0665)
Communication	0.4552	-1.0711	-3.5981	1.1944
	(0.5725)	(-1.5369)	(-0.4804)	(0.1610)
Electrical Products	-0.6510[c]	0.1908	1.2960	-0.2896
	(-1.9180)	(0.5086)	(0.3012)	(-0.0662)
Electronic Compo.	0.6089	-0.9332	-5.3223	2.2822
	(0.8735)	(-1.3994)	(-0.7427)	(0.2991)

TABLE 4

(Continued)

SECTOR	EXPOSURE COEFFICIENT			
	Permanent		Transitory	
	α_{iP}^{+}	α_{iP}^{-}	α_{iT}^{+}	α_{iT}^{-}
Energy	-1.1328[c]	0.5532	4.4485	-9.2242
	(-1.8906)	(0.8352)	(0.5856)	(-1.1946)
Entertainment	1.4749[c]	-0.5783	7.7010	5.0680
	(1.9226)	(-0.8409)	(1.1063)	(0.6867)
Finance and Secur.	-0.0808	-0.0354	-6.3599	5.4844
	(-0.2267)	(-0.0900)	(-1.4071)	(1.1937)
Foods and Beverages	-0.3088	0.2208	-4.5571	2.3684
	(-0.9916)	(0.6413)	(-1.1539)	(0.5899)
Health Care Services	-0.0797	0.0640	-4.7385	6.6474
	(-0.1882)	(0.1365)	(-0.8812)	(1.1832)
Hotels and Travel S.	0.0200	0.4799	2.8456	7.0412
	(0.0487)	(1.0555)	(0.5458)	(1.3287)
Household Goods	-0.3445	-0.5905	3.7390	-1.6306
	(-0.5781)	(-0.8964)	(0.4949)	(-0.2123)
Insurance	-0.2809	0.2788	-4.2265	0.9697
	(-0.8703)	(0.7814)	(-1.0328)	(0.2331)
Jewelry and Orname.	-0.0728	0.7343	1.8067	-12.0904[c]
	(-0.0978)	(1.1018)	(0.2732)	(-1.7219)
Machin. and Equip.	0.7259	-1.5983[b]	-1.7731	12.5019[c]
	(1.0015)	(-2.5078)	(-0.2583)	(1.8438)
Mining	-0.5405	0.5746	1.1840	3.7250
	(-1.0716)	(1.0305)	(0.1851)	(0.5731)
Packaging	0.0851	0.0467	-5.1801	0.4220
	(0.2697)	(0.1341)	(-1.2951)	(0.1038)
Pharmaceutical Prod.	-0.8374	-0.1667	-3.3332	2.2926
	(-1.1759)	(-0.2451)	(-0.4545)	(0.2946)

TABLE 4

(Continued)

SECTOR	EXPOSURE COEFFICIENT			
	Permanent		Transitory	
	α_{iP}^{+}	α_{iP}^{-}	α_{iT}^{+}	α_{iT}^{-}
Printing and Publish.	0.4969	0.0329	-1.9175	5.5026
	(0.9263)	(0.0555)	(-0.2819)	(0.7959)
Professional Services	0.5234	-0.6906	-4.3061	4.6501
	(0.8346)	(-1.0999)	(-0.6441)	(0.6641)
Property Develop.	-0.2811	-0.7955	6.3907	2.1951
	(-0.4965)	(-1.4965)	(1.0974)	(0.3556)
Pulp and Paper	0.6201	-0.1563	-1.0705	-14.3040[b]
	(1.2825)	(-0.2925)	(-0.1746)	(-2.2958)
Text, Cl.., and Foot.	0.4074[c]	0.0228	1.3183	2.7038
	(1.7740)	(0.0898)	(0.4527)	(0.9135)
Transportation	-1.7683[b]	0.8503	6.0444	-22.9406[a]
	(-2.3714)	(1.2825)	(0.9319)	(-3.2979)
Vehicles and Parts	-0.2004	0.3878	-2.8908	-3.1509
	(-0.4333)	(0.7585)	(-0.4930)	(-0.5287)
Warehouse and Silo	-0.3069	-0.2664	6.7831	-4.3186
	(-0.5672)	(-0.4454)	(0.9889)	(-0.6194)
Others	-0.4517	-0.4842	12.4106	-15.9096
	(-0.4346)	(-0.5297)	(1.1289)	(-1.6387)

sample sectors. If firms can design their strategies to take advantage of positive shocks (depreciation) and negative shocks (appreciation), the exposure coefficients for positive and negative shocks must be positive and negative, respectively.

From Table 4, nine sectors--consisting of building and furnishing materials, electrical products, energy, entertainment, jewelry and ornaments, machinery, pulp and paper, textiles, and transportation, have significant exposure to permanent and/or transitory shocks in either positive or negative direction. The number of sectors whose exposure is significant is far

greater than that for the model in eq. (9) or for the conventional tests. This result supports the proposition that firms react in different ways to positive and negative permanent and transitory shocks, so that the exposure cannot be detected by the tests which do not consider the different reaction explicitly. The result in Table 4 is consistent with that in Table 3. It is found that the transitory shock can affect the firm's value.

It is interesting to find that for most of the sectors the coefficients for the positive shock and negative shock possess different signs. However, the result for some of the sectors whose exposure is significant does not support Srinivasulu's (1981) implication that firms can design strategies to take advantage from the exchange-rate depreciation and appreciation.

The building materials sector has significant exposure to the negative permanent and transitory shocks. But the exposure coefficients are positive for the negative permanent shock while it is negative for the negative transitory shock. That is, the firm's value is decreasing with permanent appreciation but increasing with temporary appreciation. This is probably due to the fact that the firms in this sector have a large position in foreign debt. So, temporary appreciation can reduce the burden in debt servicing in terms of the baht. However, permanent appreciation may cause damage to the firms in this sector. These firms produce and sell their products in both local and foreign markets. Over time, the share of their exports is increasing. Currency appreciation makes their products more expensive and, therefore, less competitive in foreign markets.

The electrical-products as well as energy sectors report significantly negative exposure to positive, permanent shock. These two industries are similar in that their inputs are mainly imports. Currency depreciation makes the input costs higher. Even though the firms can adjust their selling price, they cannot do it fully because of the limited purchasing power of the Thai consumers in the case of electrical products and because of the government's control of energy prices in the case of energy products.

The result suggests that the entertainment sector can benefit from permanent currency depreciation. In this sector, record companies are dominant. Imported western music is the major competitor of their products. The currency depreciation causes the imported records to be more expensive, less affordable, and less competitive. So, the firms' market shares increase.

Firms in the jewelry and ornaments, pulp and paper, and textiles sectors are those that also benefit from foreign exchange. The jewelry and ornaments sector and the pulp and paper sector gain from temporary appreciation probably because of lower costs of the imported

contents. The firms in the textiles sectors are exporting firms. So, they tend to benefit from permanent currency depreciation because their products are more price competitive in the world market.

Firms in the machinery sector are importers of machinery and equipment. The table reports that these firms gain from permanent appreciation. This could be because baht appreciation makes their importing costs in baht lower and enables them to lower their prices and sell more in the long run. However, these firms lose from temporary appreciation. This is probably because in the short run they will have to adjust their prices lower to reflect the baht appreciation while the costs of their inventory were incurred earlier when the baht was weaker.

Finally, it is found that firms in the transportation sector gain from currency appreciation and lose from currency depreciation. The majority of the costs of these firms is gas whose price is quoted in the U.S. dollar. So, in the short run, temporary appreciation can lower their operations costs. However, in the long run, since the firms have to replace their vehicles--trucks, trailers, ships, etc., and since these vehicles must be imported, the permanent baht depreciation leads to a higher price of the replacement.

VII. CONCLUSION

Previous literature showed that purely domestic firms, importing and exporting firms, and multinational firms can be exposed to foreign exchange risk. However, empirical studies could detect significant exposure only for a few firms or industries in both developed and emerging markets. This study notices that the tests in the previous studies did not consider the fact that the value of firms could respond to positive and negative permanent and transitory shocks in the exchange rate in different ways. It corrects the deficiency in the previous tests by decomposing exchange rate shocks into permanent and transitory shocks and considering their positive and negative directions explicitly. Using monthly return on Thai industries during the currency-basket regime, the study finds that Thai firms can be exposed to permanent and transitory shocks, but they may not react to positive and negative shocks in the same way. Significant exposure is detected for nine industries by the test being proposed, compared to only two cases of the conventional test.

This study is not without limitations. First, in eq. (7) the causation of the shocks is from the market shock ϖ_{Mt} to the exchange rate shocks ϖ_{Pt} and ϖ_{Tt}, but not vice versa. This restriction is imposed in order to be consistent with the conventional studies which considered

the component of the exchange rate which is uncorrelated with the market shocks. However, this restriction may be incorrect and it can lead to a biased result. Second, this study does not explain the significant exposure to positive and negative permanent and transitory shocks, even though it conjectures some possible explanations. Improvement upon these limitations are left for future research.

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TABLE A

Tests for Exposure to Permanent and Transitory Shocks

in the Baht Exchange Rate

(Direction of shocks *is* considered.)

This table reports tests for exposure to permanent and transitory shocks in the baht exchange rate of industries in Thailand. In the test, the following regression is considered.

$$R_{it} = \Phi_0 + \Phi_1 X_{t-1} + \ldots + \Phi_q X_{t-q} + \alpha_{iP}^{+} D_{Pt}^{+} \varpi_{Pt} + \alpha_{iP}^{-} D_{Pt}^{-} \varpi_{Pt}$$
$$+ \alpha_{iT}^{+} D_{Tt}^{+} \varpi_{Tt} + \alpha_{iT}^{-} D_{Tt}^{-} \varpi_{Tt} + \alpha_{iM}^{+} D_{Mt}^{+} \varpi_{Mt} + \alpha_{iM}^{-} D_{Mt}^{-} \varpi_{Mt} + \eta_{it}.$$

α_{iP}^{+}, α_{iP}^{-}, α_{iT}^{+} and α_{iT}^{-} are exposure coefficients for positive and negative permanent shocks and positive and negative transitory shocks. Superscripts a, b and c indicate significance at 99%, 95% and 90%, respectively.

SECTOR	EXPOSURE COEFFICIENT			
	Permanent		Transitory	
	α_{iP}^{+}	α_{iP}^{-}	α_{iT}^{+}	α_{iT}^{-}
Agribusiness	-0.0545	0.2189	2.2268	-1.6685
	(-0.1643)	(0.6017)	(0.5323)	(-0.3927)
Banking	0.2698	-0.0204	-3.9534	1.0344
	(0.9863)	(-0.0680)	(-1.1435)	(0.2946)
Building and Furni.	-0.2097	0.5884[c]	5.4939	-8.4106[b]
	(-0.7560)	(1.9353)	(1.5715)	(-2.3692)
Chemicals and Plasti.	-0.6508	1.084	-6.4894	-4.0212
	(-1.0797)	(1.6024)	(-0.8544)	(-0.4214)
Commerce	0.0182	0.1053	-2.2410	-2.3275
	(0.0665)	(0.3496)	(-.6467)	(-0.6614)
Communication	0.5094	-0.9385	-5.0467	1.8783
	(0.6468)	(-1.3507)	(-0.6756)	(0.2551)
Electrical Products	-0.6844	0.1961	1.5357	-0.4880
	(-1.9953)	(0.5217)	(0.3553)	(-0.1112)
Electronic Compo.	0.5869	-0.9412	-4.9142	2.0328
	(0.8361)	(-1.4049)	(-0.6768)	(0.2645)

TABLE A

(Continued)

SECTOR	EXPOSURE COEFFICIENT			
	Permanent		Transitory	
	α_{iP}^{+}	α_{iP}^{-}	α_{iT}^{+}	α_{iT}^{-}
Energy	-1.1953[b]	0.5632	4.8962	-9.5948
	(-1.9743)	(0.8489)	(0.6418)	(-1.2385)
Entertainment	1.4546[c]	-0.6084	8.2662	4.8954
	(1.8866)	(-0.8786)	(1.1708)	(0.6601)
Finance and Secur.	0.0399	-0.0547	-7.2245	6.2001
	(0.1132)	(-0.1417)	(-1.6253)	(1.3735)
Foods and Beverages	-0.3787	0.2320	-4.0569	1.9543
	(-1.2127)	(0.6779)	(-1.0308)	(0.4890)
Health Care Services	-0.1494	0.0751	-4.2397	6.0545
	(-0.3498)	(0.1605)	(-0.7875)	(1.1075)
Hotels and Travel S.	-0.0754	0.4951	3.5291	6.4754
	(-0.1831)	(1.0967)	(0.6798)	(1.2283)
Household Goods	-0.3710	-.5863	3.9285	-1.7875
	(-0.6151)	(-0.8871)	(0.5169)	(-0.2316)
Insurance	-0.3554	-0.2907	-3.6935	0.5286
	(-1.0988)	(-0.8203)	(-0.9063)	(0.1277)
Jewelry and Orname.	-0.0723	0.7350	1.7929	-12.0854[c]
	(-0.0966)	(1.0943)	(0.2669)	(-1.7095)
Machin. and Equip.	0.7821	-1.4650[b]	-2.9602	13.2376[c]
	(1.0885)	(-2.2997)	(-0.4327)	(1.9667)
Mining	-0.5411	0.5747	1.1881	3.7216
	(-1.0594)	(1.0269)	(0.1846)	(0.5694)
Packaging	0.0064	0.0593	-4.6169	-0.0442
	(0.0204)	(0.1716)	(-1.1612)	(-0.0109)
Pharmaceutical Prod.	-0.8976	-0.1857	-2.3396	1.6768
	(-1.2572)	(-0.2732)	(-0.3166)	(0.2150)

TABLE A

(Continued)

SECTOR	EXPOSURE COEFFICIENT			
	Permanent		Transitory	
	α_{iP}^{+}	α_{iP}^{-}	α_{iT}^{+}	α_{iT}^{-}
Printing and Publish.	0.4218	0.0449	-1.3790	5.0568
	(0.7794)	(0.0758)	(-0.2027)	(0.7303)
Professional Services	0.4857	-0.6948	-3.9765	4.3759
	(0.7669)	(-1.1028)	(-0.5903)	(0.6186)
Property Develop.	-0.3005	-0.0825	6.7998	1.9421
	(-0.5280)	(-1.4726)	(1.1519)	(0.3124)
Pulp and Paper	0.4563	-0.1302	0.1016	-15.2744[b]
	(0.9538)	(-0.2483)	(0.0168)	(-2.4950)
Text, Cl.., and Foot.	0.4137[c]	0.0218	1.2737	2.7408
	(1.7790)	(0.0856)	(0.4346)	(0.9210)
Transportation	-1.8556[a]	0.7723	8.4636	-24.3247[a]
	(-2.6071)	(1.2203)	(1.3612)	(-3.6587)
Vehicles and Parts	-0.2406	0.3842	-2.6028	-3.3893
	(-0.5146)	(0.7693)	(-0.4418)	(-0.5665)
Warehouse and Silo	-0.5176	-0.2327	8.2918	-5.5675
	(-0.9743)	(-0.3998)	(1.2385)	(-0.8189)
Others	-0.5183	-0.6371	13.8297	-16.7556[c]
	(-0.4995)	(-0.6925)	(1.4082)	(-1.7268)