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Managing Asymmetric Foreign Exchange Exposure with Financial Derivatives: Evidence from Korean Firms

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Abstract

In this study, we examine two issues pertaining to foreign exchange exposure. Employing a large sample of Korean manufacturing firms during 1998-2005, we analyze the characteristics of firms' asymmetric foreign exchange exposures and the effectiveness of financial derivatives in managing such exposures. Our results show that exporting firms have relatively large degrees of total asymmetric foreign exchange exposure, especially in response to declining exchange rates (won/USD). In contrast, firms with dollar-denominated debt exhibit large degrees of asymmetric exposure in response to both increasing and declining exchange rates but in the opposite direction, which results in relatively small total foreign exchange exposure for these firms. Our regression results show that the usage of financial derivatives is negatively but insignificantly related to the asymmetric foreign exchange exposure, indicating limited effectiveness of financial derivatives in managing Korean firms' asymmetric foreign exchange exposure.

JEL Classification: F31; G15

Key words: Asymmetric foreign exchange exposure; Financial derivatives; Korean manufacturing firms

1. Introduction

Significant research has been done on various issues of firms' foreign exchange exposure. While the conventional research on foreign exchange exposure assumes that the relationship between changes in foreign exchange rates and firm value is one dimensional regardless of the direction of the changes in foreign exchange rates, several studies show that the relationship vary depending on the direction of the changes in foreign exchange rates, leading to the asymmetric nature of foreign exchange exposure (see, Miller and Reuer, 1998; Iorio and Faff, 2000; Carter, Pantzalis, and Simkins, 2003; Koutmos and Martin, 2003; Muller and Verschoor, 2006 & 2008). For example, Muller and Verschoor (2006) find that 29% of sample U.S. multinational firms with real operations in foreign countries have significant asymmetric foreign exchange exposure to changes in Latin American exchange rates between 1990 and 2001. Koutmos and Martin (2003) report similar evidence that about 40% of firms in Germany, Japan, the U.K., and the U.S. exhibiting significant foreign exchange exposure have asymmetric exposure profiles.

As a potential cause of asymmetric foreign exchange exposure, several previous studies have advanced firms' exporting behavior, in particular mark-up adjustments or pricing-to-market policies (Campa and Goldberg, 1999; Allayannis and Ihrig, 2001; Bodner, Dumas, and Marston, 2002). These studies offer evidence to some extent consistent with firms' behavior of increasing mark-ups of exporting goods when the foreign exchange rate goes up, allowing exporting firms to gain additional asymmetric benefits.

Along with the advancement of globalization, however, the effect of firms' exporting activities on their foreign exchange exposure has gradually declined. This is primarily due to the increase in importing activities of raw materials of exporting products from other countries, which has in turn weakened the effect of changes in exchange rates on the exporting firms. Hence, it is necessary to reassess the conventional approach of explaining firms' asymmetric foreign exchange exposure from the perspective of firms' exporting behavior. For example, as observed during the Asian financial crisis, the increases in the volatility and interdependence of financial markets have led to increases in foreign exchange exposure when firms use foreign currency-denominated (hereafter, FCD) debt. Bae and Kwon (2011) show that

dollar-denominated debt of Korean firms plays the role of offsetting the degree of asymmetric foreign exchange exposure caused by firms' exporting activities to some extent.

Firms often raise capital through FCD debt in order to hedge their foreign exchange exposure, take advantage of lower cost than domestic debt, and/or benefit from expected foreign exchange rate changes (Keloharju and Niskanen, 2001). Elliot et al. (2003), and Kedia and Mozumdar (2003) provide empirical evidence supporting the notion that raising capital through the FCD debt decreases the foreign exchange exposure. In a study of manufacturing firms in Finland, however, Keloharju and Niskanen (2001) show that firms issue FCD debt for both hedging and speculative purposes. Nguyen and Faff (2006) offer similar evidence for Australian firms.

The effectiveness of currency financial derivatives in managing firms' foreign exchange exposure has been examined by a large body of studies with mixed evidence. While several studies (e.g., Allayannis and Weston, 2001; Bartram, Brown, and Minton, 2010; Clark and Judge, 2009; Graham and Rogers, 2002) show positive hedging effects of currency derivatives, a good number of other studies cast doubt on their effectiveness in exposure management (e.g., Bali, Terrence, and Martell, 2007; Guay and Kothari, 2003; Hentschel and Kothari, 2001).

While existing studies focus on the measurement and determinants of asymmetric foreign exchange exposure and the effectiveness of currency derivatives in managing foreign exchange risk, little attention was given to the effective management of firms' asymmetric foreign exchange exposure. In this paper, we offer the theoretical foundation of the occurrence of asymmetric foreign exchange exposure and investigate whether firms' usage of financial derivatives helps firms manage their asymmetric foreign exchange exposure effectively. Under the circumstances of asymmetric foreign exchange exposure where firm value is exposed asymmetrically to the same magnitude of an increase and decrease in foreign exchange rates, a firm's symmetric benefit-loss structure would not allow the firm to effectively mange its foreign exchange rate risk. This is because the hedging tools that firms use for managing foreign exchange risk in general have symmetric benefit-loss structures except for option contracts. Similarly, the asymmetric risk and hence asymmetric benefit-loss structures of investment assets should be an important

factor to consider when investors develop their investment strategies including risk management. In our analysis, we also consider firms' exporting behavior and usage of FCD debt to examine how these well-researched factors are related to the effectiveness of financial derivatives on the firm's asymmetric foreign exchange exposure.

We focus on manufacturing companies in Korea, one of the premier developing countries. Since the Asian financial crisis in late 1997, Korean firms have been exposed to an unprecedented level of exchange risk primarily due to the adoption of the flexible exchange rate system on December 16, 1997 and the increase in their global business operations including outward foreign direct investments.[1] In addition, due to the adoption of the new accounting system that requires Korean firms to report gain and loss in asset values associated with exchange rate changes in the current year's balance sheet, the financial performance of Korean firms is affected to a greater extent by the changes in exchange rates in the same year. Furthermore, the increased role of foreign investors in the Korean capital markets and the availability of foreign stocks and mutual funds to Korean investors suggest that foreign exchange risk is a crucial factor to consider in designing investors' investment strategies for global portfolios.[2] Furthermore, Korean firms have traditionally used various types of financial derivatives to hedge their significant exposure to exchange rate changes. In sum, the highly sensitive nature of their businesses and firm values to exchange rate changes and their long reliance on financial derivatives of Korean manufacturing firms offer an invaluable opportunity to investigate the existence and the effects of financial derivatives on the asymmetric exchange exposure.

Employing 387 sample firms spanning fifteen industries during 1998-2005, we find that the values of Korean manufacturing firms are exposed asymmetrically to increases and declines in the exchange rate (Korean won/USD), with a greater degree of asymmetric exposure when exchange rate declines. We

[1] For example, the rate of Korean currency (won) relative to the US dollar has swung between a low of W912.50 on November 1, 1997 and a high of W1,707.30 on January 1, 1998. During our study period of January 1, 1998 to December 31, 2005, the exchange rate started at W686.18 and ended at W1,050.37.

[2] Kwon et al. (2005) show that foreign investors of ADRs price foreign exchange risk into the underlying firm's stock returns differently than local investors, indicating the importance of considering firms' foreign exchange risk exposure in assessing firm value.

further find strikingly different characteristics of asymmetric foreign exchange exposure between exporting firms and firms with dollar-denominated debt. Exporting firms (export to sales ratio greater than 10%) show large degrees of total asymmetric foreign exchange exposure, mainly attributed to the asymmetric exposure in response to the declining exchange rate. Unlike exporting firms, firms with dollar-denominated debt (greater than 1% of firm value) exhibit large degrees of asymmetric exposure in response to both increases and declines in the exchange rate but in the opposite direction. Accordingly, these firms' asymmetric exposure cancels out and results in relatively small total foreign exchange exposure. Finally, our regression results show that the usage of financial derivatives is negatively but insignificantly related to the asymmetric foreign exchange exposure, indicating limited effectiveness of financial derivatives in managing Korean firms' asymmetric foreign exchange exposure. These findings can be at least in part explained by the notion that the benefit-loss structures of currency derivatives except for currency options are symmetric, and hence are not suitable to manage the asymmetric nature of the foreign exchange exposure for Korean manufacturing firms.

Our paper is structured as follows. Section 2 presents research design, data, and measurement of variables. Section 3 reports empirical results, with summary and conclusions in Section 4.

2. Research Design

2.1. Data

The sample of our study includes all manufacturing companies listed on the Korea Stock Exchange (KSE) during the period of January 1998 to December 2005. Accordingly, we exclude financial and utility companies. Our sample period focuses on the post period of Korean financial crisis in late 1997 in order to avoid any compounding effects of the crisis on firm value.[3] With all the necessary information, the final sample consists of a total of 387 manufacturing firms in Korea, spanning sixteen manufacturing industries.

[3] Since the Korean financial crisis in late 1997, there have been significant changes and reforms across the financial, corporate and public sectors. Furthermore, the Korean currency markets experienced significant volatilities along with a transformation to the flexible exchange rate system during the Korean financial crisis.

2.2. Transactions of financial derivatives by Korean firms

If a firm engages in hedging activities by utilizing tools that possess an asymmetric benefit-cost structure of foreign exchange exposure, the change in foreign exchange rates would bring in asymmetric influence to firm value. Firms can hedge their foreign exchange exposure using both external market tools such as financial derivatives including currency futures, currency forwards, and currency options, and natural hedges resulting from the firms' internal operating activities.

We measure both the frequency and the transaction amount of financial derivatives trading of Korean firms by examining the section of "transactions (purchases and sales) of financial derivatives" in each firm's annual operating reports during the sample period. For example, if a firm reports transactions of financial derivatives for one or two years, a value of 1 or 2, respectively, is assigned to the firm. Table 1 reports the transaction amount (relative to firm size) and frequency by types of financial derivatives during our sample period of 1998-2005. The transactions of currency forwards and futures are further broken down into buy and sell transactions. Other financial derivatives include currency risk insurance, structured forward contracts such as KIKO options, and swaps (currency swaps and currency interest swaps).[4]

Looking first at the full sample firms in Panel A, our sample firms on average engage in 1.2351 transactions over the sample period, and 34.4% of our sample firms report at least one financial derivative transaction. Among several types of financial derivatives, currency forwards represent the largest transaction amount of 42.89% relative to firm size as well as the most frequent transactions as evidenced by the largest average transaction of 0.6692 and the largest proportion of 25.32% of sample firms. This is followed by transactions of currency futures in terms of transaction amount, but by transactions of other

[4] Currency risk insurance is a part of export insurance system offered by Korea Trade Assurance Corporation (KTAC) since 2000 for exporting and importing firms and works in a similar way to the currency forward contract offered by financial institutions. The KIKO option is designed to offer positive payoffs to the option holder when the Korean won moderately appreciates up to a certain predetermined rate against USD; in exchange, the option holder is obligated to take negative payoffs when the Korean won value depreciates significantly (see Khil and Suh, 2010).

financial derivatives in terms of transaction frequency. Hence, Korean manufacturing firms use other financial derivatives and currency options more frequently but with much lower relative transaction size than those of currency futures. For currency options, 8.79% of Korean firms engage in at least one transaction of currency options with an average transaction of 0.1576 but with a substantially smaller transaction amount of 0.1% relative to firm size over the 7-year sample period.

As expected, exporting firms engage in much larger and more frequent transactions of currency forwards, currency futures, and currency options than non-exporting firms. Export firms are firms with at least 10% of sales from foreign exporting. As shown in Panel B, the total transaction amount of currency forwards is 1.3259 times the firm size, which is substantially larger than the transaction amount of 0.4289 for full sample firms. In addition, the average transaction of currency forwards for exporting firms is 0.8470, which is also greater than that for full sample firms. Similar results are reported for currency futures and currency options.

On the other hand, firms with foreign currency-denominated debt engage in much small amount and less frequent transactions of currency forwards, currency futures, or currency options than exporting firms. Even the transactions of currency forwards and futures are exclusively buy transactions. In contrast, these firms use other financial derivatives (such as currency risk insurance, KIKOs, and swaps) in a larger magnitude and more frequently.

2.3. Regression model for the measurement of asymmetric foreign exchange exposure

Following Koutmos and Martin (2003), we estimate foreign exchange rate exposure of firm value using the following time-series regression model for each firm by adding a dummy variable representing the direction of the change in foreign exchange rates, *D*, to the Jorion's (1990) estimation model.

$$R_{i,t} = \alpha_{o,i} + \beta_{M,i} R_{M,t} + \beta_{f,i} FXR_t + \gamma_i (D_t \times FXR_t) + \varepsilon_{i,t} \quad (1)$$

In equation (1), R_i is real stock return for individual firm i and includes dividends paid using the data from the Korea Capital Markets Institute. R_M is real market return proxied by Korea Composite Stock

Price Index (KOSPI). Both R_i and R_M are adjusted by the risk-free rates of return, which are proxied by the interest rates on 1-year monetary stabilization bonds (MSBs) issued by the Korean government.[5] The foreign exchange rate is expressed as Korean won per US dollar (won/USD) and thus *FXR,* changes in real foreign exchange rates, is measured by changes in the monthly average exchange rates of daily exchange rates adjusted by the difference in inflation rates (proxied by consumer price index) between Korea and the U.S. Hence, the change in real won/USD is computed by: change in nominal won/USD – (inflation rate in Korea – inflation rate in the U.S.). *D* is a dummy variable with a value of 1 if the foreign exchange rate increases (that is, $FXR > 0$), and 0 if the rate declines (that is, $FXR < 0$); and $\varepsilon_{i,t}$ is *i.i.d.* (independently and identically distributed) error term.

The key regression coefficient in equation (1) is γ, the coefficient that represents the degree of asymmetry in foreign exchange exposure associated with changes in foreign exchange rates in different directions. A significant γ implies that the foreign exchange exposure associated with an increase in the real foreign exchange rate is not symmetric to that associated with a decrease in the real foreign exchange rate. Since the dummy *D* has a value of 1 when the foreign exchange rate increases and 0 when the rate declines, the total foreign exchange exposure associated with a decrease and an increase in the foreign exchange rate is measured by β_f and $\beta_f + \gamma$, respectively. Considering that the US dollar is the primary foreign currency that Korean firms deal with in their overseas business activities, we compare the estimation of equation (1) between exporting firms and firms with dollar-denominated debt.

2.4. Regression model for the effect of financial derivatives on asymmetric foreign exchange exposure

Because the degree of the asymmetry in a firm's foreign exchange exposure is also likely affected by several factors other than the usage of financial derivatives, we include variables representing firm attributes such as export ratio, dollar-denominated debt ratio, R&D ratio, firm size, market risk, and industry classification. In this analysis, we test the empirical relationships between a firm's asymmetric

[5] The monetary stabilization bond is a bond issued by the Bank of Korea, the central bank in Korea, to adjust the money supply and stabilize the interest rate.

foreign exchange exposure and these variables to uncover the effectiveness of financial derivatives as mechanisms of hedging the firm's asymmetric foreign exchange exposure.

In order to examine the effect of the usage of various types of financial derivatives on the asymmetric foreign exchange exposure of Korean firms, we estimate the following multivariate regression model:

$$\hat{\gamma}_i = \delta_{o,i} + \delta_1 EXPT_i + \delta_2 DDDR_i + \delta_3 RND_i + \delta_4 FSIZE_i + \delta_5 MRISK_i + \delta_6 FINDER_i + \sum_{k=1}^{15} \lambda_k IND_{i,k} + \varepsilon_{i,t} \quad (2)$$

where $\hat{\gamma}_i$ is the regression coefficients of asymmetric foreign exchange exposure of firm i estimated from equation (1); *EXPT* is export ratio; *DDDR* is dollar-denominated debt ratio; *RND* is R&D expense ratio; *FSIZE* is firm size; *MRISK* is market risk; *FINDER* is financial derivatives; and *IND* is industry dummies, spanning fifteen Korean industries.

2.5. Measurement of variables

Below we present the measurement of variables used in regression equation (2.)

EXPT (Export ratio)

EXPT is measured as a proportion of total export amount to total sales. Existing studies attempt to explain the asymmetry in foreign exchange rate exposure from the perspective of the pricing-to-market (PTM) in the firm's exporting activity. This approach is a natural one in the sense that the studies of pass-through which is opposite to the PTM have started with an interest in the asymmetric relationship between changes in foreign exchange rates and balance of payments. Mark-up adjustment coefficients are used to measure and analyze the changes in exporting goods' PTM according to changes in foreign exchange rates. Several previous studies have attempted to estimate mark-up adjustment coefficients and analyze their determinants (Krugman, 1987; Ohno, 1989; Knetter, 1993). The analyses of the relationship between firms' mark-up adjustments and foreign exchange exposure have, however, focused primarily on the theoretical aspect such as model development (Campa and Goldberg, 1999; Allayannis and Ihrig, 2001; Bodnar et al., 2002). These studies are in supportive of the notion that mark-up adjustments are

related to foreign exchange exposure under certain assumptions. Little empirical analysis on the relationship between the two variables, however, has been done due to the difficulty in measuring firms' mark-up adjustment coefficients.

It is expected that if a firm's asymmetric mark-up adjustments cause its asymmetric foreign exchange exposure, an increase in a foreign exchange rate (or a depreciation of Korean won value) will result in an increase in the positive foreign exchange exposure. In other words, if a firm engages in asymmetric mark-up adjustments in which the firm increases the mark-up to a larger extent with an increase in a foreign exchange rate, the firm is expected to experience asymmetric foreign exchange exposure such that the firm's value increases to a greater extent when the foreign exchange rate increases. Accordingly, a positive relationship is expected between a firm's export ratio and its asymmetric foreign exchange exposure.

DDDR (Dollar-denominated debt ratio)

Since the US dollar is the primary foreign currency that Korean firms deal with in their overseas business activities, we use dollar-denominated debt as representative of FCD debt. Considering that firms raise capital through FCD debt mainly to hedge their foreign exchange exposure, as well as taking advantage of lower cost than domestic debt, a negative relationship is expected between *DDDR* and the asymmetric foreign exchange exposure.

RND (R&D expenses)

RND is measured as a proportion of a firm's R&D expenses to total sales. A firm's R&D expense proxies for the firm's future growth potential. A firm with higher growth potential is more likely to engage in hedging the firm's operating and financing risk using financial derivatives such as options (Lin et al., 2008). Hence, a negative relationship is expected between a firm's R&D expense ratio and asymmetric foreign exchange exposure.

FSIZE (Firm size)

FSIZE is measured as natural log of the market value of common stock. Existing studies on foreign exchange risk show that the size of a firm is closely related to the degree of foreign exchange exposure

with contrasting evidence. On the one hand, Chow et al. (1997b) postulate that since a large firm has an advantage in implementing foreign exchange risk management and hedging strategies, a larger firm is associated with smaller foreign exchange exposure. On the other hand, Ware and Winter (1988) predict that a smaller firm has higher financial distress cost and thus a greater incentive for hedging, resulting in smaller foreign exchange exposure. Consistent with Ware and Winter's prediction, He and Ng (1998) find that larger Japanese firms have greater foreign exchange exposure than smaller Japanese firms. Dominguez and Tesar (2005) show similar evidence.

In sum, large firms are likely exposed to more risk due to its diverse domestic and overseas business operations but are more effective in managing firm costs and more flexible in dealing with firm risk than small firms. How the size of a firm is related to the foreign exchange exposure is an empirical question.

MRISK (Market risk)

MRISK is measured as a firm's beta using the market model. *MRISK* is used as a variable to control for a firm's sensitivity to the general market movement.

FINDER (Financial derivatives)

FINDER represents the frequency of financial derivatives trading of Korean firms, more specifically, the number of financial derivatives transactions of each firm over the 7-year sample period. As discussed in Section 2.2, *FINDER* is measured by examining the section of "transactions (purchases and sales) of financial derivatives" in each firm's annual operating reports during the sample period. The relationship between a firm's trading of financial derivatives and asymmetric FX exposure is based on the asymmetric benefit structure of currency options and other financial derivatives. Hence, if a firm uses financial derivatives for hedging purpose, the degree of asymmetry in the firm's foreign exchange exposure will be reduced, resulting in a negative relationship between *FINDER* and a firm's asymmetric foreign exchange exposure.

3. Empirical Results

3.1. Summary statistics of key variables

Table 2 reports summary statistics of several key variables of Korean manufacturing firms. For the full sample firms, a typical Korean manufacturing firm in our sample has on average a market value of common stock of $1.076 billion, an export ratio of 22.8%, a total FCD debt ratio of 8.17%, a dollar-denominated debt ratio of 6.92%, an R&D ratio of 0.9%, and a firm beta of 0.721. It also has a total FCD debt ratio of 8.17% and a dollar-denominated debt ratio of 6.92%; hence, the dollar-denominated debt represents the largest foreign currency-denominated debt for Korean manufacturing firms. The median values of these ratios are substantially smaller than their mean values, suggesting a skewed distribution of these values to the right.

Compared to firms with FCD debt, a typical exporting firm on average has a larger market value of common stock, and lower debt ratios of both FCD debt and dollar-denominated debt. Interestingly, exporting firms all have negative net dollar-denominated debt ratios, ranging from -1.0294 to -0.0010, suggesting that their dollar-denominated assets are far greater than their dollar-denominated liabilities.

3.2. Estimated coefficients of asymmetric foreign exchange exposure

Table 3 reports the distributions of the regression coefficient (γ_i) of asymmetric foreign exchange exposure estimated from equation (1) by two opposite directions of the change (increase and decrease) in the foreign exchange rate as well as total foreign exchange exposure. γ_i represents the degree of asymmetric in foreign exchange exposures according to the direction of a change in the foreign exchange rate. The first column lists eight categories classified by the magnitude of estimated γ_i. The numbers in the other three columns represent the number of firms whose coefficient of the degree of asymmetry in foreign exchange exposure (γ_i) belongs to the range as given in the first column. Because the dummy D in equation (1) has a value of 1 and 0 for an increase and a decrease in the foreign exchange rate, respectively, the total foreign exchange exposure associated with a decrease and an increase in the foreign exchange rate in the fourth column is measured by the sum of β_f and $\beta_f + \gamma$.

Looking at the average value of γ_i for the full sample firms in Panel A, Korean firms show asymmetric exposure to the same degree of a change in the foreign exchange rate. While Korean firms

have a relatively small coefficient of asymmetric foreign exchange exposure of 0.027 in response to an increase in won/USD rate (that is, a depreciation of the value of won relative to USD), they exhibit a much larger coefficient of asymmetric exposure of 0.221 in response to a decrease in won/USD rate. It is also shown that the majority of firms have their asymmetric foreign exchange exposure between -1.0 and +1.0, but a good number of firms exhibit much severe asymmetric exposure greater than the absolute value of 2.0 (-2 and +2).

Comparing exporting firms with firms with dollar-denominated debt reveals interesting results on the firm's asymmetric exposure to changes in foreign exchange rates, which are not documented in the previous studies. These two groups of firms show much different degrees of total foreign exchange exposure in the opposite direction, with exporting firms having greater asymmetric exposure. Exporting firms on average have a substantially greater asymmetric foreign exchange exposure of +0.205 than firms with dollar-denominated debt, whose average asymmetric exposure is -0.079. Furthermore, these two groups of firms show strikingly different exposures to the different directions of changes in the exchange rates. When foreign exchange rates increase, exporting firms on average show a negative but small coefficient of -0.003, but firms with dollar-denominated debt have a positive and much large coefficient of +0.381. In contrast, when foreign exchange rates decline, the signs of the asymmetric exposure coefficients for the two groups reverse.

The findings of the large asymmetric exposure coefficients (0.381 and -0.433) in response to the increase and decline of exchange rates but the relatively small asymmetric exposure coefficient (-0.079) for the total exposure suggest that FCD debt, especially dollar-denominated debt, is an effective hedging mechanism to offset some, though not all, of the asymmetric foreign exchange exposure of Korean manufacturing firms, as documented in Bae and Kwon (2011). These findings can be explained at least in part by the notion that as the foreign exchange rate decreases, so does the value of dollar-denominated debt, thus reducing the amount of dollar-denominated liabilities to Korean firms.

Undocumented in the previous studies, the results in Table 3 indicate that exporting firms and firms with FCD debt exhibit different degrees of asymmetric foreign exchange exposure to changes in foreign

exchange rates. Among the two groups of firms, the former exhibits a substantially greater degree of asymmetry in their total foreign exchange exposure than firms with FCD debt.

3.3. Regression results on the effectiveness of financial derivatives for full sample firms

As we find evidence that Korean manufacturing firms exhibit substantially larger degrees of asymmetry in their foreign exchange exposure, we now examine the effective of financial derivatives in managing firms' asymmetric foreign exchange exposure. Table 4 presents the results from regression equation (2) for the full sample firms in three separate cases of total foreign exchange exposure, when foreign exchange rate increases, and when foreign exchange rate declines. Model 1 omits *FINDER*, the variable measuring the frequency of a firm's financial derivatives transactions, whereas Model 2 includes the variable in the regression.

Looking first at the control variables in the regressions of total foreign exchange exposure, *FSIZE* and *MRISK* carry positive and significant regression coefficients at least at the 10% level, indicating positive effects of a firm size and market risk on the firm's asymmetric exposure. The regression coefficients of *EXPT*, *RND*, and *DDDR* are positive, positive, and negative, respectively, but none of the coefficients are statistically significant at the 10% level. Hence, a firm's export, R&D ratio, and usage of dollar-denominated debt have little effect on the degree of asymmetric foreign exchange exposure. Among the industry dummies, the regression coefficients for two industries of non-metallic mineral products and general constructions are statistically significant at least at the 10% level.

The regression coefficient of the key testing variable *FINDER* (financial derivatives) is negative as hypothesized but not statistically significant at the 10% level regardless of the way the asymmetric foreign exchange exposure is measured (total foreign exchange exposure and when foreign exchange increases and declines). These results indicate that a firm's usage of financial derivatives have little or limited, if any, effectiveness in managing the firm's asymmetric foreign exchange exposure.

3.4. Regression results of the effectiveness of financial derivatives for different groups of firms

In order to gain additional insights into the roles of a firm's export and dollar-denominated debt, and the effectiveness of financial derivatives on the firm's asymmetric foreign exchange exposure, we estimate regression equation (2) for exporting firms and firms with dollar-denominated debt. Our purpose here is to examine if a firm's usage of financial derivatives brings a different benefit to exporting firms vs. firms with dollar-denominated debt.

Table 5 reports the regression results for exporting firms and exporting firms with net dollar-denominated debt. Both groups of firms have their export to sales ratios greater than 10%, but only exporting firms with net dollar-denominated debt have their net dollar-denominated debt to firm value ratios greater than 1%.

As shown in Panel A, *EXPT* and *RND* are significantly (at least at the 5% level) positively related to asymmetric exposure when foreign exchange rate increases, and *FSIZE* has a positive and significant (at least at the 5% level) relationship with asymmetric exposure when total foreign exchange exposure is considered. Hence, a firm's firm size, export ratio, and R&D ratio have significant impacts on the degree of asymmetric foreign exchange exposure. The *FINDER* variable carries a negative coefficient, as expected, but its coefficient is not significant at the 10% level.

When exporting firms are combined firms with at least 1% of net dollar-denominated debt to firm value, *EXPT* no longer carries a significant regression coefficient. On the contrary, *DDDR* has a negative and significant regression coefficient at the 5% level, suggesting that a higher ratio of a firm's dollar-denominated debt to firm value is associated with a lower degree of asymmetric foreign exchange exposure. However, similar to exporting firms, a firm's usage of financial derivatives is not significantly related to the degree of asymmetric exposure, as evidenced by positive but insignificant regression coefficients of *FINDER*.

Table 6 shows the regression results for firms with both gross and net dollar-denominated debt. Both groups of firms have their export to sales ratios less than 10%, and either the gross or net dollar-denominated debt for these firms is less than 1% of their firm value. Among others, as expected, *DDDR* carries a negative and significant regression coefficient in most cases for both groups of firms. Hence,

raising capital through dollar-denominated debt is effective in reducing the degree of asymmetric foreign exchange exposure. *FINDER* carries a positive and significant regression coefficient only when foreign exchange rate increases for firms with net dollar-denominated debt but has an insignificant coefficient in all other cases for both groups of firms. Hence, consistent with our earlier results, a firm's usage of financial derivatives is not an effective mechanism to manage the asymmetric foreign exchange exposure.

4. Summary and Conclusions

A firm's foreign exchange exposure becomes asymmetric when firm value changes asymmetrically to the same degree of changes in foreign exchange rates. In spite of the practical importance of managing asymmetric foreign exchange exposure, little research has been done in identifying and managing asymmetric foreign exchange exposure. In this paper, we analyze the characteristics of firms' asymmetric foreign exchange exposure and examine if the use of financial derivatives effectively reduces the asymmetric foreign exchange exposure. Our paper examines these issues by focusing on Korean manufacturing firms, whose values are known to be highly sensitive to foreign exchange rate changes due to their dependence on international trades and foreign capital.

Employing 387 sample firms spanning fifteen industries during 1998-2005, our results show that the values of Korean manufacturing firms are exposed asymmetrically to the increases and declines in the exchange rate (Korean won/USD) with much greater asymmetric exposure to the increasing exchange rate than to the declining rate. Our results further show strikingly different characteristics of asymmetric foreign exchange exposure between exporting firms and firms with dollar-denominated debt. Exporting firms (export to sales ratio greater than 10%) have large degrees of total asymmetric foreign exchange exposure, which is mainly attributed to the larger asymmetric exposure in response to the declining exchange rate than to the increasing exchange rate. Unlike exporting firms, firms with dollar-denominated debt (greater than 1% of firm value) show large degrees of asymmetric exposure in response to both increases and declines in the exchange rate but in the opposite direction. Hence, the large

asymmetric exposure of these firms cancels out, resulting in relatively small total foreign exchange exposure.

Finally, our regression results show that the usage of financial derivatives by Korean firms is negatively but insignificantly related to the asymmetric foreign exchange exposure. This result offers evidence that currency financial derivatives have limited effectiveness in managing firms' asymmetric foreign exchange exposure. This evidence can be at least in part explained by the notion that due to the symmetric benefit-loss structures of currency derivatives except for currency options, currency derivatives are not adequate as effective hedging mechanisms to manage the asymmetric nature of the foreign exchange exposure for Korean manufacturing firms.

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Table 1. Transactions of financial derivatives by Korean manufacturing firms

The sample consists of 387 Korean manufacturing firms during 1998-2005. The table reports the transaction amount (relative to firm size) and frequency of financial derivatives trading of Korean firms by examining the section of "transactions (purchases and sales) of financial derivatives" in each firm's annual operating reports. For example, if a firm reports transactions of financial derivatives for one or two years, a value of 1 or 2, respectively, is assigned to the firm. Other financial derivatives include currency risk insurance, structured forward contracts such as KIKO options, and swaps (currency swaps and currency interest swaps).

		Transaction amounts/firm size	Average transactions over sample period	Average no. of firms with at least one transaction over sample period
Panel A. Full sample firms (387 firms)				
Currency forwards	Buy transactions	0.1970	0.4341	0.1990
	Sell transactions	0.1974	0.4005	0.1705
	Total transactions	0.4289	0.6692	0.2532
Currency Futures	Buy transactions	0.0388	0.0465	0.0388
	Sell transactions	0.0218	0.0517	0.0284
	Total transactions	0.0660	0.0930	0.0517
Currency options		0.0010	0.1576	0.0879
Other financial derivatives		0.0014	0.3152	0.1654
Total financial derivatives		-	1.2351	0.3440
Panel B. Exporting firms (94 firms)				
Currency forwards	Buy transactions	0.6388	0.4235	0.2471
	Sell transactions	0.6773	0.5882	0.2471
	Total transactions	1.3259	0.8470	0.3294
Currency Futures	Buy transactions	0.0460	0.0941	0.0705
	Sell transactions	0.0287	0.1882	0.0588
	Total transactions	0.0992	0.2941	0.0941
Currency options		0.0025	0.2941	0.1882
Other financial derivatives		0.0007	0.1176	0.0824
Total financial derivatives		-	1.4470	0.4471
Panel C. Firms with foreign currency-denominated debt (51 firms)				
Currency forwards	Buy transactions	0.0161	0.0588	0.0588
	Sell transactions	0.0000	0.0000	0.0000
	Total transactions	0.0161	0.0588	0.0588
Currency Futures	Buy transactions	0.0013	0.0196	0.0196
	Sell transactions	0.0000	0.0000	0.0000
	Total transactions	0.0013	0.0196	0.0196
Currency options		0.0000	0.0588	0.0588
Other financial derivatives		0.0022	0.1372	0.1176
Total financial derivatives			0.2745	0.1764

Table 2. Summary statistics of key variables by types of firms

The sample consists of 387 Korean manufacturing firms during 1998-2005. Firm size is measured as the market value of common stock. Export ratio is the ratio of sales from exporting to total sales. All debt ratios are measured as proportions of total assets. Net dollar-denominated debt (DDD) is the difference between total dollar-denominated debt and total dollar-denominated assets. R&D ratio is the ratio of annual total R&D expenditure to total sales. Total foreign currency-denominated (FCD) debt includes dollar- and other currency-denominated debt. Market risk is measured by the firm beta. All variables represent annual figures of all sample firms.

	Mean	Maximum	75%	Median	25%	Minimum
Panel A. Full sample firms (387 firms)						
Firm size ($ million)	1,076	54,041	367	98	43	5
Export ratio	0.2280	0.9819	0.4285	0.0967	0.0000	0.0000
Net DDD ratio	0.0095	0.4753	0.0359	0.0000	-0.0085	-1.0295
DDD ratio	0.0692	0.5923	0.0889	0.0235	0.0000	0.0000
R&D ratio	0.0090	0.1582	0.0115	0.0026	0.0000	0.0000
Market risk	0.7210	1.6484	0.9124	0.6756	0.5038	0.1538
Total net FCD debt ratio	0.0161	0.4986	0.0474	0.0000	-0.0077	-1.0089
Total FCD debt ratio	0.0817	0.5925	0.1084	0.0000	0.0000	0.0000
Panel B. Exporting firms (94 firms)						
Firm size ($ million)	226	6,370	102	59	33	5
Export ratio	0.4750	0.9819	0.6818	0.4568	0.2451	0.1109
Net DDD ratio	-0.1225	-0.0010	-0.0359	-0.0831	-0.1445	-1.0294
DDD ratio	0.0499	0.3509	0.0683	0.0327	0.0097	0.0000
R&D ratio	0.0181	0.1582	0.0228	0.0102	0.0035	0.0000
Market risk	0.6986	1.2650	0.8526	0.6913	0.5038	0.2114
Total net FCD debt ratio	-0.1230	0.0482	-0.0321	-0.0851	-0.1379	-1.0089
Total FCD debt ratio	0.0660	0.3509	0.0823	0.0569	0.0237	0.0000
Panel C. Firms with foreign currency-denominated debt (51 firms)						
Firm size ($ million)	120	1,067	130	67	36	6
Export ratio	0.0227	0.0740	0.0420	0.0184	0.0022	0.0000
Net DDD ratio	0.0821	0.4068	0.1142	0.0296	0.0123	-0.2490
DDD ratio	0.0998	0.4184	0.1253	0.0376	0.0234	0.0101
R&D ratio	0.0107	0.0567	0.0182	0.0045	0.0016	0.0000
Market risk	0.6245	1.3780	0.7277	0.5763	0.4951	0.2954
Total net FCD debt ratio	0.0954	0.4986	0.1389	0.0384	0.0207	-0.2402
Total FCD debt ratio	0.1146	0.4986	0.1531	0.0706	0.0299	0.0104

Table 3. Distribution of estimated regression coefficients of asymmetric foreign exchange exposure

This table reports the regression results from the equation (1) using real stock return for individual firm as dependent variable. The key variable in regression equation is γ, the coefficient that represents the degree of asymmetry in foreign exchange exposures according to the direction of a change in the foreign exchange rate. Foreign exchange (FX) rate is expressed as Korean won per US dollar (won/USD) and thus *FXR*, change in a real foreign exchange rate, is measured as changes in the monthly average exchange rates of daily exchange rates adjusted by the difference in inflation rates (proxied by consumer price index) between Korea and the U.S. The number in each cell represents the number of firms belonging to the classified group.

	When FX rate increases	When FX rate declines	Total FX exposure
Panel A. Full sample firms			
$\gamma>3$	12	7	2
$3\geq\gamma>2$	58	37	15
$2\geq\gamma>1$	59	40	37
$1\geq\gamma>0$	81	80	108
$0\geq\gamma>-1$	66	98	148
$-1\geq\gamma>-2$	40	67	60
$-2\geq\gamma>-3$	56	54	14
$-3\geq\gamma$	15	4	3
Average γ	0.027	0.221	0.137
Panel B. Exporting firms			
$\gamma>3$	2	1	1
$3\geq\gamma>2$	12	7	1
$2\geq\gamma>1$	13	8	9
$1\geq\gamma>0$	19	18	21
$0\geq\gamma>-1$	18	19	36
$-1\geq\gamma>-2$	11	17	13
$-2\geq\gamma>-3$	8	15	3
$-3\geq\gamma$	2	0	1
Average γ	-0.003	0.366	0.205
Panel C. Firms with dollar-denominated debt			
$\gamma>3$	1	2	1
$3\geq\gamma>2$	5	3	3
$2\geq\gamma>1$	9	6	6
$1\geq\gamma>0$	13	18	16
$0\geq\gamma>-1$	11	8	16
$-1\geq\gamma>-2$	3	9	6
$-2\geq\gamma>-3$	6	5	2
$-3\geq\gamma$	3	0	1
Average γ	0.381	-0.433	-0.079

Table 4. Regression analysis of the effectiveness of financial derivatives for full sample firms

The sample consists of 387 Korean manufacturing firms during 1998-2005. The dependent variable is asymmetric foreign exchange exposure of each firm estimated from equation (1). *EXPT* is export ratio (relative to total sales). *DDDR* is dollar-denominated debt ratio. *RND* is R&D expense ratio (relative to total sales). *FSIZE* is firm size. *MRISK* is market risk measured by beta. *FINDER* is financial derivatives. Industry dummies follow KSIC classifications and spanning sixteen Korean industries. t-statistics are in parentheses. *, **, *** denotes significance at the 10%, 5%, and 1% level, respectively.

	Total FX exposure		When FX rate increases		When FX rate declines	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Intercept	-1.529 (-2.61)***	-1.763 (-2.80)***	-0.083 (-0.08)	-0.273 (-0.27)	-1.106 (-1.27)	-1.330 (-1.39)
EXPT	0.162 (0.62)	0.246 (0.93)	0.631 (1.48)	0.690 (1.56)	-0.104 (-0.31)	-0.023 (-0.06)
DDDR	-0.619 (-1.45)	-0.611 (-1.48)	0.403 (0.65)	0.407 (0.66)	-0.223 (-0.43)	-0.221 (0.43)
RND	2.249 (0.62)	2.353 (0.64)	9.784 (2.07)**	9.808 (2.08)**	-1.812 (-0.39)	-1.788 (-0.38)
FSIZE	0.058 (1.86)*	0.071 (2.11)**	-0.051 (-0.95)	-0.041 (-0.72)	0.102 (2.11)**	0.114 (2.16)**
MRISK	0.582 (3.01)***	0.584 (3.05)***	1.009 (2.83)***	1.013 (2.83)***	-0.641 (-2.24)**	-0.639 (-2.25)**
FINDER		-0.026 (-1.31)		-0.019 (-0.64)		-0.025 (-0.77)
λ_1 (Food products & beverages)	-0.232 (-0.98)	-0.226 (-0.96)	-0.448 (-1.36)	-0.443 (-1.35)	-0.048 (-0.15)	-0.042 (-0.13)
λ_2 (Textiles)	0.124 (0.38)	0.086 (0.26)	-0.387 (-0.69)	-0.411 (-0.73)	0.036 (0.10)	-0.004 (-0.01)
λ_3 (Sewn apparel & fur articles)	-0.00 (-1.03)	0.007 (0.03)	0.35 (0.82)	0.358 (0.85)	-0.761 (-1.22)	-0.754 (-1.21)
λ_4 (Pulp, Paper & Paper Products)	0.104 (0.48)	0.103 (0.48)	-1.101 (-3.80)***	-1.111 (-3.84)***	0.012 (0.02)	0.012 (0.02)
λ_5 (Chemical & chemical products)	0.292 (1.35)	0.302 (1.39)	0.378 (1.26)	0.389 (1.28)	-0.392 (-1.61)	-0.382 (-1.57)
λ_6 (Rubber & plastic products)	0.129 (0.36)	0.112 (0.32)	-0.292 (-0.60)	-0.300 (-0.62)	0.215 (0.62)	0.198 (0.57)
λ_7 (Non-metallic Mineral Products)	0.595 (2.99)***	0.611 (3.10)***	0.258 (1.00)	0.268 (1.05)	0.322 (0.87)	0.335 (0.90)
λ_8 (Basic metals)	-0.382 (-1.33)	-0.352 (-1.22)	0.440 (1.15)	0.469 (1.21)	-1.262 (-4.06)***	-1.227 (-3.87)***
λ_9 (Fabricated metal products)	0.569 (1.46)	0.577 (1.50)	-0.002 (-0.00)	0.001 (0.002)	0.207 (0.40)	0.218 (0.42)
λ_{10} (Other mach. & equipment)	0.107 (0.36)	0.117 (0.39)	-0.766 (-1.58)	-0.751 (-1.55)	0.225 (0.52)	0.232 (0.54)
λ_{11}(Elec. mach. &	-0.31	-0.275	-0.719	-0.689	-0.218	-0.183

apparatuses)	(-0.99)	(0.87)	(-1.77)*	(-1.70)*	(-0.52)	(-0.42)
λ_{13}(Motor vehicles & trailers)	-0.225 (-0.75)	-0.269 (-0.91)	-0.675 (-1.46)	-0.707 (-1.51)	0.289 (0.71)	0.241 (0.59)
λ_{14}(General construction)	0.432 (0.71)	0.435 (2.02)**	-0.527 (-1.29)	-0.520 (-1.28)	1.135 (4.23)***	1.131 (4.19)***
λ_{15}(Wholesales & merch. broker)	0.151 (0.71)	0.154 (0.73)	0.715 (2.02)**	0.707 (2.01)**	-0.587 (-2.03)**	-0.585 (-2.05)**
No. of firms	376	376	307	307	337	337
Adjusted R^2	0.065	0.066	0.074	0.072	0.086	0.085

Table 5. Regression analysis of the effectiveness of financial derivatives for exporting firms

The sample consists of 94 Korean exporting manufacturing firms during 1998-2005. The dependent variable is asymmetric foreign exchange exposure of each firm estimated from equation (1). *EXPT* is export ratio (relative to total sales). *DDDR* is dollar-denominated debt ratio. *RND* is R&D expense ratio (relative to total sales). *FSIZE* is firm size. *MRISK* is market risk measured by beta. *FINDER* is financial derivatives. *IND* is industry dummies; for brevity's sake, regression estimates of *IND* are not reported here. t-statistics are in parentheses. *, **, *** denotes significance at the 10%, 5%, and 1% level, respectively.

Variables	Total FX exposure		When FX rate increases		When FX rate declines	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Panel A. Exporting firms (sample size = 94); Export to sales ratio > 10% & net dollar-denominated debt to firm value <1% (including firms with net dollar-denominated assets)						
Intercept	-2.959 (-2.35)**	-3.350 (-2.63)***	-3.023 (-1.213)	-3.262 (-1.32)	-0.125 (-0.05)	-0.602 (-0.26)
EXPT	0.046 (0.11)	0.064 (0.15)	1.501 (2.49)**	1.361 (2.17)**	0.168 (0.24)	0.178 (0.25)
RND	4.229 (0.92)	3.991 (0.84)	15.298 (4.22)***	14.158 (3.59)***	0.523 (0.07)	0.206 (0.03)
FSIZE	0.190 (2.47)**	0.212 (2.76)***	0.126 (0.84)	0.150 (1.02)	0.018 (0.15)	0.044 (0.35)
MRISK	-0.394 (-0.76)	-0.314 (0.60)	-0.858 (-1.17)	-0.895 (-1.21)	-0.059 (-0.09)	0.047 (0.08)
FINDER		-0.056 (-1.21)		-0.030 (-0.46)		-0.057 (-0.89)
IND dummies	Yes	Yes	Yes	Yes	Yes	Yes
No. of firms	83	83	75	75	74	74
Adjusted R^2	0.09	0.092	0.051	0.024	0.096	0.09
Panel B. Exporting firms with net dollar-denominated debt (sample size = 94); Export to sales ratio >10% & net dollar-denominated debt to firm value >1%						
Intercept	-1.5226 (-1.19)	-1.4145 (-0.99)	2.021 (0.97)	2.809 (1.14)	1.077 (0.57)	2.113 (0.95)
EXPT	0.4159 (0.96)	0.4120 (0.95)	-1.100 (-1.09)	-1.204 (-1.19)	0.758 (0.96)	0.618 (0.80)
DDDR	-1.8795 (-2.15)**	-1.8902 (-2.13)**	2.162 (1.07)	2.044 (0.98)	-0.253 (-0.13)	-0.417 (-0.21)
RND	3.7575 (0.53)	3.9584 (0.53)	26.843 (1.68)*	27.661 (1.71)*	14.221 (1.27)	16.122 (1.48)
FSIZE	0.0994 (1.26)	0.0935 (1.08)	-0.121 (-0.91)	-0.162 (-1.08)	-0.053 (-0.47)	-0.108 (-0.82)
MRISK	-0.4518 (-0.85)	-0.4661 (-0.86)	0.714 (0.71)	0.612 (0.63)	-0.497 (-0.59)	-0.606 (-0.71)
FINDER		0.0069 (0.21)		0.044 (0.89)		0.060 (1.03)
IND dummies	Yes	Yes	Yes	Yes	Yes	Yes
No. of firms	89	89	76	76	83	83
Adjusted R^2	0.010	0.010	0.073	0.064	0.02	0.019

Table 6. Regression analysis of the effectiveness of financial derivatives for firms with dollar-denominated debt

The sample consists of 51 Korean manufacturing firms with dollar-denominated debt during 1998-2005. The dependent variable is asymmetric foreign exchange exposure of each firm estimated from equation (1). *DDDR* is dollar-denominated debt ratio. *RND* is R&D expense ratio (relative to total sales). *FSIZE* is firm size. *MRISK* is market risk measured by beta. *FINDER* is financial derivatives. *IND* is industry dummies; for brevity's sake, regression estimates of *IND* are not reported here. t-statistics are in parentheses. *, **, *** denotes significance at the 10%, 5%, and 1% level, respectively.

Variables	Total FX exposure		When FX rate increases		When FX rate declines	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Panel A. Firms with gross dollar-denominated debt (sample size = 51): Export to sales ratio < 10% & gross dollar-denominated debt to firm value > 1%						
Intercept	-1.868 (-0.69)	-1.868 (-0.69)	5.177 (1.81)*	5.156 (1.82)*	-10.544 (-3.19)***	-10.488 (-3.17)***
DDDR	-2.331 (-2.27)**	-2.331 (-2.27)**	-2.741 (-2.30)**	-2.736 (-2.29)**	-2.029 (-1.45)	-2.009 (-1.42)
RND	-22.400 (-1.27)	-22.400 (-1.27)	-21.416 (-1.07)	-22.112 (-1.08)	-42.207 (-3.60)***	-43.487 (-3.92)***
FSIZE	0.069 (0.41)	0.069 (0.41)	-0.441 (-2.53)**	-0.442 (-2.52)**	0.648 (3.33)***	0.640 (3.25)***
MRISK	0.940 (0.82)	0.94 (0.82)	3.648 (2.95)***	3.665 (2.90)***	-1.260 (-1.32)	-1.19 (-1.21)
FINDER		-0.012 (-0.07)		0.022 (0.12)		0.068 (0.76)
IND dummies	Yes	Yes	Yes	Yes	Yes	Yes
No. of firms	49	49	51	42	45	45
Panel B. Firms with net dollar-denominated debt (sample size = 42): Export to sales ratio < 10% & net dollar-denominated debt to firm value > 1%						
Intercept	-2.363 (-1.06)	-2.235 (-1.00)	8.097 (2.82)***	7.975 (2.82)***	-10.542 (-2.74)***	-10.429 (-2.69)***
DDDR	-3.022 (-2.67)***	-3.254 (-2.97)***	-4.207 (-3.11)***	-4.785 (-3.41)***	-1.703 (-1.12)	-1.786 (-1.14)
RND	-26.938 (-1.74)*	-35.580 (-1.61)	-22.858 -1.03	-59.794 (-2.59)***	-43.181 (-3.29)***	-45.937 (-3.63)***
FSIZE	0.159 (1.22)	0.1470 (1.12)	-0.579 (-3.19)***	-0.609 (-3.39)***	0.651 (2.92)***	0.640 (2.82)***
MRISK	-0.354 (-0.42)	-0.143 (-0.15)	4.050 (3.17)***	4.676 (4.18)***	-1.293 (-1.16)	-1.205 (-1.05)
FINDER		0.305 (0.75)		1.067 (2.72)***		0.132 (0.63)
IND dummies	Yes	Yes	Yes	Yes	Yes	Yes
No. of firms	40	40	34	34	36	36
Adjusted R^2	0.026	0.005	0.302	0.365	0.214	0.182