Determinants of the Extent of Asia-Pacific Banks' Derivative Activities

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Abstract:

We present an analysis of the determinants of Asia-Pacific banks' extent of derivative activities. Our findings suggest that the probability of financial distress and economies of scale arguments are important in this regard. Further analyses reveal that Asia-Pacific dealer banks tend to use more foreign currency derivatives while interest rate derivatives are generally used for hedging purposes. The finding that government-owned banks tend to have less derivative activities provides some indication of possible moral hazard behaviour in Asia-Pacific banks. Thus, derivative activities of government-owned banks should be monitored more closely to ensure that there is no unwarranted risk taking.

1. Introduction

There has been a dramatic increase in Asia-Pacific banks' derivative activities in recent years. In April 2004, the daily turnover of over the counter (OTC) foreign currency and interest rate derivatives in the Asia-Pacific region was USD 400,000 million and USD 67,341 million, respectively. Relative to 2001, this represents a 40% increase in the turnover of OTC foreign currency derivatives and 110% increase in the turnover of OTC interest rate derivatives (Bank for International Settlements, 2005).

Derivatives are used by banks for risk management as well as for trading purposes. While the use of derivatives in non-financial firms has been well studied, considerably less attention has been given to their use in financial firms.. Given the growing importance of banks' derivative activities, several recent studies have investigated whether the determinants of banks' derivative activities are explained by a similar set of variables that explain non-financial firms' derivative activities. Some of these studies focus on small community banks (Carter and Sinkey Jr., 1998) while other studies focus on dealer banks (Shyu and Reichert, 2002).

Studies investigating the determinants of banks' derivative activities have generally been confined to US banks.[1] This is despite the growing importance of derivative usage in the Asia-Pacific region. Asia-Pacific banks are unique relative to US and European banks as they typically play a more important role in economic growth, especially in the developing Asian economies. Additionally, they have different financial and ownership characteristics. Genay (1998), for example, identifies that Japanese banks are more leveraged, more dependent on deposits as their source of funds and have significantly greater equity investments relative to US

[1] One exception is Shyu and Reichert's (2002) study which includes large US, European and Japanese dealer banks.

banks. Government ownership of banks is also more common in the Asia-Pacific region relative to the US and Europe (Barth *et al.*, 2001). As such, an investigation of the determinants of the extent of Asia-Pacific banks' derivative activities is warranted. In our paper, we investigate the determinants of the extent of Asia-Pacific banks' derivative activities. Our sample of Asia Pacific banks is representative as it includes commercial banks, government owned banks and dealer banks. Further, including dealer banks presents the opportunity to investigate whether there are any differences in derivative activities of dealer and non-dealer banks. Given the highly publicised failure of some dealer banks (e.g. Orange County and Barings), regulators are most concerned about banks that are actively involved in derivative activities, since bank failures can have a devastating effect on the economy.

Our paper contributes to the literature by providing new empirical evidence on the determinants of Asia-Pacific banks' derivative activities. This strength of this achievement is underscored in several ways. Since Asia-Pacific and US banks have different financial and ownership characteristics, the results will assist in determining whether the theories explaining banks' derivative activities are applicable to Asia-Pacific banks. This analysis enables the comparison of the importance of these theories for Asia-Pacific banks relative to US banks. The findings of this study will assist investors and bank regulators in identifying characteristics of banks that are more likely to have a greater extent of derivative activities.

We find evidence of the probability of financial distress and economies of scale being important in explaining Asia-Pacific banks' derivative activities. Consistent with previous studies investigating US banks, bank size is not a significant determinant of derivative activities for non-dealer banks. With country dummies, a greater number of independent variables are found to be statistically significant

including dividends, long-term interest rate exposure, ownership dispersion and government ownership, supporting the substitutes for hedging, exposure to risks and moral hazard hypotheses. These results are generally consistent with past studies of US banks.

2. Prior Literature

2.1 Theories of Determinants of Banks' Derivative Activities

Finance theory offers several hypotheses to explain why firms use derivatives. These hypotheses suggest that corporate hedging increases firm value by reducing the probability of financial distress, the expected tax liability and underinvestment costs in the presence of market imperfections. Smith and Stulz (1985) show that hedging reduces the probability of financial distress by reducing the variance of a firm's cash flows. Thus, a firm that faces a greater probability of financial distress is more likely to use derivatives. Smith and Stulz (1985) also postulate that a convex tax schedule in the firm's pre-tax income would indicate that hedging reduces the volatility of a firm's cash flows and produces tax benefits. Reduced volatility of cash flows through hedging enables more effective management of tax obligations, thereby increasing firm value.

Myers (1977) demonstrates the underinvestment problem by characterising firms' potential investment opportunities as options. He argues that with debt in a firm's capital structure, taking positive net present value projects can reduce shareholders' wealth if the gains accrue primarily to debtholders. Consequently, the shareholders may have incentives to forego positive net present value projects. Froot *et al.* (1993) argue that hedging can reduce the underinvestment problem by ensuring

that a firm has sufficient internal funds available to take advantage of attractive investment opportunities.

Numerous studies have attempted to test propositions explaining corporate hedging decisions. Nance *et al.* (1993) provide a comprehensive examination of these propositions. They also recognise that firms can effectively control their risk through adjustments of balance sheet items such as convertible debt, preferred stock and maintenance of high liquidity to reduce cash flow volatility. The use of convertible debt helps control conflicts of interest among stockholders and bondholders and thereby reduces incentives to hedge. Preferred stock reduces the probability of financial distress because firms can omit a preferred dividend payment without being forced into bankruptcy. The use of these methods represents a substitute to the use of off-balance sheet hedging.

Fok *et al.* (1997) additionally suggest that corporate ownership structure may affect the desirability of hedging. Larger managerial ownership may make hedging more valuable due to managerial risk aversion, since a large percentage of their personal wealth depends on the performance of the firm. Tufano (1996) argues that firms with a larger percentage of institutional shareholders tend to hedge less because these shareholders tend to be better diversified in their investments. In addition to corporate ownership structure, Geczy *et al.* (1997) support foreign exchange risk and economies of scale in hedging activities as important determinants of the use of currency derivatives.

Since banks are in the business of managing risk for themselves and for clients, and are the largest users of financial derivatives, investigation of the

determinants of derivative usage has also been conducted in the banking industry.[2] However, the use of derivatives by banks is more complicated because often they are derivative end-users as well as dealers. Compared to non-banks, commercial banks are also unique in the sense that they operate in a highly regulated and protected environment (Sinkey Jr. and Carter, 1997).

Recognising the uniqueness of the banking industry, Sinkey Jr. and Carter (1997, 2000) modify the derivative usage model of Nance *et al.* (1993) to capture bank specificity with respect to derivative activities. In particular, they suggest that banks' derivative activities can increase bank value by reducing the probability of financial distress, expected taxes and agency costs, or by increasing fee income and enhancing bank-customer relationships. To reflect the highly regulated and protected operating environment of banks, Sinkey Jr. and Carter (1997) introduce the regulatory hypothesis and moral hazard hypothesis as additional explanations of banks' derivative usage. The regulatory hypothesis suggests that banks should only use derivatives when they have sufficient capital to meet regulatory requirements. Alternatively, the moral hazard hypothesis suggests that riskier banks might refrain from hedging to exploit government deposit insurance[3] or engage in derivative activities for speculative reasons. However, the moral hazard behaviour can be offset or reduced by market or regulatory discipline or both.

[2] The previous literature has also looked into the derivative usage in other industries. For example, Tufano (1996) in the gold mining industry, Koski and Pontiff (1999) in the mutual fund industry and Harwick and Adams (1999) in the life insurance industry.

[3] Deposit insurance is a government guarantee scheme for deposits to promote the stability of the banking systems, as well as to protect small depositors from losses due to bank failures (Demirguc-Kunt and Sobaci, 2000). Demirguc-Kunt and Sobaci (2000) argue that authorities in every country establish a de facto insurance system (either implicitly or explicitly) to prevent bank failures.

2.2 Empirical Literature on the Determinants of Banks' Derivative Activities

Similar to the empirical literature investigating the determinants of derivative use by non-banks, previous literature investigating the determinants of banks' derivative activities addresses two related questions: (1) What are the determinants of banks' decisions to participate in derivatives activities? (e.g. Gunther and Siems, 1995; Sinkey Jr. and Carter, 2000) and (2) If banks use derivatives, what determines the extent of usage? (e.g. Sinkey Jr. and Carter, 2000; Gunther and Siems, 2002; Shyu and Reichert, 2002).

Previous studies of the determinants of banks' derivative activities include the following explanatory variables: firm size (to proxy for economies of scale); leverage (to proxy for probability of financial distress); capital (to proxy for regulatory and moral hazard behaviour); interest rate and credit risks (to proxy for risk exposures); net interest margin (to proxy for intermediation profitability); and liquidity and dividend payout (to proxy for substitutes for hedging).

2.2.1 Determinants of Banks' Decisions to Participate in Derivative Activities

The extant literature examining the determinants of banks' decisions to participate in derivative activities suggests that banks that use derivatives are frequently found to be larger and have higher leverage relative to non-user banks (Gunther and Siems, 1995; Sinkey Jr. and Carter, 2000). However, the evidence for exposure to risks and intermediation profitability are mixed. Although Sinkey Jr. and Carter (2000) show that derivative users tend to have higher interest rate risks and lower net interest margins, Gunther and Siems (1995) find contrasting evidence. This divergence in results could be due to the different sample periods investigated.[4]

[4] The sample period of Gunther and Siems (1995) is 1991 to 1994 while, the sample period of Sinkey Jr. and Carter (2000) is 1996.

Another strand of literature investigates the determinants of derivative activities of end-user banks (i.e. banks that use derivatives for hedging only) to empirically separate hedging motives from other reasons for engaging in derivative transactions. Carter and Sinkey Jr. (1998) and Gunther and Siems (2002) investigate US commercial banks with total assets between $100 million and $1 billion because these banks are more likely to be end-users of derivatives. Hogan and Rossi (1997) and Hogan and Malmquist (1999) investigate US savings associations' derivative usage. By regulation, US savings associations can only be end-users of derivatives and cannot engage in dealer activities.

Carter and Sinkey Jr. (1998) and Gunther and Siems (2002) present evidence that the use of interest rate hedging derivatives is positively related to bank size and exposure to interest rate risk (measured by the absolute value of the 12 month maturity gap). Hogan and Rossi (1997) find that the use of hedging derivatives by thrifts (end-users of derivatives) is positively associated with total assets and interest rate risk, and negatively associated with capital, leverage and net interest margin.

The studies thus far mentioned focus only on banks' financial characteristics of banks to explain derivative usage and ignore banks' ownership characteristics. Whidbee and Wohar (1999) do examine whether corporate-control and ownership-structure characteristics influence the hedging decision of banks. They assert that, unlike managers in non-financial firms, managers in the banking industry are less likely to hedge as their shareholding increases (when insider shareholding is greater than 10% of total shareholding). In addition, they also find that banks are less likely to use derivatives as outside director shareholding increases. This is attributed to the risk shifting opportunities provided by government deposit insurance. When insider shareholding is below 10% and outside directors hold a large percentage of board

seats, banks are more likely to use derivatives for risk management due to external monitoring.

2.2.2 Determinants of Banks' Extent of Derivative Activities

Examining the determinants of banks' extent of derivative activities, Gunther and Siems (1995) find that the results are very similar to their investigation of banks' decisions to participate in derivative activities. However, relative to other US bank studies, the results remain mixed. For example, Sinkey Jr. and Carter (2000) report that bank capital is negatively associated with the extent of derivative activities while Gunther and Siems (1995) find contrasting evidence.

Although interest rate risk and net interest margin are both significant determinants of the extent of derivative activities, Gunther and Siems (1995) demonstrate that interest rate exposure (net interest margin) is negatively (positively) associated with the extent of derivative activities. Sinkey Jr. and Carter (2000) find contrary evidence. The different results could be due to different sampling periods and variables investigated.[5]

Sinkey Jr. and Carter (2000) further investigate the effect of being a dealer bank on the extent of derivative use. They run three separate regression models: all banks, all banks with a dealer dummy variable and all banks excluding dealer banks. They observe very similar results for dealer and non-dealer banks except for differences for net interest margin (NIM) and leverage (NOTES). They find that NIM is only significantly negative when dealer banks have been excluded from the sample or when a dealer dummy is included. They interpret this finding as non-dealer banks

[5] While Gunther and Siems (1995) investigate the derivative activities of US commercial banks from 1991-1994, Sinkey Jr. and Carter (2000) examine derivative activities in 1996. In addition to the variables examined by Gunther and Siems (1995), Sinkey Jr. and Carter (2000) include the effect of credit risk and bank holding company. However, they exclude growth opportunities and preference shares.

using derivatives, at least in part, to protect their net interest income. The coefficient on NOTES is positive and significant only for non-dealer banks. This finding supports the hypothesis that derivatives are used by non-dealers as a hedging tool to reduce the probability of financial distress.

The only international study examining financial and regulatory factors that influence the extent of derivative activities is Shyu and Reichert (2002). They study thirty-two large international dealer banks (including US, European and Japanese banks) during the 1995-1997 period. They focus on international dealer banks because these banks have substantial international activities and are exposed to a variety of risks such as interest rate risk, foreign exchange risk and credit risk.

Shyu and Reichert (2002) report that banks' derivative activities are positively associated with banks' capital ratio, size, maturity gap, and credit rating but inversely associated with bank profitability. Comparing the effect of regulations across countries, they find that commercial banks that are allowed to pursue direct securities activities (i.e. European banks) have less derivative activities relative to banks that are restricted in their ability to pursue direct securities activities (i.e. US and Japanese banks). The European banks allowed to make direct investment in industrial firms have a greater level of derivative activities relative to banks that are restricted in their ability to make such investments. Direct investment in industrial firms provides more opportunities for European banks to cross-sell various types of derivatives.

3. Hypothesis Development and Variable Definitions

Based on the extant literature, this study hypothesises that the extent of Asia-Pacific banks' derivative activities is a function of the probability of financial distress, underinvestment cost, economies of scale, hedging substitutes, ownership structure,

regulatory and moral hazard hypothesis, exposure to risks, intermediation profitability, dealer status and country specific dummies.

3.1 Dependent Variable: Extent of Derivative Activities (TDER)

The extent of derivative activities (TDER), the dependent variable, is measured by the ratio of the notional value of outstanding derivative contracts scaled by total assets. Following Demsetz and Strahan (1997) and Sinkey Jr. and Carter (2000), this study recognises that although the notional value does not reflect either the market value or the risk of the contracts, it is a satisfactory measure of the extent of derivative involvement as there is no available superior alternative measure. In additional analysis, this study also measures the extent of interest rate derivatives (IRD) and foreign currency derivatives (FCD) by the ratio of notional value of outstanding interest rate and foreign currency derivatives scaled by total assets, respectively.[6]

3.2 Independent Variables

3.2.1 Probability of Financial Distress: Leverage (LEV)[7]

Smith and Stulz (1985) argue that hedging can reduce the probability of financial distress by reducing the variance of cash flows. Therefore, banks with greater leverage (LEV), hence a greater probability of experiencing bankruptcy, are more likely to use derivatives to a greater extent (Sinkey Jr. and Carter, 2000). Sinkey Jr. and Carter (2000) measure leverage as total notes and debentures scaled by total assets. Since not all sample banks report in a disaggregated manner their total notes and debentures, this study employs bank borrowings scaled by total assets as a proxy.

[6] For the majority of the sample banks, the notional value of derivative contracts reported in annual reports is not disaggregated into hedging and trading categories. Thus, a more detailed analysis of the determinants of banks' use of derivatives for hedging versus trading purposes could not be conducted.

[7] The tax hypothesis is not investigated here since the taxation regime varies across Asia-Pacific countries and some sample countries do not have a progressive corporate tax rate.

However, as noted by Sinkey Jr. and Carter (1997), the notion that risk management reduces the costs of financial distress may not apply to banks because of deposit insurance. Therefore, this study hypothesises an association between LEV and TDER but does not predict the direction of the association.

3.2.2 Underinvestment Cost: Asset Growth (GRW)

Froot *et al.* (1993) suggest that hedging enhances firm value by ensuring that a firm has sufficient internal funds available to take advantage of attractive investment opportunities. Thus, banks with more growth opportunities are more likely to hedge to avoid underinvestment costs. This study hypothesises a positive association between asset growth (GRW) and TDER. Following Sinkey Jr. and Carter (1997), a bank's growth opportunities are proxied by the growth rate of total on-balance sheet assets from year 2001 to year 2002 for observations in 2002 and from year 2002 to year 2003 for observations in 2003.

3.2.3 Economies of Scale: Bank Size (SIZE)

Bank size (SIZE) is measured as the natural logarithm of total assets. Larger banks tend to be involved in derivative activities to a greater extent because they are better able to absorb the cost of managing derivative activities. These include the costs of hiring skilled personnel and the implementation of internal controls. Hogan and Malmquist (1999) also find that smaller banks faced higher transaction costs when using over the counter derivatives. Since larger banks have larger customer bases and greater investment in the technical expertise relative to smaller banks, they are also more likely to deal with derivatives. This is consistent with the suggestion of Demsetz and Strahan (1997) that large banks are better diversified than small banks and they

use their diversification advantage to operate with lower capital ratios and pursue riskier activities such as derivative activities.

Bank size can capture many facets of a bank. For example, bank size may also be an inverse proxy for financial distress cost. Smaller banks, relative to larger banks, can benefit more from hedging with derivatives because the cost of bankruptcy for smaller banks is proportionately greater than those for larger banks (Sinkey Jr. and Carter, 2000). However, this might not apply in the Asia-Pacific banking industry due to government deposit insurance. Therefore, this study hypothesises a positive association between SIZE and TDER.

3.2.4 Substitutes for Hedging

In addition to managing risk using derivatives, Nance *et al.* (1993) suggest that firms can also manage their risk on-balance sheet by investing in safer (more liquid) assets and limit their dividend payouts.

3.2.4.1 Liquidity (LIQ)

Since liquid assets can be converted into cash more easily, the danger associated with variable cash flows can be reduced (Sinkey Jr. and Carter, 2000). As such, liquidity represents a substitute for hedging and a negative association is hypothesised between liquidity (LIQ) and TDER. LIQ is measured as liquid assets (sum of cash, call loans and short-term trading assets) scaled by total assets.

3.2.4.2 Dividends (DIV)

Banks can use derivatives to hedge to reduce the volatility of their cash flows. This enables banks to payout a higher percentage of income as dividends (than it otherwise would) while ensuring that sufficient cash is available for debt payments (Carter and Sinkey Jr., 1998). Therefore, a positive association is hypothesised between the

amount distributed as dividends (DIV) and TDER. DIV is measured as total dividends paid scaled by total assets.

3.2.5 Ownership Structure

Whidbee and Wohar (1999) illustrate that corporate-control and ownership-structure characteristics influence banks' hedging decisions. However, data on ownership structure, such as managerial shareholding, outside directors on the board and percentage shares held by institutional investors, are generally not available for the sample of Asia-Pacific banks.

While US banks are often widely held, ownership and control of Asia-Pacific banks tends to be concentrated. Claessens *et al.* (2000) highlight that more than two-thirds of firms (both banks and non-banks) are controlled by a single shareholder in East Asian countries and that the concentration of control generally diminishes with the country's level of economic development.[8] In addition, government ownership of banks is also prevalent in the Asia-Pacific region (Barth *et al.*, 2001). Therefore, our study employs ownership dispersion and government ownership as ownership structure measures.

3.2.5.1 Ownership Dispersion (DISP)

Laeven (2002) observes that banks with dispersed ownership engage in a relatively low level of risk taking compared to banks with concentrated ownership. This is because shareholders with concentrated ownership in banks, such as companies belonging to Japanese *Keiretsu* and Korean *Chaebols*, tend to take on more risks for their own commercial interest. Thus, we hypothesise a positive association between

[8] Claessens *et al.* (2000) investigate the ownership and control of 2980 publicly traded companies including financial institutions and non-financial institutions of nine East Asian countries (Hong Kong, Indonesia, Japan, South Korea, Malaysia, the Philippines, Singapore, Taiwan and Thailand).

ownership dispersion (DISP) and TDER. The DISP dummy variable takes the value of unity if no shareholder owns more than 25 percent of the banks' shares and zero otherwise.[9]

3.2.5.2 Government Ownership (GOV)

Laeven (2002) also finds that banks with state ownership tend to take on less risk relative to family-owned and company-owned banks. This is probably due to the government monitoring of banks. Thus, a positive associated between government ownership (GOV) in banks and TDER is hypothesised. GOV is measured by a dummy variable coded one if the government is among the top 10 shareholders of a bank and zero otherwise.

3.2.6 Regulatory Hypothesis and Moral Hazard Hypothesis: Capital (CAP)

Merton and Bodie (1992) suggest that because of regulatory capital requirements, banks must have 'assurance capital' to participate in new activities. They describe assurance capital as a cushion that can serve as an alternative to frequent surveillance by bank regulators. In addition, bank capital may be viewed as a measure of creditworthiness by the market. Jagtiani (1996) argues that higher levels of capital are required for participation in the market for swaps because banks with more capital are viewed as being more creditworthy. The same should be true for other over-the counter instruments (Carter and Sinkey Jr., 1998).

Alternatively, there could be a negative relationship between capital and the extent of derivative activities because of moral hazard behaviour, where banks with low capital ratios tend to be involved in greater derivative activities since they are

[9] While Laeven (2002) measures dispersion as a dummy equal to one if no shareholder owns more than 5% shares (and 20% shares in robustness test), the measure of dispersion in this study (dummy equal to unity if no shareholder owns more than 25% shares in banks, zero otherwise), is reported by *Bankscope* and is the best available consistent measure of shareholder dispersion for Asia-Pacific banks.

protected by government deposit insurance (Besanko and Kanatas, 1996). However, Konishi and Yasuda (2004) find that rather than increasing risk taking, the implementation of a capital adequacy requirement in 1993 reduced risk taking by Japanese commercial banks. Thus, we hypothesise an association between capital (CAP) and TDER but no prediction is made for the direction of this association. CAP is measured as a bank's book value of equity scaled by total assets.

3.2.7 Risk Exposures

Monitoring from regulators and investors also encourages banks to hedge their various risk exposures (e.g. interest rate risk, exchange rate risk and credit risk) resulting from their business activities.

3.2.7.1 Long-term and Short-term Interest Rate Exposures (LTIREXP and STIREXP)

Interest rate risk arises because of duration mismatches resulting from borrowing short and lending long, the traditional business of banking (Sinkey Jr. and Carter, 2000). Since derivatives are seen as useful tools for risk management, banks with a greater exposure to interest rate risks are expected to use derivatives to a greater extent.

On the other hand, Buser, Chen and Kane (1981) argue that while deposit insurance helps ensure confidence in the banking system, it encourages moral-hazard behaviour, given that banks may take on more risk or speculate with derivatives to exploit the government guaranteed scheme for deposits. However, Carter and Sinkey Jr. (1998) suggest that moral hazard can be offset or at least reduced by market discipline and/or regulation. Similarly, Hovakimian *et al.* (2003) find that the tendency for risk taking due to deposit insurance is tempered by incorporating

features such as risk-sensitive premiums, coverage limits and coinsurance into a country's deposit insurance system. Thus, we hypothesise a positive relationship between long-term (short-term) interest rate exposure and TDER.

Sinkey Jr. and Carter (2000) use the variable GAP 12 to capture a bank's exposure to unexpected changes in interest rates. GAP 12 is calculated by taking the absolute value of the dollar gap in the 0-12 month maturity range. Given that interest rate gap is not reported by many of our sample banks we use the absolute value of the long-term (short-term) interest rate factor coefficient from an augmented market model, standardised by standard-error (i.e. the absolute value of *t*-statistics) as a measure of long-term (short-term) interest rate exposure (labelled as LTIREXP and STIREXP, respectively). The coefficients are standardised by their precision of estimation (the standard-error) since not all sample banks have significant exposure to interest rates in the augmented market model regression. The absolute value is employed because bank investors and stakeholders are most interested in the amount of risk exposure regardless of the direction of exposure.

The augmented market model, Equation (1), is run by employing weekly data over the period of January 1999 to December 2002 for estimation of banks' 2002 exposures and over the period of January 2000 to December 2003 for estimation of banks' 2003 exposures:[10]

$$R_{it} = \alpha_i + \beta_{im} R_{mt} + \beta_{iLTIR} LTIR_t + \beta_{iSTIR} STIR_t + \beta_{iEX} EX_t + u_{it} \quad (1)$$

where R_{it} is the return on bank stock i in period t; R_{mt} is the return on the market index of the country of bank i in period t; $LTIR_t$ is the return on a long-term (7 to 10 years) government bond index; $STIR_t$ is the holding period return on three-month

[10] The extant literature suggests that an estimation period of between 3 to 5 years gives a good approximation of interest rate and exchange rate exposures (Allayannis and Ofek, 2001; Reichert and Shyu, 2003).

Treasury bills or comparable 3-month interest rates; EX_t is the rate of change in local currency against the Japanese Yen (JPY) for Malaysia and Hong Kong (since their currencies are pegged to the USD) and against the USD for all other countries. This model is widely used in studies investigating banks' market, interest rate and exchange rate exposures (see for example, Choi and Elyasiani, 1997).

3.2.7.2 Exchange Rate Exposure (EREXP)

As an extension to Sinkey Jr. and Carter (2000), this study includes exchange rate exposure (EREXP) as a potential determinant of a bank's extent of derivative activities. Exchange rate exposure is included because of its importance to Asia-Pacific banks due to their high foreign borrowings. To manage their exchange rate exposure, Asia-Pacific banks can utilise foreign currency derivatives. Thus, a positive association between EREXP and TDER is hypothesised. Similar to interest rate exposure, this study employs the absolute value of the exchange rate coefficient from the augmented market-model, standardised by its standard-error (i.e. absolute value of the *t*-statistic) as a measure of exchange rate exposure.

3.2.7.3 Credit Risk (RES)

Following Sinkey Jr. and Carter (2000), we test for the presence of coordinated risk management by banks using loan loss reserves scaled by total assets as a proxy for credit risk (RES). Schrand and Unal (1998) investigate hedging and coordinated risk management used by thrifts to control both credit risk and interest rate risk. If banks are practicing coordinated risk management, then the use of derivatives to hedge interest-rate risk should also be related to banks' credit exposure. Thus, a positive association is hypothesised between RES and TDER.

3.2.8 Intermediation Profitability: Net Interest Margin (NIM)

Banks with high net interest margins will attempt to lock in their "spreads" by using derivatives to hedge (Sinkey Jr. and Carter, 2000). This suggests a positive association between TDER and the net interest margin (NIM). Alternatively, banks with low net interest margins might attempt to increase fee income by speculating and selling derivative products (Shyu and Reichert, 2002). Thus, this study includes NIM in the model but it does not predict the direction of the association between NIM and TDER. NIM is measured as net interest income scaled by total assets.

3.2.9 Dealer Dummy (DEAL)

Since dealer banks use derivatives for dealing in addition to hedging, the dealer dummy (DEAL) is used as a control variable. A positive association between DEAL and TDER is hypothesised. Following Sinkey Jr. and Carter (2000), DEAL is coded one if the bank is a primary member of International Swap and Derivative Association (ISDA) and zero otherwise.

3.2.10 Country Specific Dummies

3.2.10.1 Country Dummies

To control for cross-country differences in institutional and regulatory environments, we include a country dummy coded one if the bank belongs to a specific country and zero otherwise. The country dummies included in the analysis are dummies for Australia (AUSDUM), Hong Kong (HKDUM), Japan (JPDUM), Malaysia (MSDUM), the Philippines (PHDUM), Singapore (SGDUM), South Korea (KRDUM), Taiwan (TWDUM) and Thailand (THDUM).

3.2.10.2 Activity and Ownership Restrictions (ACT and OWN)

Shyu and Reichert (2002) find evidence that activities and ownership regulations in different countries affect the extent of banks' derivative activities. Accordingly, we measure activity restriction (ACT) using a dummy variable of unity if a country does not restrict banks' ability to participate in direct securities activities, zero otherwise. Similarly, an ownership restriction dummy (OWN) is coded one if a country does not restrict banks' ability to own shares in non-financial firms, zero otherwise.[11] Since the country specific dummies are employed as control variables, the directions of association between various country specific dummies and TDER are not hypothesised. Table 1 summarises the independent variables, their labels, definitions and predicted signs.

[Insert Table 1 about here]

4. Data and Method

4.1 Sample Selection

A list of locally incorporated commercial banks[12] was first obtained from the central bank (or regulatory authority) websites of each Asia-Pacific country. Then, a search of each banks' 2002 annual report was conducted. Banks with annual reports without notes to the financial statements were eliminated since the notional value of derivatives is often reported in the notes, leaving a sample of 146 banks. We then obtained the stock price data for each bank from *Datastream*. Thirty-six banks were

[11] Activity and ownership restrictions were identified from the World Bank (2004) database. The database classifies banks' activities and ownership restrictions as being unrestricted, permitted, restricted or prohibited. For the purpose of this study, unrestricted or permitted is coded as one and restricted or prohibited is coded as zero.

[12] Locally incorporated banks are banks that are licensed by the central banks to operate in a home or host country and need to comply with local bank disclosure requirements set by the relevant central bank. Thus, branches of overseas incorporated banks and bank representative offices are excluded from the sample.

further eliminated as data on stock price,[13] ownership dispersion, government ownership and loan loss reserves cannot be obtained for these unlisted banks, resulting in a final sample of 110. The same set of annual reports is also obtained for year 2003, giving a total of 218 observations.[14] Data on bank financial characteristics are obtained from the bank annual reports and supplemented by ownership dispersion and government ownership data from *Bankscope.*

The geographic location of the sample banks is summarised in Table 2. The Japanese banks make up the largest proportion of the sample (49%), followed by Hong Kong banks (10%). Overall, the sample represents more than 40% of total banks in each country except for New Zealand, the Philippines and Taiwan.

[Insert Table 2 about here]

4.2 Method

This study employs the Tobit model to investigate the determinants of the extent of Asia-Pacific banks' derivative activities. The Tobit model is employed because the extent of derivative activities (as proxied by the notional value of derivatives scaled by total assets) is censored at zero for a number of observations. Since the data employed are cross-sectional involving multiple countries in the Asia-Pacific region, heteroskedasticity is expected in the error variance. Thus, all regressions are adjusted for 'White's heteroskedasticity consistent covariance standard-errors' to remove

[13] Stock price data are not available for these banks because they are either not listed on an organized stock exchange or have merged with other local banks. Stock price data are needed to estimate the interest rate and exchange rate exposures of banks using the augmented market model over the period of January 1999 to December 2003. In addition to stock price data, we also obtained from Datastream, the following weekly data for each sample country: i) equity market index, ii) bond index, iii) short-term interest rate (3 month) and iv) exchange rate for the same period.

[14] The unavailability of the 2003 'Notes to the Financial Statements' for two of the fifty-four Japanese sample banks necessitated their exclusion in 2003.

heteroskedasticity in the residuals. The Tobit model specification for this study, Equation (2), is as follows:[15]

$$TDER_i = \alpha_0 + \alpha_1 LEV_i + \alpha_2 GRW_i + \alpha_3 SIZE_i + \alpha_4 LIQ_i + \alpha_5 DIV_i + \alpha_6 DISP_i + \alpha_7 GOV_i + \alpha_8 CAP_i + \alpha_9 LTIREXP_i + \alpha_{10} STIREXP_i + \alpha_{11} EREXP_i + \alpha_{12} RES_i + \alpha_{13} NIM_i + \alpha_{14} YEARDUM_i + \alpha_{15} DEAL_i + \varepsilon_i \quad (2)$$

where *TDER* is the notional value of derivatives/ Total assets; *LEV* is bank borrowings/ Total assets; *GRW* is the growth rate of total assets from 2001 to 2002 for 2002 observations and from 2002 to 2003 for year 2003 observations; *SIZE* is the natural log of bank's total assets; *LIQ* is liquid assets/ Total assets; *DIV* is dividend paid/ Total assets; *DISP* is a dummy variable taking a value of unity if no shareholder owns more than 25% of shares in the bank, zero otherwise; *GOV* is a dummy variable taking a value of unity if the government is among the top 10 shareholders, zero otherwise; *CAP* is Book value of equity/ Total assets; *LTIREXP* is the absolute value of the augmented market model estimates of long-term interest rate risk, standardised by the standard-error; *STIREXP* is the absolute value of the augmented market model estimates of short-term interest rate risk, standardised by the standard-error; *EREXP* is the absolute value of the augmented market model estimates of exchange rate risk, standardised by the standard-error; *RES* is Loan loss reserve/ Total assets; *NIM* is Net interest income/ Total assets; *YEARDUM* is a dummy variable taking a value of unity if the bank is an observation of year 2003, zero otherwise; *DEAL* is a dummy variable taking a value of unity if bank is a member of the International Swaps and Derivative Association, zero otherwise.

[15]Alternative specifications of this regression incorporating country effects, are also used in later analysis.

5. Results and Discussion

5.1 Descriptive Statistics

Table 3 Panel A presents the summary statistics for all variables. For the sample of 218 observations, the mean (median) TDER is 0.49 (0.06), with a maximum of 7.80. The large difference between the mean and median TDER implies that the mean level of TDER is influenced by a number of large banks that are active dealers of derivatives.[16] This finding of considerable variation of TDER across sample banks is consistent with prior US evidence (for example, Choi and Elyasiani, 1997; Hirtle, 1997). The notional value of sample banks' interest rate derivatives scaled by total assets (mean of 0.38) is higher than the notional value the foreign currency derivatives scaled by total assets (mean of 0.20).

Table 3 Panel B reports the pair-wise correlation between the variables. Banks with higher leverage, that are larger and that are derivative dealers are more likely to have greater derivative activities as indicated by the correlations of 0.53, 0.46 and 0.71 between LEV, SIZE and DEAL with TDER. The high correlation between interest rate derivatives (IRD) and foreign currency derivatives (FCD) suggests that banks with a higher level of interest rate derivative activities relative to total assets are also more likely to have a higher level of foreign currency derivative activities relative to assets. Multicollinearity is unlikely to be a problem in this study since the independent variables included in the Tobit regressions are not highly correlated.[17]

[Insert Table 3 about here]

[16] Following Sinkey Jr. and Carter (2000), a dealer dummy is included in the analysis to account for any possible bias due to the influence of banks with large derivative activities. There are 26 sample banks with extensive derivative activities (TDER greater than 1) and 93% of these are derivative dealer banks.

[17] Additionally, a Variance Inflation Factor (VIF) analysis is conducted to detect multicollinearity. As a rule of thumb, multicollinearity becomes harmful when VIF is greater than 10 (Kennedy, 2003). The VIFs for the independent variables included in our Tobit regressions range from 1.05 to 2.04 - as such, multicollinearity is not a problem in our setting.

5.2 Tobit Regression Analysis (without Country Effects)

Variations of the Tobit regression model are tested with the results reported in Table 4. In the first model (Model 1), the variables proxying the probability of financial distress, underinvestment cost, economies of scale, hedging substitutes, ownership structure, regulatory and moral hazard hypotheses, exposure to risks and intermediation profitability are included. The estimates are corrected for the presence of heteroskedasticity. The results show that LEV, a proxy for the probability of financial distress, is positive and statistically significant. This corroborates previous findings that banks with higher leverage engage in greater derivative activities to minimise the probability of financial distress (Sinkey Jr. and Carter, 2000). Consistent with the predicted sign, SIZE is also a significant determinant of derivative activities. Large banks have the scale and scope necessary to justify the expenditure of resources to manage extensive derivative activities (Sinkey Jr. and Carter, 2000; Shyu and Reichert, 2002).

In contrast to their predicted signs, a negative coefficient estimate is found for GOV and GRW. These results indicate that banks with higher growth opportunities and with government ownership tend to hedge less relative to banks without these characteristics. These results reflect possible moral hazard behaviour of Asia-Pacific banks. The banks may not hedge adequately, knowing that they can rely on government deposit insurance to bail them out in the event of insolvency. LIQ is marginally significant at the 10% level. However, the positive sign obtained is inconsistent with the liquidity as a substitute for hedging hypothesis. This hypothesis is also not supported in previous US studies (Gunther and Siems, 1995; Sinkey Jr. and Carter, 2000). Consistent with Sinkey Jr. and Carter (2000), the positive sign for

LTIREXP indicates that banks with greater interest rate risk tend to engage in greater derivative activities.

Model (2) incorporates a dealer dummy to control for the existence of large derivative users due to their dealing activities. The results are consistent with Model (1) with LEV, SIZE and GOV remaining statistically significant at the 5% level, and LTIREXP at the 1% level. DEAL is also statistically significant indicating that Asia-Pacific dealer banks use derivatives more extensively than non-dealer banks.

Model (3) excludes the 18 dealer banks from the analysis. The variables LEV and SIZE remain statistically significant. However, instead of a positive association between SIZE and TDER, a significantly negative relationship is found. This finding suggests that economies of scale are not present for Asia Pacific non-dealer banks. This finding is similar to Carter and Sinkey Jr. (1998) where they report that economies of scale in derivative usage are not found in their US community non-dealer bank sample. In addition, DIV (at 1% level), EREXP and RES (at 10% level) are also significant in explaining the extent of derivative activities. The positive sign for DIV suggests that banks paying out greater dividends tend to use more derivatives for hedging, supporting dividends as a substitute for hedging hypothesis. The negative association found between EREXP and TDER could be an indication of the speculative use of derivatives. The extent of derivative activities is also higher the greater the level of RES, supporting the view that banks' derivative activitities are associated with hedging credit risk (Schrand and Unal, 1998).

[Insert Table 4 about here]

5.3 Tobit Analysis with Country Effects

The analysis is then extended to include country effects. As in Shyu and Reichert (2002), we include ACT and OWN to capture cross-country differences in bank regulations. Among the sample countries, participation in direct securities activities is unrestricted in all countries except Thailand. Countries that do not restrict bank ownership in non-financial firms are Hong Kong, the Philippines, Australia and New Zealand (World Bank, 2004). As presented in Table 4 Model (4), the coefficient of ACT is negative and significant. This finding is consistent with Shyu and Reichert (2002) and suggests that banks which are allowed to pursue direct securities activities engage in less derivative activities for hedging due to their more diversified operations. On the other hand, the coefficient of OWN is not statistically significant. When ACT and OWN are taken into account, LEV, SIZE, LTIREXP and DEAL remain statistically significant. In addition, GRW and GOV also become statistically significant. Similar to Model (1), GRW and GOV are negatively associated with TDER.

Model (5) includes country dummies. Most of the country dummies are statistically significant, suggesting that cross-country differences exist in banks' derivative activities. By including country dummies in the model, there are a greater number of significant determinants including LEV, SIZE, DIV, DISP, GOV, LTIREXP and DEAL. Similar to the model without country dummies (i.e. Model 2), LEV, SIZE and DEAL are positively associated with banks' derivative activities. The negative sign for DIV indicates that a smaller dividend payout is associated with greater derivative activities and is consistent with Carter and Sinkey Jr. (1998). The two ownership variables (i.e. DISP and GOV) are also statistically significant although not in the predicted direction. The negative association between DISP and

TDER indicates that the more disperse the bank ownership, the lower a bank's derivative activities. This finding is puzzling as banks with dispersed ownership are expected to have a lower level of risk taking (Laeven, 2002) and hence, greater extent of derivative activities.[18] GOV is also significantly negative, supporting the argument that Asia-Pacific banks generally suffer from moral hazard behaviour in risk management. As in Models (1), (2) and (4), banks with greater LTIREXP also tend to have greater derivative activities.

CAP is not significantly associated with the level of derivative activities. Thus, the regulatory hypothesis, suggesting that banks must have stronger capital positions to engage in derivative activities, is not supported in the Asia-Pacific context. This finding is similar to Sinkey Jr. and Carter (2000) although they obtained a stronger result against the regulatory hypothesis, where a significantly negative association between capital and extent of derivative activities is found.

Model (6) tests the relationship between the characteristics of non-dealer banks and banks' derivative activities, taking into account country dummies. Similar to Model (3), LEV is still statistically significant. SIZE is not a significant determinant of derivative activities. Again, this finding indicates that within the non-dealer banks, economies of scale are not found. A negative association is found between EREXP and TDER suggesting possible speculative use of derivatives with respect to exchange rate changes. The positive association between RES and TDER indicates that banks also use derivatives for hedging credit risks (Schrand and Unal, 1998).

[18] This is possibly due to the less stringent definition of dispersion employed. In Laeven (2002), a bank is classified as having a dispersed ownership if no shareholder owns more than 5% shares. In our study, a bank is classified as having a dispersed ownership if no shareholder owns more than 25% shares, due to data unavailability.

5.4 Extended Analyses and Robustness Checks

5.4.1 Japanese vs. Non-Japanese Banks

Since the sample consists of a large number of Japanese banks, the analysis is also partitioned into separate Japanese and non-Japanese banks. The regression results are presented in Table 5. Model (7) is for the sub-sample of Japanese banks only and Model (8) for the sub-sample of non-Japanese banks. Explaining derivative activities of Japanese banks, only LEV significantly influences the level of derivative activities. This suggests that Japanese banks generally employ derivatives to reduce their probability of financial distress. For the sub-sample of non-Japanese banks, controlling for country dummies, more variables (i.e. LEV, SIZE, LIQ, DIV, DISP, GOV and LTIREXP) are found to influence TDER.

5.4.2 Risk Exposure by Derivative Type

To further examine the determinants of the extent of banks' derivative activities, TDER is disaggregated into interest rate derivatives (IRD) and foreign currency derivatives (FCD). The results of this analysis are presented in Table 5, Model (9) for IRD and Model (10) for FCD. Similar to the results using TDER, SIZE also significantly explains the use of both IRD and FCD. On the other hand, LEV, DIV and the two ownership variables (i.e. DISP and GOV) are only significant in explaining the use of IRD, while the dealer dummy is a significant determinant of only FCD. These findings suggest that FCD are used more in the dealing activities of banks while IRD are generally used for hedging purposes.

[Insert Table 5 about here]

6. Summary and Conclusions

Our paper presents an investigation of the determinants of the extent of Asia-Pacific banks' derivative activities during 2002 and 2003. The results support the probability of financial distress and economies of scale arguments in explaining Asia-Pacific banks' extent of derivative activities, except for the non-dealer banks. Consistent with previous studies investigating US banks, bank size is not a significant determinant of the extent of derivative activities for non-dealer banks.

With the inclusion of country dummies, more independent variables are found to be associated with banks' level of derivative activities. These include dividends, ownership dispersion, government ownership and long-term interest rate risk exposure, and support the substitutes for hedging, the moral hazard and the exposure to risks hypotheses. These results are generally consistent with previous US studies. Further investigation of the extent of IRD and FCD suggests that dealer banks tend to use more FCD, while IRD are generally used for hedging purposes.

Our findings indicate that banks generally engage in derivative activities to reduce the probability of financial distress. However, the findings that banks with government ownership tend to have less derivative activities indicate some moral hazard behaviour amongst Asia-Pacific banks. This suggests that it may be prudent to more closely monitor the risk management activities of banks with government ownership to ensure that risk taking is not excessive.

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Table 1: Determinants of the Extent of Asia-Pacific Banks' Derivative Activities: Factors, Definitions, Labels and Predicted Signs

Independent Variable	Definition	Label	Predicted Sign	Previous Literature
i) Financial Distress Costs				
Leverage	Bank borrowings/ Total assets	LEV	?	Sinkey Jr. and Carter (2000) Gunther and Siems (2002)
ii) Underinvestment Costs				
Asset Growth	Growth rate of total assets from 2001 to 2002 for observations in 2002, and from 2002 to 2003 for observations in 2003.	GRW	+	Sinkey Jr. and Carter (1997)
iii) Economies of Scale				
Bank Size	Natural log of bank's total assets	SIZE	+	Gunther and Siems (1995) Sinkey Jr. and Carter (2000) Shyu and Reichert (2002)
iv) Substitutes for Hedging				
Liquidity	Liquid assets/ Total assets	LIQ	-	Gunther and Siems (1995) Sinkey Jr. and Carter (2000)
Dividend	Dividend paid/ Total assets	DIV	+	Gunther and Siems (1995) Sinkey Jr. and Carter (2000) Shyu and Reichert (2002)
v) Ownership Structure				
Ownership Dispersion	1 if no shareholder owns more than 25% of the banks' shares, 0 otherwise.	DISP	+	-
Government Ownership	1 if the government is among the top 10 shareholders, 0 otherwise.	GOV	+	-
vi) Regulatory and Moral Hazard Hypothesis				
Capital	Book value of equity/ Total assets	CAP	?	Gunther and Siems (1995) Sinkey Jr. and Carter (2000) Shyu and Reichert (2002)
vii) Exposure to Risks				
Interest Rate Exposure	Absolute value of the augmented-market model estimates of long-term (short-term) interest rate coefficient, standardised by standard-error.	LTIREXP and STIREXP	+ +	Gunther and Siems (1995) Sinkey Jr. and Carter (2000) Shyu and Reichert (2002)
Exchange Rate Exposure	Absolute value of the augmented-market model estimates of exchange rate coefficient, standardised by standard-error.	EREXP	+	-
Credit Risk	Loan loss reserve/ Total assets	RES	+	Sinkey Jr. and Carter (2000) Shyu and Reichert (2002)
viii) Intermediation Profitability				
Net Interest Margin	Net interest income/ Total assets	NIM	?	Gunther and Siems (1995) Sinkey Jr. and Carter (2000) Shyu and Reichert (2002)
ix) Bank Specific Dummies				
Dealer	1 if the bank is a primary member of ISDA, 0 otherwise.	DEAL	+	Sinkey Jr. and Carter (2000)
x) Country Specific Dummies				
Country Dummies	1 if the bank belongs to a specific country, 0 otherwise.	AUSDUM,HKDUM, JPDUM, MSDUM , PHDUM, SGDUM, KRDUM, TWDUM , THDUM	?	Shyu and Reichert (2002)
Activity Restriction	1 if a country does not restrict bank's ability to participate in direct securities activities, 0 otherwise.	ACT	?	Shyu and Reichert (2002)
Ownership Restriction	1 if a country does not restrict bank's ability to own shares in non-financial firms, 0 otherwise.	OWN	?	Shyu and Reichert (2002)

Table 2: Country of Domicile of Sample Banks

Country	No. of Sample Banks	% of Sample Banks	Total Local Banks in Country	% of Country's Local Banks in Sample
Australia	9	8	12	75
Hong Kong	11	10	26	42
Japan	54	49	135	40
Malaysia	8	7	11	73
New Zealand	1	1	6	17
Philippines	3	3	23	13
Singapore	3	3	4	75
South Korea	8	7	17	47
Taiwan	7	6	53	13
Thailand	6	5	13	46
Total	**110**	**100**	**300**	**37**

Note: The number of sample banks in each country is the same for both years 2002 and 2003 except for Japan. The number of sample Japanese banks is 54 and 52 in 2002 and 2003, respectively.

Table 3: Descriptive Statistics and Correlation Matrix

Panel A: Descriptive Statistics

	Mean	Median	Max.	Min.	Std. Dev.
TDER	0.4856	0.0646	7.7980	0.0000	1.1418
IRD	0.3804	0.0387	7.0784	0.0000	0.9434
FCD	0.1991	0.0426	2.2276	0.0000	0.3838
LEV	0.0782	0.0507	0.3902	0.0013	0.0764
GRW	0.0376	0.0154	0.6006	-0.1310	0.0889
SIZE	23.9090	23.9307	27.6087	20.9768	1.0965
LIQ	0.1306	0.0898	0.5344	0.0133	0.1027
DIV	0.0021	0.0005	0.0197	0.0000	0.0031
CAP	0.0607	0.0546	0.1500	0.0072	0.0274
LTIREXP	0.8507	0.7250	4.0600	0.0000	0.6691
STIREXP	0.9715	0.8250	3.6400	0.0000	0.7468
EREXP	0.7382	0.6200	3.3200	0.0000	0.5773
RES	0.0207	0.0150	0.1104	0.0004	0.0182
NIM	0.0192	0.0180	0.0388	0.0036	0.0054
DISP	0.6273	1.0000	1.0000	0.0000	0.4846
GOV	0.0962	0.0000	1.0000	0.0000	0.2955
DEAL	0.1636	0.0000	1.0000	0.0000	0.3708

Panel B: Correlation Matrix

	TDER	IRD	FCD	LEV	GRW	SIZE	LIQ	DIV	CAP
IRD	0.9585								
FCD	0.8344	0.6625							
LEV	0.5227	0.4048	0.5723						
GRW	0.0531	-0.0233	0.0974	0.3017					
SIZE	0.4591	0.4302	0.4029	0.2262	-0.0770				
LIQ	0.1838	0.1135	0.2339	0.2358	0.1975	-0.2160			
DIV	0.3104	0.1934	0.4369	0.4418	0.2261	-0.0037	0.4589		
CAP	0.0775	0.0229	0.1613	0.1501	0.1610	-0.3730	0.6049	0.4715	
LTIREXP	0.3157	0.2139	0.4522	0.2262	0.0286	0.1239	0.0320	0.2087	0.0760
STIREXP	-0.1629	-0.1431	-0.1997	-0.1634	0.0797	-0.2692	-0.0112	-0.0876	0.2063
EREXP	-0.0217	-0.0439	-0.0268	0.0762	-0.0542	-0.1761	0.1512	0.0526	0.0074
RES	-0.1311	-0.0914	-0.1259	-0.1132	-0.1086	-0.1517	-0.0862	-0.2967	0.0411
NIM	-0.0749	-0.0872	0.0162	0.0851	0.0846	-0.3209	0.1752	0.2168	0.3444
DISP	-0.1070	-0.1018	-0.0535	-0.2146	-0.1651	0.1863	-0.4328	-0.2360	-0.2658
GOV	-0.0863	-0.0754	-0.0546	0.0156	-0.0027	-0.0307	0.0493	-0.1275	0.0065
DEAL	0.7119	0.6420	0.7084	0.5631	0.0871	0.4575	0.2902	0.4288	0.1430

	LTIREXP	STIREXP	EREXP	RES	NIM	DISP	GOV
IRD							
FCD							
LEV							
GRW							
SIZE							
LIQ							
DIV							
CAP							
LTIREXP							
STIREXP	-0.0322						
EREXP	0.0487	0.0386					
RES	-0.1306	-0.0193	0.0072				
NIM	0.0356	0.0941	0.0730	0.2359			
DISP	-0.0186	0.0163	-0.1295	-0.1567	-0.3104		
GOV	0.0793	-0.0285	0.0723	0.3836	0.0579	-0.2077	
DEAL	0.2535	-0.1833	-0.0114	-0.1695	-0.0677	-0.0910	-0.0630

Notes: Panel A reports the descriptive statistics of variables employed in the Tobit model, while Panel B reports the pair-wise correlation matrix of these variables. Refer to Table 1 for a description of the independent variables and their definitions. IRD = Interest rate derivatives, FCD = Foreign currency derivatives.

Table 4: Tobit Analysis of the Determinants of the Extent of Banks' Derivative Activities

Independent Variable	Predicted Sign	Model					
		(1) All Banks	**(2)** With Dealer Dummy	**(3)** Non-Dealer Banks only	**(4)** With Country Characteristics	**(5)** With Country Dummies	**(6)** Non-dealer with Country Dummies
CONSTANT		-10.8686***	-5.8580**	1.6363**	-6.2255**	-7.3753***	0.7042
		(-3.2821)	(-2.3504)	(2.0095)	(-2.5088)	(-3.0698)	(1.2828)
LEV	?	5.5916***	2.8409**	1.9151***	2.4241*	3.2615**	1.8061***
		(5.2917)	(2.4206)	(4.8003)	(1.8758)	(2.1783)	(3.7163)
GRW	+	-0.9897*	-0.5272	0.1527	-0.9115*	-0.6116	-0.1409
		(-1.7720)	(-1.0983)	(0.8956)	(-1.8277)	(-1.1647)	(-0.6404)
SIZE	+	0.4446***	0.2454**	-0.0655**	0.2912**	0.3779***	-0.0065
		(3.1094)	(2.2600)	(-2.0466)	(2.5634)	(3.4329)	(-0.3297)
LIQ	-	1.2198*	0.0565	-0.2132	-0.0109	0.7867	-0.3303
		(1.6484)	(0.0809)	(-0.9255)	(-0.0160)	(0.9875)	(-1.2807)
DIV	+	12.5398	-18.5443	19.1371***	-46.1803	-59.6931**	4.4583
		(0.3304)	(-0.6250)	(2.6711)	(-1.4851)	(-2.1049)	(0.6220)
DISP	+	-0.2107	-0.2601	0.0105	-0.3053	-0.4564*	-0.0215
		(-0.9081)	(-1.1741)	(0.3270)	(-1.3626)	(-1.9286)	(-0.7180)
GOV	+	-0.5150**	-0.4140**	-0.0021	-0.5287**	-0.3955*	-0.0372
		(-2.5268)	(-2.1096)	(-0.0535)	(-2.1726)	(-1.9287)	(-0.9744)
CAP	?	4.5013	3.0100	-0.6526	2.1798	-3.7451	-0.1511
		(1.1919)	(0.9708)	(-0.8990)	(0.6384)	(-1.5838)	(-0.1809)
LTIREXP	+	0.3229***	0.2511***	0.0276	0.1710**	0.1450*	-0.0056
		(3.3352)	(2.8958)	(1.2645)	(2.0212)	(1.6762)	(-0.3458)
STIREXP	+	0.0096	0.0054	-0.0040	0.0007	0.0370	0.0032
		(0.1222)	(0.0789)	(-0.3247)	(0.0105)	(0.5999)	(0.2979)
EREXP	+	-0.0331	-0.0218	-0.0519*	-0.0482	0.0020	-0.0433**
		(-0.4003)	(-0.3035)	(-1.9522)	(-0.6776)	(0.0329)	(-2.2126)
RES	+	4.1054	2.7342	1.8848*	-1.3829	-5.5579	3.1632*
		(1.5669)	(1.0174)	(1.9123)	(-0.3353)	(-1.3212)	(1.9079)
NIM	?	-18.6486	-11.7315	-4.8170	-7.0087	7.6272	-4.9603
		(-1.5836)	(-1.1763)	(-1.1858)	(-0.6914)	(0.8537)	(-0.8245)
YEARDUM	?	0.0649	0.0715	0.0419*	0.0557	0.0540	0.0282
		(0.6314)	(0.7878)	(1.8023)	(0.6023)	(0.6797)	(1.1890)
DEAL	+		1.4790***		1.4875***	0.6354*	
			(4.3692)		(4.4982)	(1.8429)	
JPDUM						-1.3851***	-0.4795***
						(-3.2654)	(-2.6419)
HKDUM						-0.9824***	-0.2657
						(-2.9588)	(-1.5009)
TWDUM						-1.5463***	-0.3529**
						(-3.6587)	(-2.0248)
KRDUM						-1.9597***	-0.4531***
						(-5.1257)	(-2.7160)
SGDUM						0.9702	
						(1.1281)	
MSDUM						-1.3735***	-0.4265**
						(-4.2601)	(-2.3754)
THDUM						-0.7441*	-0.4821***
						(-1.7603)	(-2.6503)
PHDUM						-0.7412**	-0.4088**
						(-2.2974)	(-2.3554)
AUSDUM						-0.3519	
						(-0.9639)	
ACT	?				-0.5547**		
					(-2.0267)		
OWN	?				0.4151		
					(1.4453)		
Adjusted R^2		0.44	0.54	0.34	0.55	0.65	0.42

Notes: This table reports the coefficient estimates and corresponding z-statistics (in parentheses) of the Tobit regression Equation (2):

$$TDER_i = \alpha_0 + \alpha_1 LEV_i + \alpha_2 GRW_i + \alpha_3 SIZE_i + \alpha_4 LIQ_i + \alpha_5 DIV_i + \alpha_6 DISP_i + \alpha_7 GOV_i + \alpha_8 CAP_i + \alpha_9 LTIREXP_i + \alpha_{10} STIREXP_i + \alpha_{11} EREXP_i + \alpha_{12} RES_i + \alpha_{13} NIM_i + \alpha_{14} YEARDUM_i + \alpha_{15} DEAL_i + \varepsilon_i$$

For Models (4), (5) and (6), relevant country specific dummies are included in the Tobit regression. ACT and OWN are included in Model (4). The sample consists of 110 and 108 Asia-Pacific banks for 2002 and 2003, respectively. Refer to Table 1 for a description of explanatory variables. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively. White adjusted statistics are reported.

Table 5: Tobit Regression Results: Extended Analysis

Independent Variable	Predicted Sign	Model			
		(7)	(8)	(9)	(10)
		Japanese banks only	Non-Japanese banks	IRD	FCD
CONSTANT		-17.4465	-5.7699***	-6.0376**	-2.6357***
		(-1.5033)	(-3.6663)	(-2.1208)	(-4.1367)
LEV	?	7.0156***	3.6034***	2.4068*	0.8474
		(3.7180)	(3.1230)	(1.8896)	(1.6283)
GRW	+	-1.0580	-0.3199	-0.2830	-0.3253*
		(-0.6605)	(-0.6303)	(-0.6098)	(-1.7390)
SIZE	+	0.6984	0.3054***	0.3476***	0.1240***
		(1.4906)	(4.2406)	(2.6763)	(4.3603)
LIQ	-	3.8726	1.3760*	0.0531	0.3423
		(1.5381)	(1.6755)	(0.0560)	(0.9425)
DIV	+	150.7624	-43.7644*	-70.0802***	-6.3535
		(0.5239)	(-1.7153)	(-2.7269)	(-0.5306)
DISP	+	-0.6778	-0.4894**	-0.4505*	-0.0524
		(-1.5858)	(-2.4280)	(-1.7199)	(-1.5508)
GOV	+	0.3010	-0.5448***	-0.3858*	-0.0885
		(1.2601)	(-2.6006)	(-1.8155)	(-1.3702)
CAP	?	3.7116	-5.3418	-2.6764	-1.5432
		(0.6432)	(-1.6393)	(-1.3164)	(-1.6315)
LTIREXP	+	-0.1717	0.3882***	0.0084	
		(-1.5764)	(3.2250)	(0.1125)	
STIREXP	+	0.0682	-0.0586	0.0262	
		(1.0944)	(-0.5654)	(0.3998)	
EREXP	+	0.0306	-0.1039		-0.0260
		(0.3965)	(-0.8749)		(-1.1023)
RES	+	0.0594	-6.6431	-4.2224	-1.3502
		(0.0111)	(-1.1535)	(-0.9750)	(-1.3623)
NIM	?	37.3429	12.7867	2.1901	8.1316
		(0.8036)	(1.1819)	(0.2725)	(1.3731)
YEARDUM	?	-0.0543	0.1354	-0.0043	0.0014
		(-0.4722)	(1.0789)	(-0.0556)	(0.0472)
DEAL	+		0.2711	0.2683	0.2113**
			(1.0695)	(0.8980)	(2.2666)
JPDUM				-1.8201***	-0.3627*
				(-3.6062)	(-1.7777)
HKDUM			-1.2008***	-1.3573***	-0.0731
			(-2.8284)	(-3.4102)	(-0.4811)
TWDUM			-1.5826***	-1.7456***	-0.3464**
			(-4.0733)	(-3.6915)	(-2.0476)
KRDUM			-1.9950***	-2.4067***	-0.4396**
			(-5.0542)	(-4.6826)	(-2.4338)
SGDUM			1.2972	0.3728	0.3114*
			(1.4012)	(0.4762)	(1.7937)
MSDUM			-1.4595***	-1.6349***	-0.3470**
			(-3.9415)	(-3.9848)	(-2.2025)
THDUM			-0.6314	-1.2008**	-0.0256
			(-1.2172)	(-2.3107)	(-0.1382)
PHDUM			-0.7772*	-0.9884**	-0.0221
			(-1.9145)	(-2.3505)	(-0.1284)
AUSDUM			-0.5219	-0.9684**	0.1810
			(-1.3435)	(-2.2113)	(1.0072)
Adjusted R^2		0.46	0.71	0.52	0.68

Notes: This table reports the coefficient estimates and corresponding z-statistics (in parentheses) of the Tobit regression Equation (2):

$$TDER_i = \alpha_0 + \alpha_1 LEV_i + \alpha_2 GRW_i + \alpha_3 SIZE_i + \alpha_4 LIQ_i + \alpha_5 DIV_i + \alpha_6 DISP_i + \alpha_7 GOV_i + \alpha_8 CAP_i + \alpha_9 LTIREXP_i + \alpha_{10} STIREXP_i + \alpha_{11} EREXP_i + \alpha_{12} RES_i + \alpha_{13} NIM_i + \alpha_{14} YEARDUM_i + \alpha_{15} DEAL_i + \varepsilon_i$$

In the IRD (FCD) model, IRD (FCD) is used as the dependent variable in place of TDER in the above Tobit regression. In Models (7) to (10), only relevant country dummies are included in the Tobit regression. Deal dummy is excluded from the "Japanese bank only" model due to the high correlation with leverage to address potential multicollinearity problem. The sample consists of 110 and 108 Asia-Pacific banks for 2002 and 2003, respectively. Refer to Table 1 for a description of explanatory variables. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively. White adjusted statistics are reported.