AN ANALYSIS OF THE DIFFERENCE BETWEEN EURODOLLAR
AND DOMESTIC INTEREST RATES

DISSERTATION

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To My Parents and Parents-In-Law
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Abstract

This paper attempts to explain the difference between Eurodollar and domestic interest rates. Analyses provided in this paper show that the divergence in interest rates stems from the difference in functions and services that domestic and Eurobanks provide.

We find insignificant stock price reactions to the announcement of Eurodollar loan arrangements. This result contrasts with results found in previous studies on domestic loans in which positive significant reactions were reported. The evidence provided in this paper is consistent with the hypothesis that Eurobanks do not have uniqueness that domestic banks have. Therefore, unlike domestic bank loans, Eurodollar loans can not command a premium. Under this hypothesis, the difference in loan rates is the price for the unique service that the domestic bank seems to provide.

We also provide evidence that rejects the previous hypothesis that the difference is mainly due to regulatory cost differences. We present an alternative model based on the level of insurance. Results consistent with the implication of the alternative model are reported.
Chapter I

Introduction

With developments in communications and settlement technologies, financial markets seem to be integrated more closely than ever before. We expect closer relationship between the domestic market and its Euro-counterpart since both use the same currency. Therefore, it has been of great interest to many researchers to understand how they are related and how one is linked with another. Hendershott's (1967) first empirical study on the subject and many other following studies show strong correlation between domestic and Euromarket interest rates.¹

Yet another stream of research interest is directed toward the difference between those two markets. A study of the Eurobond market by Kim and Stulz (1989) addresses this issue. They show real-world impediments to the adjustment of asset supplies may create financing windows of opportunities. In a direct financial market such as a bond market, supply imbalance may exist. The Eurocurrency market, however, is an indirect as well as an interbank market. Active interbank

¹ Since studies on this subject are numerous, we do not list all of them here. A more recent study of causal relationship is provided by Hartman (1984).
transactions\textsuperscript{2} provide a continuous flow of funds between demanders and suppliers of funds. Hence, supply imbalance that may exist in the Eurobond market does not seem to exist in the Eurocurrency market. However, we still observe persisting divergence in interest rates between the domestic market and its Euro-counterpart. Specifically, Eurocurrency loan rates appear to be lower than domestic loan rates while Eurocurrency deposit rates appear to be higher than domestic deposit rates.

In this paper, we investigate the difference in interest rates between the domestic and the Eurocurrency market. Since the majority of Eurocurrency funds are denominated in U.S. dollars, we focus on U.S. domestic interest rates and Eurodollar interest rates.

The divergence in interest rates between the Eurodollar and the domestic market is frequently associated with lack of regulatory burdens in the Eurodollar market and, hence, the ability of Eurobanks to operate on a narrower margin. Despite this seemingly absolute advantage of Eurobanks over domestic banks, the domestic market does not seem to be completely dominated. The existence of such an interest rate structure is, therefore, quite puzzling. There seems to be no reason

\textsuperscript{2} About 70\% or more of Eurobanks' assets and liabilities are deposits and loans to other banks. For further information, see Giddy, Ian H. (1983).
for borrowers to continue to use high cost funds from domestic banks while they can borrow funds from Eurobanks more cheaply, and no reason for depositors to continue to invest in low yielding domestic CD's while they can invest in higher paying Eurodollar deposits. Notice that both types of deposits are largely considered to be close substitutes by investors. If indeed they are perfect substitutes and there are no market imperfections, we do not expect to see any systematic divergence.

However, as shown in table 1 and figures 1 and 2, there appears to be substantial and persisting difference in interest rates. The average 3-month Eurodollar loan rate during the period from January 1, 1979 to February 1, 1985 was 12.81% while the average of the domestic counterpart, the U.S. prime rate, during the same period was 14.04%. The average interest rate on Eurodollar deposit was 12.67% but

---

3 Grabbe (1982) points out that investors such as trustee funds, private individuals, and firms appear to use Eurodollar deposits mainly as a substitute for holding other types of money-market instruments.

4 In this paper, we use 3-month rates. One of the reason for the use of 3-month rate is that the largest transaction is on 3-month or shorter term and, hence, the data are less prone to errors due to infrequent trading. Another reason is that the prime rate, the reference rate of domestic bank loan, is based on 90-day money market rates. Therefore, using rates for different maturity will introduce biases due to term premium effects.
its counterpart, the domestic CD (certificate of deposit), had an average of 11.77%. The difference not only persists but is also highly variable.

The persisting divergence does not seem to be related to any artificial barriers that may segregate those two markets. Notice that this phenomenon, as shown in Table 1 and Figures 1 and 2, persists even after the removal of U.S. capital controls in 1974. Of course, if transaction costs are high, we may see persisting divergences even if there are no artificial controls. However, transaction costs may not be the factor since, as Aliber (1980) points out, transaction costs associated with moving funds in and out of the Euromarket do not seem to be different from those in the domestic market (at least for dollar denominated funds).

The divergence in loan rates has not been studied analytically and chapter 2 of this paper attempts to fill the gap in the literature. On the deposit side, there have been some attempts. In previous analyses, Eurobanks are viewed as conventional domestic banks. In other words, it is either implicitly or explicitly assumed that Eurobanks perform the same function as domestic banks and Euro-instruments provide the same service as those of domestic banks. As a result,

5 For example, see Johnston (1979), Aliber (1980), Kreicher (1982), and Logue and Senbet (1983).
previous studies focus on the difference in regulatory environments of banks, especially reserve requirements. However, if Eurobanks perform a simple financial intermediation function as other non-bank financial intermediaries, we expect reserve requirements to be irrelevant since non-bank financial intermediaries are not subject to reserve requirements.

If Eurobanks perform just a simple financial intermediation function, instruments the Eurobank offers must be charged or earn market rates of interest similar to other money market instruments of equivalent risk. Therefore, the cost of the Eurodollar loan must be the same as the cost of other sources of funds such as commercial paper. If this argument is true, the divergence between the domestic loan rate and the Eurodollar loan rate must stem from different functions that the domestic bank and other non-bank money market institutions perform. We argue that the divergence between the domestic loan rate and the Eurodollar loan rate is mainly due to the fact that domestic banks provide unique services that Eurobanks do not.

Fama (1985) and James (1987) show evidence that the reserve tax\(^6\) is borne by bank borrowers but not domestic CD

\(^6\) As in Fama (1986), we use the term "tax" to refer to interests foregone on reserves since it resembles a tax on deposits.
depositors. This evidence implies that domestic CD's must earn the same rate of return as other non-bank money market instruments and supply and demand for domestic CD's should not be affected by the reserve tax. Hence, we expect that reserve requirements do not play any role in the spread between the Eurodollar deposit rate and the domestic CD rate. We argue that the observed spread between the Eurodollar deposit rate and the domestic CD rate is mainly due to lack of insurance on the Eurodollar deposit.

The organization of this paper is as follows. In chapter 2, we attempt to explain the difference in loan rates by focusing on functions of Eurobanks as a financial intermediary. Comparison of Eurodollar loan rates to outside debt as well as stock price reactions to the Eurodollar loan arrangements will be studied. In chapter 3, factors contributing to systematic divergence in Eurodollar deposit rates and domestic CD rates will be analyzed, models of competing hypotheses will be developed, and test results based on proposed models will be presented. Chapter 4 contains our concluding remarks.
Chapter II

An Analysis of Eurodollar Loan Rates

1. Introduction

Fama (1985) points out that the domestic bank loan, serving as inside debt and being a low-priority claim, conveys information that helps lower the contracting cost of other contracts. Apparently, for small organizations, direct information production would be very costly and it would be cheaper to borrow from a single agent, the bank, who has direct access to inside information. The fact that large organizations purchase lines of credit when issuing outside debt indicates that contracting costs of outside debt is still substantial even for large organizations who can produce information with relative ease. Hence, as Fama (1985) puts it, borrowers would be willing to pay a premium over other money market instruments of equivalent risk.

Eurodollar loans, however, seem to be different from domestic bank loans. Domestic banks can get access to inside information from a long on-going deposit history with their customer or from participating in the decision process as a member of the board of directors. However, it will be very hard for Eurobanks to monitor the customer without incurring
great expenses due to factors such as geographic locations or
due to lack of local expertise which would be essential to
evaluate the customer or to participate in the decision
process. Another piece of evidence that indicates lack of
close bank-customer relationship in the Euromarket is recent
development of deposit-brokerage firms which serve the
corporate segment. It is evidently not a common practice in
the domestic banking market.

As explained above, lack of a long ongoing history of
bank-customer relationship and difficulties in monitoring the
customer make Eurobanks unable to function well as an
insider. Consequently, the cost of information production by
Eurobanks may not be as low as those of domestic banks and
Eurobanks may not be able to perform the same information
production function. Eurodollar loans can best be considered
as just another type of outside debt and, hence, cannot
command a premium as domestic bank loans do and the demand
for the Eurodollar loan is perfectly elastic at the market
rate. The cost of the Eurodollar loan to the borrower must
equal the cost of other sources of funds such as commercial
paper.

In section 2, we investigate whether the Eurodollar loan
commands a premium over other outside debt. In section 3, we

7 See George and Giddy (1983) p. 3.3-10.
investigate the fundamental issue of the role of Eurobanks by examining the stock price reaction to the announcement of Euroloan arrangements.

2. Eurodollar loan vs. Commercial Paper

The cost of commercial paper includes the interest paid to the lender and additional costs of maintaining lines of credit. Since commercial paper is a short term instrument and usually expected to be rolled over, a natural concern is the availability of sufficient funds to pay off the debt on its maturity. All or a large portion of outstanding papers are backed by lines of credit obtained from banks. Most commercial paper issuers try to maintain 100% lines of credit, but the percentage varies with issuers and seasons. Smaller issuers tend to back their issues with 100% lines while large issuers such as GMAC (General Motors Acceptance Corporation) usually maintain 60% lines of credit. Borrowers with different seasonal cash demands can run over- or under-line. The standard agreement is to compensate banks for a line of credit by holding non-interest-bearing compensating balances with their banks. The compensating balance is
usually 10% on the unused portion and 20% on amounts borrowed.\textsuperscript{8}

The cost of commercial paper can be calculated as

\[
\frac{\text{Commercial Paper Rate}}{1 - (\% \text{ of line})(\% \text{ of compensating balance})}.
\]

For example, let us consider a case where the borrower maintains 60% line. If all the line is unused, the compensating balance will be 10% of the line or 6% of the amount borrowed. It means that 6% of the amount borrowed cannot be used; that is, actual usable funds are 94%. Hence, the actual cost of the fund is the rate charged divided by .94.

If the cost of a Eurodollar loan is the same as the cost of commercial paper, the differential between the Eurodollar loan rate and the commercial paper rate must be the same as the cost of lines of credit. The solid line in Figure 3 is the differential between Eurodollar loan rate and commercial paper rate.\textsuperscript{9} Two dotted lines represent reasonable upper and lower bounds of the cost of maintaining lines of credit for

\begin{itemize}
  \item Another popular method is to pay a straight fee, typically 3/8 or 3/4\%, instead of holding compensating balances. When money is tight, the fee gets higher. For further information on commercial paper, see Stigum (1983), Chapter 18.
  \item Eurodollar loan rates are from I. P. Sharp Associates and commercial paper rates are from Harris bank data tape. This data base consists of weekly data observed on every Friday and covers the period from January 1, 1979 to February 1, 1985.
\end{itemize}
commercial paper. The lower bound line represents the cost of maintaining 60% line with all the line unused (10% compensating balance) and the upper bound line represents the cost of maintaining 100% line with all the line used (20% compensating balance). The differential is almost always within the bounds, suggesting that the cost of raising funds in the Eurodollar market is not different from the cost of raising funds using commercial paper.

3. Announcement effects of Eurodollar loans

Fama (1985) argues that domestic banks provide special services with their lending activities.\textsuperscript{10} If Eurobanks do not provide such services other than a simple transaction service, then the difference in loan rates can be explained by the premiums that domestic bank borrowers are paying for the special service domestic banks provide. We study whether Eurobanks perform the same function as domestic banks by inspecting stock price reactions to Euroloan announcements.

3.1 Methodology

To study the effects of loan announcements, we use standard event study methodology found in many corporate

\textsuperscript{10} Supporting evidence can be found in James (1987) and Lummer and McConnell (1988).
finance literatures. Prediction errors around the date of loan announcements are calculated using the market model. To estimate the market model we use a period from 270 days prior to the announcement until 21 days prior to the announcement. Although there are no particular rules for the choice of the estimation period, it seems reasonable to choose about a year of data to avoid possible bias due to known calendar effects.\textsuperscript{11} For the market model estimation, we use CRSP value-weighted index returns. Prediction error for the i-th firm on day \( t \) is defined as

\[
PE_{i,t} = R_{i,t} - \hat{R}_{i,t},
\]

where \( \hat{R}_{i,t} \) is predicted value from the market model.

Average prediction error is formed by taking cross-sectional averages. The average prediction error at date \( t \) is defined as

\[
APE_t = \frac{1}{N} \sum_{i=1}^{n} PE_{i,t},
\]

\textsuperscript{11} Firms in the test sample are mostly large firms whose stock price do not have discernible calendar effects. However, we took a year as a precautionary measure. James (1987) uses 120 trading days prior and after the announcements excluding middle 41 observations. This could be a good practice if there exists possibilities of structural changes due to announced loan arrangements. However, this method may prohibit one from including more recent events in the test due to the requirement of return data well after the announcements.
where \( N \) represents the number of firms in the sample.

To calculate \( n \)-day abnormal returns, prediction errors during the \( n \)-day period are summed. Average \( n \)-day abnormal returns are calculated by taking cross-sectional averages.

For significance tests as well as cross-sectional regression analyses, standardized prediction errors are used to avoid possible heteroscedasticity. The standardized prediction error is formed by taking the prediction error divided by the square root of its estimated forecast variance, \( s_{i,t} \).

\[
SPE_{i,t} = \frac{PE_{i,t}}{s_{i,t}}
\]

with

\[
s_{i,t} = \sigma_i \left[ 1 + \frac{1}{L_i} + \frac{(R_{m,t} - \bar{R}_m)^2}{L_i} \sum_{i=1}^{L_i} (R_{m,1} - \bar{R}_m)^2 \right]
\]

where \( \sigma_i \) is the estimated residual standard deviation form the market model regression, \( L_i \) is the number of days in the estimation period for the \( i \)-th firm, \( \bar{R}_m \) is the mean of the market return over the estimation period.

Cumulative standardized prediction errors for the period from day \( t \) to day \( t+t \) are defined as
Assuming cross-sectional independence, the test for the $(t+1)$-day abnormal returns can be based on a $z$-statistic given as

$$Z_{(t,t+1)} = \sqrt{N} \left[ \frac{1}{N} \sum_{i=1}^{n} CSPE_{i,(t,t+1)} \right].$$

3.2. The data

Monthly issues of Euromoney contain a list of firms that signed Eurocurrency syndicated loans. Although Euromoney provides lists of firms that arranged Eurocurrency loans, they report neither the date the loan is signed nor the date such an arrangement is announced. Dow Jones News Retrieval Service was used to identify announcement dates. Dow Jones News Retrieval Service covers both Dow Jones news as well as Wall Street Journal news for the period from 1979 until present. Although Dow Jones News Retrieval Service covers most of Wall Street Journal news, we found that some of the news did not appear in the Dow Jones News Retrieval Service.
data base. Hence, we supplemented the search by using Wall Street Journal Index.\footnote{Wall Street Journal announcements lags a day or so due to press time, while Dow Jones news is transmitted electronically. Hence, we use Dow Jones dates if the news appears on both services.}

Due to the need for daily stock returns in this study, we use only those firms whose stocks are covered either by the CRSP (Center for Research in Security Prices) daily stock return file or by the NASDAQ daily master file also supplied by CRSP. During the search process through Dow Jones News Retrieval Service, additional Eurodollar loan arrangements were found and were included in the data set. The reason some of the announcements are not reported in Euromoney seems that either the loans are provided by a single Eurobank or by a small group of banks which did not form a syndication or they represent amendments to existing syndicated Euroloans.\footnote{The number of additional cases is 11. Although syndicated loans are more popular in the Euroloan market, only about half of the loans provided to final borrowers represent syndicated loans. However, loans made by a single bank tend to be small in amount and not well publicized. As a result, most of the publicly available information are on syndicated loans.} This search resulted in 183 announcements.

To avoid contamination, we excluded announcements accompanied by other news during the five day period beginning two days before and ending two days after the loan
announcement. Contaminating events include announcements of other debt arrangements, take-over attempts, stock buyouts, anti-takeover measures, quarterly earnings reports, employee stock ownership plans, and other news that are known to affect stock prices. There were 34 cases with such contamination. We also excluded 5 cases because of missing observations of stock returns during the event period. As a result, the data set consists of 144 cases.

For a controlled test, we also collected a separate sample of domestic bank loan announcements. Since most of the cases of Euroloan arrangements are through a syndicate of banks, we required the sample to be formed of syndicated bank loan with a size of $20 million or greater. These loan announcements are gathered from Dow Jones News Retrieval Service. After removing contaminated events, we get 103 announcements. 14 A description of the data set is in tables 3 through 6. 15

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14 Total sample size was 119. There were 9 cases with contaminating news around the announcement date and 7 cases with missing return data during the event period.

15 Since we do not have full information on the maturity of loans, we do not provide frequency distributions of the maturity. However, by judging from the information we have, there seems to be no discernible differences. The mean value for the Euroloan sample is 5.73 years (100 cases) and the mean value for the domestic loan sample is 6.86 years (51 cases).
3.3 Stock Price Reactions to Loan Announcements.

Results of full sample test of stock price reaction to loan announcements is reported in table 7. The two-day average prediction error for the Euroloan announcement turns out to be -0.06% and not significant. This result is quite different from findings in previous studies on domestic loan announcements. James (1987) found 1.26% two-day average abnormal returns with a z-statistic of 3.96 from a sample of 80 domestic loan announcements. An extended test by Lummer and McConnell (1988) also find significant positive abnormal stock price reactions. Two-day average prediction error was 0.61% with a z-statistic of 2.69 from a sample of 728 announcements.

Observed differences could be because Eurobanks do not function as an information producer. Equally possible, however, is the fact that the particular result is due to the difference in characteristics of the loan or the borrower rather than the difference in the characteristics of banks that supply the fund. Investigation of these issues are in the following sections.
3.4 An investigation of the characteristics of the Euroloan.

3.4.1 Loan Syndication

Our sample consists of mainly syndicated loans. When the loan is supplied by a syndicate, borrowers sign only one contract with the lead bank and do not have further obligations to supply information to other participants. The lead bank supplies a placement memorandum, which contains description of the transaction and information on the borrower's credit, to the participating banks. Although this placement memorandum provides some information on the borrower, participating banks tend to be smaller banks with no particular relationship with the borrower. Many times, even lead banks themselves are not borrowers' primary banks. Therefore, banks participating in the syndicate may not have inside information and may not have advantage over others in information production.

To investigate the issue related to the syndication practice we examine a sample of syndicated domestic loan

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16 Although some borrowers prefer asking their banks to lead the syndicate, there are many others who prefer rotating the lead manager. Also there are many cases of solicitation for the position of the lead manager. For more information on syndication practice, see Goodman (1983).
announcements.\textsuperscript{17} As reported in table 7, the two-day prediction error is 0.88\% and significant with a z-statistic of 2.22. This result is consistent with previous findings by James (1987) and Lummer and McConnell (1988) in their domestic loan studies. Even in a syndicated form, domestic bank loans appear to carry information which is not yet transmitted to the public. Lack of stock price reactions in the Euroloan case, hence, does not seem to be related to the syndicated nature of Euroloans.

3.4.2. Analysis by the primary usage of funds.

In this section, we investigate whether the observed difference in stock price reaction to the loan announcement is due to differences in primary usage of funds.

James (1987) concluded that "An analysis \ldots indicates that differences in abnormal performance are not due solely to differences in characteristics of the loan or characteristics of borrowers." However, there were clear indication of different stock price reactions among different supplier groups. When the borrower arranged funds for general corporate use or repayment of bank loans, there were significant positive stock price reactions to bank loan

\textsuperscript{17} The description of the sample of domestic syndicated loan is in section 3.2.
agreements while there were no reactions to private placements and public straight debt issues. However, in all the other groups, stock price reactions were insignificant even for bank loan agreements.  

Given the evidence that there could be some cases where even domestic bank loan announcement do not result in abnormal stock price reactions, one might suspect that the particular result we obtain could be because the Euroloan announcement sample consists of mainly such a type. To investigate the issue of clustering, we divided our sample by the usage of funds. The sub-sample groups are (1) general corporate use, (2) special finance, and (3) all the other miscellaneous use and no purpose given.

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18 Finding cases when there are no reactions to bank loan agreements is not necessarily inconsistent with Fama's (1985) argument. It may simply indicate that the information production function is not the sole contributor to the uniqueness of domestic bank services. However, one can still establish the fact that domestic banks do perform information production services, particularly when the loan was provided for general corporate use and repayment of bank loans. The information needed to assess the borrower may be different depending on the purpose and banks may not have informational advantage in some cases. For example, in case of funding for a new investment project, the existing knowledge of the firm acquired through long on-going history may not be sufficient and banks may not have informational advantage.
The first group, the general-corporate-use group, consists of loans arranged for general corporate use, for working capital use, and to support future contingencies due to expected normal growth of the firm. The second group, the special-finance group, consists of cases with stated purpose of capital expenditures as well as project financing. All the others as well as cases with no statements of the purpose of credit arrangements are put together to form the third group.

Results reported in table 8 show that, in all categories, Euroloan announcements do not result in abnormal stock price movements. All the two-day prediction errors are small and not significantly different from zero. Lack of stock price reactions does not seem to be due to particular clustering of the Euroloan sample.

Results on the domestic syndicated loan sample, however, were consistent with the results obtained by James (1987). The general corporate use group had 2.17% abnormal returns and a z-statistic were 3.62. The special purpose financing group and the third group had insignificant reactions.

3.4.3 Analysis by the type of loan agreements.

Another aspect to be considered is whether the loan agreement is a new one or a revision to the existing one. Lummer and McConnell (1988) report that refinancing
agreements result in significantly positive stock reactions while new financing agreements do not. Their maintained argument is that it is the bank loan review and renewal process that plays an important role.

The sample was divided into four categories, (1) new financing, (2) refinancing bank debt, (3) refinancing outside debt, and (4) no statements.

Two-day average prediction errors for the four categories are reported in table 9. The Euroloan sample show no significant stock price reactions in all categories. In case of domestic syndicated loan announcements, results were similar to those reported by Lummer and McConnell (1988). Two-day average prediction error for the bank-refinancing category was 1.62% (a z-statistic = 3.121) while there were no significant reactions in other categories.

3.4.4. Other explanations

Data descriptions reported in tables 4 through 6 show that the size of the firm measured by the market value of equity as well as the loan size are markedly different. Even the loan amount to the market value of equity ratios (referred hereinafter as loan ratios) are different from those of the domestic loan sample.
As Fama (1985) points out, it would be costly for smaller firms to produce information directly. If the domestic bank is indeed the most efficient in information production and serves as an information producer,\(^{19}\) it would make sense for smaller firms to choose the domestic bank. In other words, if the Eurobank also functions as an information producer, there would be no reason for smaller firms to use the domestic bank despite higher costs due to reserve taxes. Descriptive statistics reported in tables 4 and 5 are consistent with the view that the Eurobank does not function as an information producer. It seems that smaller firms tend to use domestic banks while larger firms tend to use Eurobanks.

We can further clarify this issue by regressing abnormal stock returns on a variable that proxies the need for outside information production. The market value of equity and the number of months the firm is listed on either New York Stock Exchange (NYSE) or American Stock Exchange (AMEX) are used to proxy the need for outside information production.

In particular, we take the two-day standardized prediction errors of an individual firm \(i\) (SPE\(_i\)) as a dependent variable and take the market value of equity (MV\(_i\))

\(^{19}\) For a discussion of the efficiency in information production and the role of financial intermediary as a information producer, see Campbell and Kracaw (1980).
and the number of months the firm is listed on NYSE or AMEX (NY_i) as independent variables.

Notice that the two-day standardized prediction error is given by

\[
SPE_{i,-1,0} = SPE_{i,-1} + SPE_{i,0} = \frac{PE_{i,-1}}{S_{i,-1}} + \frac{PE_{i,0}}{S_{i,0}}
\]

where s is the square root of estimated forecast variance as defined in equation (4). Hence, following the weighted least squares principle, we apply weights to the independent variables given as \((1/s_{i,-1} + 1/s_{i,0})\).

Letting I be a vector of 1's for the domestic loan sample and 0's for the Euroloan sample and 1 be an iota vector, we can write a weighted least squares regression equation as

\[
SPE_i = \beta_0 \cdot I^* + \beta_1 \cdot MV_i^* + \beta_2 \cdot NM_i^* + \beta_3 \cdot I^* + \epsilon_i
\]

where **'s represent corresponding variables multiplied by the weights.

The result is presented below.

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20 For one-day prediction errors, a weighted least squares regression equation can be written as

\[
PE_{i,t} = a \frac{1}{s_{i,t}} + \beta \frac{X}{s_{i,t}} + \epsilon_t
\]

Hence, for two-day prediction errors we get

\[
\sum_{t=-1}^{0} \frac{PE_{i,t}}{s_{i,t}} = a \left( \frac{1}{s_{i,-1}} + \frac{1}{s_{i,0}} \right) + \beta \cdot X \left( \frac{1}{s_{i,-1}} + \frac{1}{s_{i,0}} \right) + \epsilon_t.
\]
\[ \text{SPE}_i = -0.011652 \cdot t^* - 6.27E^{-10} \cdot \text{MV}_i^* + 2.748E^{-5} \cdot \text{NM}_i^* \]

\[ (-3.494) \quad (-0.010) \quad (3.546) \]

\[ + 0.0043539 \cdot I^* \quad (1.780) \]

\[ R^2 = 0.0711 \text{ (number of observations: 185)} \]

The coefficient for the number of listing months is positive and significant at 1% level (one-tail). Sub-sample results reported in table 10 also show that the coefficient is positive and, in general, significant. These results seem to indicate that the longer a firm is listed on an exchange, the larger the abnormal stock price reaction.

The coefficient for the market value of shareholders' equity, however, is insignificant in all cases. As in James (1987), we find no statistically significant relation between the stock price reaction and the market value of equity. This result, however, need not be interpreted as counter-evidence against the aforementioned hypothesis of Fama (1985). The market value of equity may not correctly represent the size of the firm and, hence, the need for outside information production.

\[ 21 \quad \text{The coefficient for the dummy variable represents the difference in intercepts. The difference in intercepts is significant at 5\% (one-tail) level. Further inspection of the sub-sample results reported in table 10 shows that intercept differences are significant when there are abnormal stock prices reactions.} \]
Another noticeable difference is the loan ratio reported in table 6. The loan ratio of the domestic sample is higher than that of the Euroloan sample. Notice that the loan ratio is a standardized value that only tells the proportion of the loan size per one dollar of market value of equity. The loan ratio no longer proxies the need for information production but may proxy the riskiness of the loan. We would expect that the riskier the loan arrangement is, the stronger the certification of the information is. In other words, we expect bigger stock price reactions for riskier loan arrangements.

However, the result reported below show that the loan ratio \( (\text{LR}_i) \) has virtually no explanatory power.

\[
\text{SPE}_i = 0.00069 \cdot t^* - 0.00102 \cdot \text{LR}_i^* + 0.00261 \cdot t^* + \varepsilon_i
\]

\[\text{(11)}\]

\[\begin{array}{ccc}
(0.501) & (-0.751) & (1.169) \\
\end{array}\]

\[R^2 = 0.0103\]

\[22\] Separate regressions on sub-samples reported in table 11 show that indeed the above result is due to cases with no abnormal reactions. For the sub-sample of general corporate use, \( \beta_2 \) is significant at 5% level. The result for the sub-sample classified by the type of arrangements, however, show no difference in stock price responses. The estimates of \( \beta_2 \) were insignificant. This particular sample of syndicated loans do not seem to support Lummer and McConnell's (1988) view that the action of the bank, rather than the usage of debt, is what signals information to the market. Since this issue is not
Separate regressions for each group, as reported in table 11, produce similar results.\textsuperscript{23} This result contrasts with the result obtained by Lummer and McConnell (1988). In their test, the coefficient was significant at 5\% level (one tail) with a t-statistic of 1.89. This difference seems to be due the difference in the sample. Our sample consists of mainly syndicated loans. One of the reason for forming a syndication is to diversify the loan risk. Therefore, risk characteristics of the loan may not be an important factor in the case of syndicated loans.

4. Summary

Over the period we examined, we did not find any significant stock price reaction to the announcement of Euroloan arrangements. Lack of stock price reactions was not due to particular clustering of the sample or any other nature that is specific to the borrower or the loan itself.

\textsuperscript{23} We also used total long-term debt to market value of equity ratio but the result was almost the same as the result reported here. Obviously, since those two variables proxy the same information, the riskiness of the loan, we expect the result to be similar. Hence, to avoid redundancy, we do not report the result for total long-term debt ratio.
The domestic syndicated loan sample show similar results obtained in aggregate domestic loan studies. Sub-sample inspection indicates that domestic banks may have informational advantage in some cases but not in other cases. This result raises a further question. Why would borrowers use domestic bank loans in a situation when domestic bank loans do not provide signalling information? If the information production function is the sole reason for their willingness to pay reserve taxes, borrowers would not seek domestic bank loans in such situations. There seems to be some other services that the domestic bank provides and that special service may in fact be available even in a syndicated form. We need further studies to identify what that uniqueness is and from where such uniqueness comes from.²⁴

The evidence provided in section 2 and 3 seems to indicate that Eurobanks do not function as information producers and that the Eurobank does not have uniqueness that the domestic bank has. Therefore, Euroloans can not command a premium as domestic bank loans.

²⁴ Thus far, the theory of financial intermediation focuses on the informational aspects with an assumption of asymmetries of information. Those studies include Leland and Pyle (1977), Campbell and Kracaw (1980), Diamond (1984), and other cited papers in this paper.
Chapter III
An analysis of Eurodollar deposit rates

1. Introduction

Domestic CD's do not provide any special transactions or liquidity services such as checking privileges. Hence, Fama (1985) points out that domestic CD's must yield the market rate of interest. Like domestic CD's, Eurodollar deposits do not provide any special services to depositors. Hence, for the Eurodollar deposits to be competitive, it must also yield the market rate of interest. It implies that if Eurodollar deposits and domestic deposits were in the same risk class, the interest rate on the Eurodollar deposit and the domestic deposit must be the same.

Before we further discuss the riskiness of Eurodollar deposits, let us first examine the issue of reserve taxes which has been a central focus in many previous analyses.

One of the arguments in previous analyses, called "outward arbitrage" argument, predicts that the Eurodollar deposit rate can not be greater than the cost of domestic funds, otherwise, as they argue, banks can engage in a

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25 This proposition is subsequently supported by an empirical study by James (1987).
profitable arbitrage by raising funds in the domestic market and simultaneously depositing them in the Eurodollar market. However, this argument fails to explain the recent behavior of interest rate differences. During the most of 80's, as Kreicher (1982) shows, the cost of domestic funds measured by the cost of certificate of deposits (CD's) were persistently lower than the Eurodollar deposit rates. Notice that the "outward arbitrage" is not a pure arbitrage but a risky investment. By matching maturities, of course, they can eliminate the interest rate risk but they are still subject to risk of default by the deposit-taking bank. Their prediction is not expected to hold.

In another form, the bank arbitrage argument predicts that since banks can switch source of funds between two markets if the cost of funds in one market deviates from the cost of funds from another, the cost of funds in both markets must be equated in equilibrium. Equilibrium in this case is similar in spirit to Miller's (1977) equilibrium. It is argued that supply of the Eurodollar deposit by investors would not be flat at the domestic CD rate but slope upwards due to risk difference between Eurodollar deposits and domestic CD's, while demand of Eurodollar deposits by banks would be infinitely elastic at the cost of domestic CD's.
This argument implies that the difference in deposit rates is the difference in regulatory costs.

One important deficiency in the above argument is oversight of the loan side. If bank borrowers bear the reserve tax, we do not expect supply and demand of the domestic CD to depend on the reserve tax. Notice further that only the banks are subject to reserve taxes. If the Eurodollar deposit rate is higher than the domestic CD rate simply due to reserve taxes, any non-bank institution, which is in the same risk class as domestic money center banks, can engage in profitable arbitrage activities by just raising funds in the domestic market and depositing the proceeds in the Eurodollar market.

The interest rate on Eurodollar deposits could be different depending on the location of the Eurobank due to differences in so-called sovereign risk. This risk is related to the possibility of losing all or part of deposits due to exchange controls or outright seizure of assets or liabilities of the bank by the regulatory body where the bank resides. Eurobanks located in a country which tends to heavily regulate the banking system or is politically unstable are in fact faced with higher sovereign risk. However, if government policies or political systems of the countries where Eurobanks reside are identical, we do not
expect to see any systematic divergence in interest rates. The same logic applies to the case of domestic deposit rate versus Eurodollar deposit rate. That is, if government policies or political systems of the domestic market are the same as those of external Eurodollar centers, any systematic divergence in interest rates must not be due to sovereign risk.

Difference in insurance between those two markets, however, seems to be substantial. Domestic CD's are insured up to $100,000.²⁶ Moreover, although Federal Depository Insurance Corporation is not legally liable for the portions that exceed the $100,000 limit, dominant practice is rather to reorganize or to bail out the ailing bank than to allow the bank to fail.²⁷ Hence, we expect that insurance on the domestic CD is substantial.

However, Eurodollar deposits do not carry any explicit insurance. Moreover, there seems to be high uncertainty about whether the parent bank or its central bank would back up depositors in a case of disputes. If the Eurobank is a

²⁶ $100,000 coverage started from Mar. 31, 1980 when the Depository Institutions Deregulation and Monetary Control Act of 1980 was signed. Before Mar. 31, 1980, the coverage was up to $40,000 for the private accounts ($100,000 for the government time and savings accounts).

²⁷ See Dufey and Giddy (1984) and also Ronn and Verma (1986).
branch, any support to parent banks by its central bank also extends to their foreign branches since the branch is not a separate entity. However, if the Eurobank is a subsidiary or an affiliate, there is no guarantee that the central bank will act as a lender of last resort.\textsuperscript{28} Even if the Eurobank is a branch, generally the parent bank is relieved from liability for the failure of its branches as a result of foreign governments' or courts' action such as seizure of assets or exchange controls.\textsuperscript{29} Hence, we argue that the deposit rate differential is mainly due to lack of insurance in the Eurodollar market.

A new model based on the difference in the level of insurance is presented in section 2. The insurance-based model is compared with the previous cost-based model and tested in section 3. Section 4 provides a brief discussion of other possible factors. A summary of this chapter is in section 5.

2. Models

Explanation based on reserve tax, as discussed in the previous section, predicts that the cost of Eurodollar

\textsuperscript{28} For a detailed discussion on Eurobank risks and examples, see Dufey and Giddy (1984).

\textsuperscript{29} See Dufey and Giddy (1984) for further discussion.
deposits is the same as the cost of domestic CD's. Let $i_{ED,t}(t)$ be the cost at time $t$ of Eurodollar deposit with time to maturity of $t$ and $i_{CD,t}(t)$, the cost of domestic CD's. Then,

$$i_{ED,t}(t) = i_{CD,t}(t), \text{ or}$$

$$R_{ED,t}(t) + C_{ED} = \frac{R_{CD,t}(t) + C_{CD}}{1 - RR_i} \quad (13)$$

where $R_{ED,t}(t)$ represents the rate of interest paid on $t$-period Eurodollar deposits at time $t$, $R_{CD,t}(t)$ stands for the rate of interest paid on $t$-period domestic CD, and $RR_i$ is the reserve requirement ratio for domestic CD's in $i$-th period.\(^{30}\) $C$ is issuing and maintenance cost where the subscripts ED and CD represent Eurodollar and domestic CD, respectively. The issuing and maintenance cost is assumed to be constant during the sample period.

Rewriting equation (13), the spread between the Eurodollar deposit rate and the domestic CD rate, $H$, can be represented as

\(^{30}\) The reserves are to be kept either as a vault cash or non-interest-paying deposit with the Federal Reserve Bank. It means that the usable fund is a fraction $(1-RR)$ of every dollar raised. Hence, the effective cost of domestic CD is the total cost per this fraction of a dollar.
The second term on the right hand side of equation (14) represents the reserve tax on domestic CD's and the first term on the right hand side is issuing and maintenance cost differences.

Under the alternative explanation based on insurance, the spread can be modeled using isomorphic relationships between equity and a call option, insurance and a put option, as shown in Merton (1974). Merton (1974) derives a closed-form solution for the yield spread under the assumption of constant interest rates and log-normal firm value dynamics.

Merton's (1974) approach can be extended to a case with stochastic interest rates. Following Merton (1973), we assume that the riskless discount bond price follows a diffusion process with deterministic diffusion coefficients. An undesirable property of this approach is that the assumed process for the riskless discount bond does not preclude the possibility of the riskless discount bond price being greater than 1. Alternatively, we can derive a partial differential equation under a more plausible assumption as adopted in
However, if the undesirable property of Merton's (1973) approach does not affect the particular testable implications we extract from the closed-form solution, availability of a closed-form solution would make the Merton's (1973) approach preferable. We present a closed-form solution for the spread based on Merton's (1973) approach.

If the insurance on domestic CD's is complete, then the rate of interest on domestic CD's must be the same as the riskless rate of interest. However, we do not have any prior reason to believe that the domestic CD has perfect guarantee. Moreover, as shown in Figure 4, the difference between the domestic CD and the Treasury bill rate seems to be substantial and also highly variable, implying that the insurance on large domestic CD's is rather incomplete.

One way to handle incomplete insurance problem is to introduce a variable that shows the extent to which the domestic CD is insured. Suppose that a fraction \( \xi \) of the total debt is completely insured. \( \xi \) can be considered a policy variable which depends on government policy and may

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31 A model for the spread under similar distributional assumptions as in Ramaswamy and Sundaresan (1985) is provided in appendix A.

32 Further discussion of testable implications and undesirable properties of Merton's (1973) approach will be provided in appropriate sections.
vary with time. However, if the government maintains a consistent policy, we would expect $\zeta$ to be fairly constant. Hence, for simplicity of exposition, we assume that $\zeta$ is a constant.

The current value of domestic CD with partial guarantee can be considered a portfolio of risky debt with a put option written on a fraction $\zeta$ of risky debt. Letting $CD_t$ be the value of domestic CD at time $t$, we get

$$CD_t = D_t + G_t$$

(15)

where $G_t$ is the value of a put option on the fraction $\zeta$ of the debt and $D_t$ is the value of risky debt. As shown in appendix B, $D_t$ can be represented as

$$D_t = K e^{-\tau R_f}$$

(16)

where $R_{f,t}(\tau)$ is the rate of return on a riskless zero-coupon bond which matures at time $t+\tau$,

$$P = \Phi(h_2) + \frac{1}{x} \Phi(h_1),$$

(17)

$$x = \frac{K e^{-\tau R_f}}{V},$$

(18)

$$h_2 = - \frac{1}{2} \zeta^2 \tau + \log(x)$$

(19)

$$h_1 = - \frac{1}{2} \zeta^2 \tau - \log(x).$$

(20)
\[ \Phi(h) = \int_{-\infty}^{h} \frac{1}{\sqrt{2\pi}} e^{-\frac{y^2}{2}} \, dy \] is a cumulative normal distribution function and \( \xi^2 = \sigma^2 + \delta^2 - 2\rho \sigma \delta \), where \( \sigma^2 \) is the instantaneous variance of the return on the bank, \( \delta^2 \) is the instantaneous variance of the return on the riskless zero-coupon bond, and \( \rho \) is the correlation coefficient between (unexpected) the rate of changes in the bank value and the rate of changes in the riskless zero-coupon bond price.\(^{33}\)

Now consider the value of a proportion \( \zeta \) of debt which is insured. The current value of the insured portion of debt will be \( \zeta Ke^{-RT} \) since it is now riskless. It can also be shown that the current value of insured proportion of debt equals the current value of the proportion \( \zeta \) of risky debt plus the value of guarantee. Hence,

\[ \zeta Ke^{-RT} = \zeta D_t + G_t. \quad (21) \]

Therefore, from equation (16) and (21), we get

\[ G_t = \zeta Ke^{-RT}(1 - P). \quad (22) \]

Substituting equation (16) and (22) into (15), the current value of domestic CD can be shown as

\[ CD_t = Ke^{-RT} [\zeta + (1 - \zeta) P]. \quad (23) \]

\(^{33}\) See Appendix B for further details.
The current value of domestic CD can also be written as $K e^{-R_{CD,t} \tau}$ using interest rate on domestic CD, $R_{CD,t}(\tau)$. Setting equation (23) equal to $K e^{-R_{CD,t} \tau}$ and solving for $R_{CD,t}(\tau)$, we get

$$R_{CD,t}(\tau) = R_{f,t}(\tau) - \frac{1}{\tau} \log \left[ \frac{1}{\tau} + (1 - \zeta) P \right].$$  \hspace{1cm} (24)

Notice that $D_t$ is a value of risky debt with the same promised payment of $K$. In other words, $D_t$ is the value of the Eurodollar deposit. Hence, letting the interest rate on Eurodollar deposit be $R_{ED,t}(\tau)$ and following similar steps as in the derivation of domestic CD rate, we get

$$R_{ED,t}(\tau) = R_{f,t}(\tau) - \frac{1}{\tau} \log (P).$$  \hspace{1cm} (25)

Above formulations are intuitively appealing. Notice that $P$ can be interpreted as a (multiplicative) risk premium. The current value of domestic CD, as shown by equation (23), equals the value of riskless proportion, $\zeta$, and the value of the risky proportion, $(1 - \zeta)$. Therefore, the domestic CD rate must be the same as the riskless rate of interest if the insurance is complete, while the domestic CD rate must be equal to the Eurodollar deposit rate if there are no insurance. Equation (24) is indeed consistent with the above intuition since when $\zeta = 1$, $R_{CD} = R_f$ and when $\zeta = 0$, $R_{CD} = R_{ED}$. 
From equations (24) and (25), the spread between Eurodollar deposit rate and domestic CD rate can be represented as

\[ H_t(t) = R_{ED,t}(t) - R_{CD,t}(t) = -\frac{1}{\tau} \log \left( \frac{P}{\zeta + (1 - \zeta)P} \right). \]  

(26)

3. Empirical Investigation

In this section, we investigate the determinants of the spread between the Eurodollar deposit and the domestic CD. Of particular interest is whether the spread is largely determined by the reserve tax or whether it is mainly due to lack of insurance in the Eurodollar market.

3.1 The Data

Data are from various sources. Daily 3-month Eurodollar deposit rates are from the Board of Governors of the Federal Reserve System. The Board of Governors of the Federal Reserve System provided a macro data tape which covers the period from January 1971 to May 1987. Daily 3-month domestic Treasury bill rates are from I. P. Sharp Associates, an on-line data service firm. I. P. Sharp Associates' Treasury bill data base starts from January 1982. Daily 3-month domestic certificate of deposit rates are gathered from many issues of Bank and Quotations Record. Bank and Quotations Record is a
monthly publication and it reports daily CD rates each month. Data set collected covers the period from January 1976 to December 1986.

3.2 A test of Structural Change

One of noticeable differences between equation (14) and (26) is that equation (14) is a function of reserve requirement ratios while equation (26) is not. Therefore, under the cost-based model, there must be structural changes associated with changes in the reserve requirement ratio.\(^{34}\)

Notice, however, that equation (14) in its given form cannot be readily used in a regression analysis since the independent variable, \(R_{CD,t}(\tau)\), also appears in the dependent variable, \(H_t(\tau) = R_{ED,t}(\tau) - R_{CD,t}(\tau)\). Rearranging equation (14), we get

\[
R_{ED,t}(\tau) = \left( \frac{C_{CD}}{1 - RR_{i}} - C_{ED} \right) + \frac{1}{1 - RR_{i}} R_{CD,t}(\tau). \tag{27}
\]

Assuming that costs of issuing and maintenance in both markets are constant during the test period, we can write a test equation as

\(^{34}\) This implication is not affected by the implausibility of Merton's (1973) assumption pointed out in section 2 since the model for the Eurodollar rate under a more plausible assumption of the riskless rate dynamics would still be independent of reserve requirements.
\[ R_{ED,t}(\tau) = \alpha_i + \beta_i R_{CD,t}(\tau) + \varepsilon_t, \] (28)

where the subscript \( i \) represents \( i \)-th reserve requirement regime. \( \{\varepsilon_t\} \) can be interpreted as random errors or additive measurement errors.

Structural change can be tested using dummy variables. Following Maddala (1977, p.136), we can write a stacked regression equation as follows.

\[
\begin{bmatrix}
R_{ED,i} \\
R_{ED,i+1}
\end{bmatrix} = \alpha_i \begin{bmatrix}
1_i \\
1_{i+1}
\end{bmatrix} + (\alpha_{i+1} - \alpha_i) \begin{bmatrix}
0_i \\
1_{i+1}
\end{bmatrix} + \beta_i \begin{bmatrix}
R_{CD,i} \\
R_{CD,i+1}
\end{bmatrix} + (\beta_{i+1} - \beta_i) \begin{bmatrix}
0_i \\
R_{CD,i+1}
\end{bmatrix} + \begin{bmatrix}
e_i \\ e_{i+1}
\end{bmatrix} \] (29)

where \( 1_i \) and \( 0_i \) represent vectors of 1's and 0's for the regime \( i \).

If the cost-based model is correct, \( \alpha_i \) and \( \beta_i \) must be different from \( \alpha_{i+1} \) and \( \beta_{i+1} \), respectively. The test of structural change, therefore, can be performed by testing significance of the coefficients, \( (\alpha_{i+1} - \alpha_i) \) and \( (\beta_{i+1} - \beta_i) \).

Under ideal conditions, each coefficient can be tested using standard \( t \)-statistics. However, least squares residuals seem highly autocorrelated as shown by Durbin-Watson d-
statistics reported in table 13. Notice further that the test period includes October 1979. It is well known that there had been substantial changes in the volatility of interest rates after October 1979 thereby causing potential heteroscedasticity problems.

To handle the problem of autocorrelated and heteroscedastic errors, we follow White and Domowitz (1984), who provide a method for testing hypothesis under both heteroscedasticity and autocorrelation of unknown form. Since the null model does not suggest any particular form of autocorrelation and neither is easy to determine a suitable form of autocorrelation from the data, the method suggested by White and Domowitz (1984) seems to best suit our purpose.

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35 Most interest rate series can be described by an AR(1) process and first differencing usually clears up the problem. However, in the present case, use of first differences did not show any improvement.

36 Many researchers including White (1980), Hansen and Hodrick (1980), Hansen (1982), Cumby, Huisenga and Obstfeld (1983), and Hsieh (1983) contributed to the development of test procedures under autocorrelated and/or heteroscedastic errors under different conditions. White and Domowitz (1984) unified and further improved previous results. They provide general conditions which ensure consistency and asymptotic normality for the least squares estimator where errors may be autocorrelated and/or heteroscedastic.

37 As pointed out earlier, errors under the null model are either random shocks or some additive measurement errors. Hence, the evidence of autocorrelation may even suggest that the given model – the cost-based model – is not a correct description.
Moreover, White and Domowitz (1984) show that the number of nonzero autocorrelations does not have to be known a priori or even be finite. The variance-covariance matrix can still be consistently estimated if the number of non-zero autocorrelations is allowed to grow slowly enough with the sample size.

Although White and Domowitz's (1984) method allows autocorrelations of unknown form, there is one important restriction to the type of autocorrelation; that is, current events must be almost independent of distant events even though there can be considerable dependence in recent events. Notice that figures 5 through 10 show that the autocorrelation dies out.\textsuperscript{38} It appears to be reasonable to assume that the mixing condition in White and Domowitz (1984) is satisfied.

As shown by White and Domowitz (1984), we can develop a statistic for hypothesis testing similar, in principle, to the Wald test. For ease of exposition let equation (29) be represented as

\[ y_t = X_t \beta + e_t \]

\textsuperscript{38} One of the interesting fact revealed by the autocorrelograms shown in figures 4 through 9, although irrelevant to the issues addressed here and not pursued in this paper, is that the autocorrelations of residuals in 80's declines at a considerably slower rate than those in earlier periods.
where $\beta$ is a vector of unknown parameters.

Let the null hypothesis be $R\beta = r$ with row rank of $k$, then

$$T(R\beta - r)'[R\Theta R']^{-1}(R\beta - r),$$

will have a limiting $\chi^2$ distribution with $k$ degrees of freedom. $\Theta$ in the above equation (29) is a consistent estimator of the variance-covariance matrix of parameter estimates, given as

$$\Theta = \left(\frac{X'X}{T}\right)^{-1}\Omega \left(\frac{X'X}{T}\right)^{-1}$$

where

$$\Omega = T^{-1}\sum_{t=1}^{T} \hat{e}_t^2 X_t'X_t$$

$$+ T^{-1}\sum_{j=1}^{m} \sum_{t=j+1}^{T} (1 - \frac{1}{m+1})\hat{e}_t\hat{e}_{t-j} (X_t'X_{t-j} + X_{t-j}'X_t)$$

and $\hat{e}_t = y_t - X_t\hat{\beta}$. $m$ is a function of $T$. Notice that, following the suggestion by Newey and West (1987), the weight $(1 - \frac{1}{m+1})$ is added to the original derivation of White and Domowitz (1984) to ensure positive semi-definiteness of the variance-covariance estimate. When $m$ grows more slowly than $T^{1/4}$, as shown by theorem 2 in Newey and West (1987), the variance covariance estimator can still be consistently estimated by the above equation (32). We use $m$ so that each
lagged term included is significantly different from zero while \( m < T^{1/4} \). To identify significant lags, we use Akaike's information criteria.\(^{39}\) When the identified lag is smaller than \( T^{1/4} \), we use the identified lag as our \( m \) and if the identified lag is greater than \( T^{1/4} \), we use the largest integer less than \( T^{1/4} \).\(^{40}\)

The result of the test performed on daily data for the period from January 1976 to December 1986 is reported in table 13. Significant changes in the intercept were identified in 4 out of 6 cases. In case of the slope coefficients, only 2 out of 6 cases were statistically significant. Even those cases with significant differences are not consistent with the cost-based model. Under the cost-based model, we would expect the coefficient to be smaller (larger) when the reserve requirement ratio falls (rises). In other words, the difference in coefficients must be positive when the reserve requirement ratio rises and negative when the reserve requirement ratio falls. Hence, coefficients for the first 3 cases must be positive while those for the last 3

\(^{39}\) For a discussion on order selection and Akaike's information criteria, see Judge et. al. (1985, Chapter 7).

\(^{40}\) This choice of the truncation lag, \( m \), relies on the assumption that \( m \) grows with the number of observations, \( T \), but at a speed less than \( T^{1/4} \). Of course, this assumption is an operating assumption which cannot be verified from a finite sample with currently available knowledge. For further discussion, see White and Domowitz (1984).
cases must be negative. Signs of the estimates, however, are rather erratic and inconsistent.

Notice further that the cost-based model implies that

\[ \beta_i = \frac{1}{1 - \hat{RR}_i}. \]  

(33)

Therefore, we can calculate implied reserve requirement ratios from the estimates of slope coefficients in each regime by

\[ \hat{RR}_i = 1 - \frac{1}{\beta_i}. \]  

(34)

Table 14 reports implied reserve requirements. In earlier periods, especially in first two periods, implied reserve requirement ratios seem to be somewhat close to actual reserve requirement ratios. However, in later periods, implied reserve requirement ratios largely deviate from actual reserve requirement ratios. The estimates for the sub-period 4 through 6 may not be reliable since the number of observation is quite small, but the number of observations for the latest sub-period seems to be sufficient.
3.3 Changes in the spread induced by changes in the interest rate level.

Another testable implication is that two models have completely different predictions on changes in the spread caused by changes in interest rates. If the interest rate goes up, the cost-based model predicts that the spread will be widened since the reserve tax will be larger when the interest rate is high. However, the insurance-based model predicts that the spread will be narrowed since the value of the insurance, or put option, will be smaller when the interest rate is high. This point can be formally shown using partial derivatives.

Under the cost-based model, (14), the partial derivative of the spread with respect to \( R_{CD} \) is positive. That is,

\[
\frac{\partial H}{\partial R_{CD}} = \frac{R_{R_i}}{1 - R_{R_i}} \geq 0,
\]

(35)

since \( 0 \leq R_{R_i} < 1 \).

A partial derivative of the cumulative standard normal distribution can be shown as,

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41 The testable hypothesis, again, is not affected by the undesirable nature of the assumption of the underlying process of Merton (1973). The direction of changes in the value of a put option with respect to changes in the interest rate does not depend on the assumed stochastic behavior of the underlying interest rate process.
\[
\frac{\partial \Phi(x(\alpha))}{\partial \alpha} = \Phi'(x(\alpha)) \frac{\partial x(\alpha)}{\partial \alpha} = \phi(x(\alpha)) \frac{\partial x(\alpha)}{\partial \alpha},
\]

(36)

where \( \Phi'(x) \equiv \phi(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}} \) is a standard normal density function at \( x(\alpha) \). Hence, it is easy to show that the partial derivative of the risk premium under the insurance-based model with respect to \( R_f \) is

\[
\frac{\partial \delta H}{\partial R_f} = - \frac{\zeta \Phi(h_1)}{x \Phi([\zeta + (1 - \zeta) P]} \leq 0.
\]

(37)

From equation (22), we can also show that

\[
\frac{\partial R_{CD}}{\partial R_f} = \frac{x\zeta + (1 - \zeta)x\Phi(h_2)}{x\zeta + (1 - \zeta)x\Phi(h_2) + (1 - \zeta)\Phi(h_1)} \geq 0.
\]

(38)

Therefore, changes in the spread with respect to changes in the domestic CD rate will be negative as shown below.

\[
\frac{\partial \delta H}{\partial R_{CD}} = \frac{\delta H/\partial R_f}{\partial R_{CD}/\partial R_f} = - \frac{\Phi(h_1)}{x \Phi([\zeta + (1 - \zeta) P]} \left[ 1 + \frac{(1 - \zeta) \Phi(h_1)}{x\zeta + (1 - \zeta)x\Phi(h_2)} \right] \leq 0.
\]

(39)

Now consider a Taylor series expansion of the spread around \( R_{CD,t} \). Ignoring second and higher order terms, we get

\[
H_t = H_{t-1} + \frac{\partial H}{\partial R_{CD}} (R_{CD,t} - R_{CD,t-1})
\]

(40)

or
Now consider a test equation

\[ \Delta H_t = \alpha + \beta \Delta R_{CD,t} + \varepsilon_t. \]  

(45)

If the cost-based model is true, the coefficient, \( \beta \), must be positive while \( \beta \) will be negative if the insurance-based model is true. Notice, however, that as pointed out in section 3.3.2, this setup has a potential problem since the independent variable, \( \Delta R_{CD,t} \), also appears in the dependent variable. Hence, recognizing that \( \Delta H_t = \Delta R_{ED,t} - \Delta R_{CD,t} \), we can rewrite the test equation as

\[ \Delta R_{ED,t} = \alpha + \beta' \Delta R_{CD,t} + \varepsilon_t. \]  

(46)

where \( \beta' = 1 + \beta \).

Under the given setup, the cost-based model predicts that \( \beta' \) is greater than 1 while the insurance-based model predicts that \( \beta' \) is less than 1.

If the cost-based model is a correct description, \( \beta' \) will be a constant in each reserve requirement regime. Therefore, we can use linear regression to estimate the coefficient. The estimates of coefficients as well as test statistics are reported in Table 15. The estimates, \( \hat{\beta}' \), were all less than 1. The data does not seem to support the cost-based model.
Of course, under the insurance-based model, $\beta'$ will be time-varying and we cannot use ordinary least squares to estimate $\beta'$. Although the above test seems to have some power to reject the null when it is false, results reported in table 15 cannot be interpreted as supporting evidence of the alternative model. We now turn to a model specification test.

3.4 A model specification test.

All the parameters and variables of the cost-based model are identified but the insurance-based model includes many parameters and variables which are very hard to estimate. Problems arise due to factors such as multiplicity of debts held by banks and non-traded debts, market value of which is unknown. However, we can eliminate most of the parameters by substitution. From equation (24) and (25), we can eliminate $P$ and get

$$R_{ED,t}(\tau) = R_{f,t}(\tau) - \frac{1}{\tau} \log \left( \frac{e^{-(R_{CD} - R_f)\tau} - \zeta}{1 - \zeta} \right). \tag{47}$$

One way to test the validity of those two competing models is to form an artificial compound model since two models are non-nested in a sense that neither model is a special case of the other. We use Davidson and MacKinnon's (1981, 1982) test procedure for non-nested hypothesis tests, called J-test. Competing models we use are the equation (28)
and the equation (47). Taking the cost-based model as our null hypothesis and letting $\lambda$ be the mixing parameter, a nested test model can be written as

$$R_{ED,t} = (1 - \lambda) f(R_{CD,t}; \alpha, \beta) + \lambda g(R_{CD,t}, R_{f,t}; \zeta) + \varepsilon_t$$  \hspace{1cm} (48)$$

where

$$f(\cdot) = \alpha + \beta R_{CD,t}$$

$$g(\cdot) = R_{f,t} - \frac{1}{\tau} \log \left( \frac{e^{-(R_{CD,t} - R_{f,t})\tau \zeta}}{1 - \zeta} \right)$$

$\zeta$ is a non-linear least squares estimate of $\zeta$, the fraction of domestic CD's insured, and $g(\zeta)$ represents $g(\cdot)$ evaluated at $\zeta = \zeta$. Notice that coefficients $\alpha$ and $\beta$ do not have subscript $i$. Since 3-month Treasury-bill rates are available only for the period from January 1982 through December 1986, our test is performed over this period. The reserve requirement ratio did not change during the test period. As a result, coefficients in the equation (28) are constants and we deleted the subscript $i$. Furthermore, since under the cost-based model the coefficient $\beta$ must equal to $1/(1 - RR)$, we employ this restriction.

The above test setup enables us to test failure of the null model, $f(\cdot)$, in the direction suggested by the alternative model, $g(\cdot)$. Essentially, it is a test of $\lambda = 0$. 
Since $f(\cdot)$ is a linear equation, the equation (48) is also linear in its arguments and, hence, we can estimate $\lambda$ by a linear regression. Results are reported below.

$$R_{ED,t} = 0.00161 + 0.60235 \frac{R_{CD,t}}{1 - RR} + 0.39765 \hat{g}_t$$

(49)

(4.831) (31.148) (14.886)

Under full ideal conditions, the test statistic would simply be the ordinary t-statistic for a test of $\lambda = 0$. However, regression errors seem to be autocorrelated as evidenced by the Durbin-Watson d-statistic of 0.570. Hence, we use $\chi^2$ statistics of White and Domowitz (1984) with corrections suggested by Newey and West (1987). $\chi^2$ values are reported in the parenthesis. $\chi^2$ value of 14.886 is significant at 1% level (one tail). Notice that, as shown by Davidson and MacKinnon (1982), J-test seems to perform well and has sufficient power to reject the null model when it is false, especially with large samples.42 Their simulated results also show that Type I error of J-test is quite close to the size of the test.43 Hence, it seems to be safe to

---

42 Davidson and MacKinnon (1982) used sample size of 100 to show the power. Our sample size was 1,232.

43 With their sample size of 100, frequency of rejecting the null when it is true were slightly higher than the size of the test but the difference was very small.
conclude that the cost-based model is rejected in favor of the insurance-based model.

4. Other possible factors

An aspect we did not analyze in this paper is the possible difference in the liquidity of those two instruments. The domestic CD has a secondary market established in New York while the Eurodollar deposit is a time deposit which can be withdrawn only at a penalty. The difference would then depend on the difference in costs associated with unwinding their positions. We can formulate this problem in the context of a first passage problem of a Poisson event and the difference can be shown as

\[ T \int_0^T \left[ \text{Present value of the cost difference at } t \right] \cdot \text{Prob(First Pass at time } t) \]  

(50)

We assume the cost difference is minimal on the ground that deposits are already short-term in nature.

5. Summary

The observed difference in interest rates on deposit instruments could be due to something intrinsic to the instrument or something that is specific to the institutions that issue those instruments. One of the old view, namely the
cost-based model, attempts to find the difference in institutions as well as regulatory environments those institutions operate. They focus on the fact that the Euromarket is free of regulatory controls and Eurobanks do not face additional regulatory costs such as reserve taxes. We contrast this view with an alternative explanation focuses on the nature of the instruments. Domestic CD's carry substantial insurance while Eurodollar deposits do not. In an attempt to identify major determinants, we examined the time-series behavior to distinguish between those two views.

The time-series behavior of the spread between Eurodollar deposit rates and domestic CD rates were consistent with the insurance-based explanation of the spread and in all the tests the competing cost-based model was rejected. If the regulatory cost difference is the major factor, we expect changes in the spread when regulatory costs change. Particularly when reserve requirements change so must spreads. Also, since regulatory costs are positive functions of the level of interest, we expect positive changes in the spread when interests change. Contrarily, however, if the insurance-model is correct we would expect no structural changes caused by regulatory regime change. Moreover, under the insurance-model, we expect negative changes in the spread
when interest rates change since the spread is more like a put option.

We conducted various tests based on those implications. A test of structural changes, a test of sensitivity to changes in the interest rate, as well as a non-nested test all show strong rejections to the predictions under the cost-based model. The test of sensitivity to changes in the interest rate show negative association between changes in the spread and changes in the interest rate. This result is consistent with the insurance-based model. Also the non-nested test show rejections of the cost-based model in favor of the insurance based model.
Chapter VI
Concluding Remarks

The difference in loan rates between the domestic market and the Eurodollar market seems to be related to the difference in roles that Eurobanks and domestic banks play. Evidence provided in this paper shows that the cost of a Eurodollar loan for borrowers is not different from the cost of other non-bank short-term funds such as commercial paper. Also, we provided evidence which suggests that Eurobanks do not perform special services which domestic banks seem to provide. Hence, differences in loan rates must be the premium for the domestic bank's unique services.

As for deposit rates, time-series inspection largely supports the insurance-based model while provides strong rejection to the cost-based model. In fact, lack of regulatory burdens in the Eurobanking system seems to be merely a necessary condition for its existence but not a sufficient condition for the difference in interest rates. As Fama (1985) points out, domestic banking system is viable even though they face cost disadvantage due to reserve taxes because of the special service that domestic banks provide. In other words, if there is nothing special about domestic banks as with Eurobanks, domestic banking system will not be
viable. This inverse reasoning implies that the Eurobanking system will not be viable if there are additional cost burdens such as reserve taxes.
Appendix A

A partial differential equation for a risky debt when the riskless rate of interest rate follows the CIR square-root process.

We make following assumptions.

1) The value of the bank, $V(t)$, follows

$$\frac{dV}{V} = \alpha dt + \sigma dz$$  \hspace{1cm} (A.1)

where $\alpha$ is the instantaneous expected rate of return on the value of the bank, $\sigma^2$ is the instantaneous variance of the return, and $dz$ is a standard Wiener process.

2) The instantaneous riskless rate of interest follows

$$dr = \kappa(\mu - r)dt + \delta \sqrt{r} dq$$  \hspace{1cm} (A.2)

where $\kappa$ is speed of adjustment, $\mu$ is long-run mean, $\delta^2 r$ is the instantaneous variance, and $dq$ is a standard Wiener process.

It is assumed that unexpected changes in riskless rate of interest and unexpected changes in the value of the bank are correlated so that

$$dq \cdot dz = \rho dt$$  \hspace{1cm} (A.3)

where $\rho$ is the correlation coefficient.
In case of a bank, the difficulty in valuation arises due to multiplicity of debt issues. However, as shown by Merton (1974), if we reinterpret the maturity as the time until next audit, then the standard method that utilize the isomorphic relationship between equity and a call option can still be used. Let $K$ be the maturity value of debt and $\tau$ be the time until the maturity (the next audit).

Now notice that the market value of debt equals to the value of the bank minus the market value of equity. Hence, the market value of debt must be a function of $V$, $r$, $\tau$, $K$, and $\tau$. That is,

$$D(r,V,\tau;K,\tau) = V(\tau) - S(r,V,\tau;K,\tau). \quad (A.4)$$

where $S(r,V,\tau;K,\tau)$ is the value of equity at time $\tau$.

Boundary conditions for the value of equity, which is an European option on the value of the firm, are

$$S(\infty,V,\tau;K,\tau) = 0 \quad (A.5.a)$$

$$S(r,V,\tau^*;K,\tau) = \text{Max}[V(\tau^*) - K, 0]. \quad (A.5.b)$$

where $\tau^*$ represents the maturity date.

Hence, the maturity and boundary conditions for the value of debt will be

$$D(\infty,V,\tau;K,\tau) = V(\tau) \quad (A.6.a)$$
Applying Ito's lemma to $D(r,V,t;K,t)$, we get

$$\frac{dD}{D} = D_x dr + D_y dV + D_t dt + \frac{1}{2} D_{xx} (dr)^2 + \frac{1}{2} D_{VV} (dV)^2 + D_r dV dr$$

$$= \left[ \frac{1}{2} \sigma^2 r D_{rr} + \rho \sigma \sqrt{r} D_{rV} + \frac{1}{2} \sigma^2 V^2 D_{VV} \right] dt + \sigma \sqrt{r} D_{r} dq + \sigma V dV dz$$

$$= \beta dt + \gamma dq + \eta dz$$

Notice that the price of a riskless discount bond, $B(r,t;\tau)$, is a function of only $r$. Hence, dynamics of the bond price can be represented as

$$\frac{dB}{B} = G dt + H dq.$$  
(A.8)

Now consider a portfolio which consists of the firm, $V(t)$, the debt of the firm, $D(r,V,t;K,t)$, and a riskless bond, $B(r,t;\tau)$. It's instantaneous rate of return is

$$\frac{dW}{W} = \frac{dV}{V} + \frac{dD}{D} + \frac{dB}{B},$$  
(A.9)

where $w_i$, $i = 1, 2, 3$ are weights for each asset such that $w_1 + w_2 + w_3 = 1$.

Substituting (A.1), (A.7), and (A.8) into (A.9), we get

$$G = \frac{1}{B} \left[ \frac{1}{2} \sigma^2 r B_{rr} + \kappa (\mu - r) B_t + B_t \right]$$

and

$$H = \frac{1}{B} \sigma \sqrt{r} B_t.$$
\[ \frac{dW}{W} = (w_1 \alpha + w_2 \beta + w_3 \gamma) dt + (w_2 \gamma + w_3 \delta) dq + (w_1 \sigma + w_2 \eta) dz. \]

If we set the portfolio weights \( w_1^*, w_2^*, \) and \( w_3^* \) such that:

\[ w_2^* \gamma + w_3^* \delta = 0 \]

\[ w_1^* \sigma + w_2^* \eta = 0, \]

this portfolio becomes locally riskless and, hence, its instantaneous expected rate of return must be \( r dt \). Therefore,

\[ w_1^* \alpha + w_2^* \beta + w_3^* \gamma = r \]

or

\[ w_1^*(\alpha - r) + w_2^*(\beta - r) + w_3^*(\gamma - r) = 0 \]

Writing equations (A.10), (A.11), and (A.12) in a matrix form, we obtain

\[
\begin{bmatrix}
\alpha - r & \beta - r & \gamma - r \\
\sigma & \eta & 0 \\
0 & \gamma & \delta
\end{bmatrix}
\begin{bmatrix}
w_1^* \\
w_2^* \\
w_3^*
\end{bmatrix} =
\begin{bmatrix}
0 \\
0 \\
0
\end{bmatrix}
\]

The coefficient matrix must be singular for a unique solution to exist. Hence, we can represent the rows as linear combinations and get
\[ \beta - r = \frac{(\alpha - r)}{\sigma} \eta + \frac{(G - r)}{H} \gamma \]  

\text{(A.14)}

If we assume local expectations hypothesis, 

\[ E_t \left[ \frac{dB}{B} \right] = r dt, \]

then we get \( G = r \), since \( E_t \left[ \frac{dB}{B} \right] = G dt \) from (A.8). Hence, the equation given by (A.14) can be further reduced to

\[ \beta - r = \frac{(\alpha - r)}{\sigma} \eta \]  

\text{(A.15)}

Using the definition of \( \eta \) and (A.15), we get

\[ \beta = \frac{(\alpha - r) V D_y}{D} + r. \]  

\text{(A.16)}

Since \( \beta \) is defined to be

\[ \beta = \frac{1}{D} \left[ \frac{1}{2} \delta^2 r_{D_{xx}} + \rho \sigma^2 \nu \sqrt{r_{D_{xx}} + \frac{1}{2} \sigma^2 \nu^2 D_{y y}} \right. \]

\[ + \left. \kappa (\mu - r) D_x + \alpha V D_y - D_t \right] \]  

\text{(A.17)}

From (A.16) and (A.17) we get,

\[ \frac{1}{2} \delta^2 r_{D_{xx}} + \rho \sigma^2 \nu \sqrt{r_{D_{xx}} + \frac{1}{2} \sigma^2 \nu^2 D_{y y}} + \kappa (\mu - r) D_x \]

\[ + rvD_y - rD - D_t = 0. \]  

\text{(A.18)}

The partial differential equation (A.18) subject to boundary conditions given by (A.6) describes dynamics of the value of risky debt.
Notice that the value of risky debt at time $t$ is promised payment, $K$, discounted at a risky rate (yield-to-maturity), $R(r, V, t; K, \tau)$. That is, $D(r, V, t; K, t) = Ke^{-R\tau}$, where $\tau = T - t$. Hence, the yield-to-maturity of risky debt will be

$$R(r, V, t; K, \tau) = -\frac{1}{\tau} \ln \left( \frac{D}{K} \right) = \frac{1}{\tau} \ln \left( \frac{K}{D} \right)$$

(A.19)

and, the spread between risky and riskless debt, $H(r, V, t; K, \tau)$, can be found by substituting the value of $D$ from equation (A.18) into the following equation

$$H(r, V, t; K, \tau) = \frac{1}{\tau} \ln \left( \frac{K}{D} \right) - r.$$

(A.20)
Appendix B

A closed form solution for risky debt

Here we derive closed form solution for the spread between Eurodollar deposit rate and domestic counterpart under more restrictive assumptions as in Merton (1973). The following derivation is heavily drawn from the works by Merton (1973, 1974). The purpose of this derivation is not to claim originality but to show underlying assumptions, critical variables, and their relationships.

We make following assumptions.

1) The value of the bank, \( V(t) \), follows the same dynamics given in assumption A.1; that is,

\[
\frac{dV(t)}{V(t)} = \alpha(V,t)dt + \sigma(V,t)dz \tag{B.1}
\]

where \( \alpha \) is the instantaneous expected rate of return on the value of the bank, \( \sigma^2 \) is the instantaneous variance of the return, and \( dz \) is a standard Wiener process. \( \alpha \) can be stochastic but \( \sigma \) is assumed to be nonstochastic and at most a known function of time.

2) The price of a riskless zero-coupon bond, \( B(\tau) \), follows

\[
\frac{dB}{B} = \mu(\tau)dt + \delta(\tau)dq \tag{B.2}
\]

where \( \mu \) is the instantaneous expected return, \( \delta^2 \) is the instantaneous variance of the return, and \( dq \) is a
standard Wiener process. \( \mu \) is not restricted but \( \delta \) is assumed to be nonstochastic and independent of the level of \( B \).

It is assumed that unexpected returns on the riskless zero-coupon bond and unexpected changes in the value of the bank are correlated so that

\[
dq \cdot dz = \rho dt
\]

where \( \rho \) is the correlation coefficient.

Let \( K \) be the maturity value of debt and \( t \) be the time until the maturity (the next audit). Then, since the value of equity, \( S(V,B,t;K,t) \), can be considered as a call option on the value of the bank, we can use Merton's (1973) derivation for a call option and show that

\[
S(V,B,t;K,t) = KB(t)\left[ \frac{1}{\sqrt{\pi}} \Phi(d_1) - \Phi(d_2) \right]
\]

where

\[
x = \frac{KB(t)}{V},
\]

\[
T = (\sigma^2 + \delta^2 - 2\rho\sigma\delta) \cdot \xi^2
\]

\[
d_1 = \frac{- \log(x) + \frac{1}{2}T}{\sqrt{T}}
\]

\[
d_2 = d_1 - \sqrt{T}
\]
and $\Phi(d)$ is the cumulative standard normal distribution function defined as

$$
\Phi(d) = \int_{-\infty}^{d} \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}} \, dx.
$$

Now notice that the value of the bank at time $t$ can be represented as the market value of equity plus the market value of debt. Hence,

$$
D(V, B, t; K, \tau) = V(t) - S(V, B, t; K, \tau). \tag{B.5}
$$

where $D(V, B, t; K, \tau)$ is the value of debt at time $t$. Substituting equation (B.4) to (B.5), we obtain

$$
D(V, B, t; K, \tau) = KB(\tau) \left[ \Phi(h_2) + \frac{1}{x} \Phi(h_1) \right]. \tag{B.6}
$$

where

$$
\begin{align*}
\frac{1}{2} \frac{t + \log(x)}{T} & = - \frac{\xi^2 \tau + \log(x)}{\tilde{\tau}} \tag{B.6.1} \\
\frac{1}{2} \frac{t - \log(x)}{T} & = - \frac{\xi^2 \tau - \log(x)}{\tilde{\tau}} \tag{B.6.2}
\end{align*}
$$
Table 1
Descriptive statistics $^1$

<table>
<thead>
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<th>Interest Rates</th>
<th>Obs.</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
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<td>14.0447%</td>
<td>3.1659%</td>
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<td>Eurodollar Deposit</td>
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<td>12.6656</td>
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<td>Domestic CD</td>
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<td>11.7745</td>
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<table>
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<tbody>
<tr>
<td>Prime vs. Eurodollar Offering Rate</td>
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<td>1.0592</td>
<td>-1.688</td>
<td>5.625</td>
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<td>Eurodollar Deposit vs. Domestic CD</td>
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<td>3.125</td>
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<td>Prime vs. Domestic CD</td>
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<td>Eurodollar Loan vs. Eurodollar Deposit</td>
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<td>0.1713</td>
<td>0.2786</td>
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<td>1.375</td>
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</tbody>
</table>

Sources of Data:
Prime rates and Eurodollar deposit rates are from Harris bank data tape, domestic CD rates are from various issues of Bank and Quotations record, and Eurodollar loan rates are from I.P.Sharp which collects the data from Financial Times.

$^1$ The descriptive statistics reported here are calculated using weekly data which covers the period from Jan. 1979 to Jan. 1985.
Table 2
Descriptive statistics II
Autocorrelations

Panel A: Raw Data

<table>
<thead>
<tr>
<th>Lag</th>
<th>Prime</th>
<th>Euro Loan</th>
<th>Euro Deposit</th>
<th>Domestic CD</th>
<th>Spread Prime vs Eurodeposit</th>
<th>Spread Euroloan vs CD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.99907</td>
<td>0.99853</td>
<td>0.99788</td>
<td>0.99820</td>
<td>0.97144</td>
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<td>2</td>
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Panel B: First Differences

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<tr>
<th>Lag</th>
<th>Prime</th>
<th>Euro Loan</th>
<th>Euro Deposit</th>
<th>Domestic CD</th>
<th>Spread Prime vs Eurodeposit</th>
<th>Spread Euroloan vs CD</th>
</tr>
</thead>
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<tr>
<td>1</td>
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<td>-0.01266</td>
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<td>0.17744</td>
<td>-0.03926</td>
<td>0.31027</td>
<td>0.11508</td>
<td>-0.02945</td>
<td>0.26279</td>
</tr>
<tr>
<td>6</td>
<td>0.06149</td>
<td>-0.02303</td>
<td>-0.13336</td>
<td>0.02759</td>
<td>-0.11272</td>
<td>-0.15671</td>
</tr>
</tbody>
</table>

1 Autocorrelations are calculated using daily data. Eurodollar deposit rates are from the Federal Reserve Bank, domestic CD rates are from various issues of Bank and Quotations Record, and domestic prime rate and Eurodollar offer rates are from I.P.Sharp.


3 From January 1979 to December 1986.

4 From January 1976 to December 1986.

5 From January 1976 to December 1986.
Table 3
Frequency distributions of Euroloan announcements and
domestic syndicated loan announcements (1979-1987)

<table>
<thead>
<tr>
<th>Year</th>
<th>Euroloan</th>
<th>Domestic Loan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan. 79 - Dec. 79</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Jan. 80 - Dec. 80</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Jan. 81 - Dec. 81</td>
<td>16</td>
<td>21</td>
</tr>
<tr>
<td>Jan. 82 - Dec. 82</td>
<td>20</td>
<td>16</td>
</tr>
<tr>
<td>Jan. 83 - Dec. 83</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Jan. 84 - Dec. 84</td>
<td>25</td>
<td>11</td>
</tr>
<tr>
<td>Jan. 85 - Dec. 85</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>Jan. 86 - Dec. 86</td>
<td>23</td>
<td>11</td>
</tr>
<tr>
<td>Jan. 87 - Dec. 87</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>144</strong></td>
<td><strong>103</strong></td>
</tr>
</tbody>
</table>

Table 4
Means and frequency distributions of the market value of the stockholders' equity (1979-1987)

A. Means (in million dollars)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euro</td>
<td>2,202.73</td>
<td>8.26</td>
<td>97,928.35</td>
</tr>
<tr>
<td>Domestic</td>
<td>551.50</td>
<td>41.00</td>
<td>3,671.50</td>
</tr>
</tbody>
</table>

B. Frequency Distribution

<table>
<thead>
<tr>
<th>Market Value (in millions)</th>
<th>Euroloan</th>
<th>Domestic</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 500</td>
<td>56 (38.89%)</td>
<td>72 (69.90%)</td>
</tr>
<tr>
<td>501 - 1,000</td>
<td>30 (20.83%)</td>
<td>13 (12.62%)</td>
</tr>
<tr>
<td>1,001 - 1,500</td>
<td>14 (9.72%)</td>
<td>8 (7.27%)</td>
</tr>
<tr>
<td>1,501 - 2,000</td>
<td>14 (9.72%)</td>
<td>5 (4.85%)</td>
</tr>
<tr>
<td>2,001 - 2,500</td>
<td>7 (4.86%)</td>
<td>-</td>
</tr>
<tr>
<td>2,501 - 3,000</td>
<td>6 (4.17%)</td>
<td>2 (1.94%)</td>
</tr>
<tr>
<td>3,001 - 3,500</td>
<td>4 (2.78%)</td>
<td>1 (0.97%)</td>
</tr>
<tr>
<td>3,501 - 4,000</td>
<td>-</td>
<td>2 (1.94%)</td>
</tr>
<tr>
<td>4,001 - 4,500</td>
<td>2 (1.39%)</td>
<td>-</td>
</tr>
<tr>
<td>4,501 - 5,000</td>
<td>6 (4.17%)</td>
<td>-</td>
</tr>
<tr>
<td>over 5,000</td>
<td>5 (3.47%)</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>144</td>
<td>103</td>
</tr>
</tbody>
</table>
Table 5
Means and frequency distributions of the loan amount (1979-1987)

A. Loan Amount (in million dollars)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euro</td>
<td>505.94</td>
<td>6.00</td>
<td>14,000.00</td>
</tr>
<tr>
<td>Domestic</td>
<td>247.73</td>
<td>20.00</td>
<td>2,000.00</td>
</tr>
</tbody>
</table>

B. Frequency Distribution

<table>
<thead>
<tr>
<th>Amount (in millions)</th>
<th>Euro</th>
<th>Domestic</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 100</td>
<td>58 (40.85%)</td>
<td>47 (46.08%)</td>
</tr>
<tr>
<td>101 - 200</td>
<td>29 (20.42%)</td>
<td>20 (19.61%)</td>
</tr>
<tr>
<td>201 - 300</td>
<td>12 (8.45%)</td>
<td>10 (9.80%)</td>
</tr>
<tr>
<td>301 - 400</td>
<td>8 (5.63%)</td>
<td>8 (7.84%)</td>
</tr>
<tr>
<td>401 - 500</td>
<td>9 (6.34%)</td>
<td>6 (5.88%)</td>
</tr>
<tr>
<td>501 - 600</td>
<td>4 (2.82%)</td>
<td>1 (0.98%)</td>
</tr>
<tr>
<td>601 - 700</td>
<td>2 (1.41%)</td>
<td>3 (2.94%)</td>
</tr>
<tr>
<td>701 - 800</td>
<td>4 (2.82%)</td>
<td>1 (0.98%)</td>
</tr>
<tr>
<td>801 - 900</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>901 - 1,000</td>
<td>3 (2.11%)</td>
<td>3 (2.94%)</td>
</tr>
<tr>
<td>over 1,000</td>
<td>13 (9.16%)</td>
<td>3 (2.94%)</td>
</tr>
<tr>
<td>Total</td>
<td>142</td>
<td>102</td>
</tr>
</tbody>
</table>
Table 6
Means and frequency distributions of the loan to market value of equity ratio (1979-1987)

A. Means

<table>
<thead>
<tr>
<th>Loan Type</th>
<th>Mean</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euroloan</td>
<td>.484</td>
<td>.0051</td>
<td>4.79</td>
</tr>
<tr>
<td>Domestic</td>
<td>.894</td>
<td>.0670</td>
<td>10.37</td>
</tr>
</tbody>
</table>

B. Frequency Distribution

<table>
<thead>
<tr>
<th>Loan Ratio</th>
<th>Euro</th>
<th>Domestic</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% - 10%</td>
<td>26 (18.31%)</td>
<td>4 (3.92%)</td>
</tr>
<tr>
<td>11% - 20%</td>
<td>34 (23.94%)</td>
<td>11 (10.78%)</td>
</tr>
<tr>
<td>21% - 30%</td>
<td>23 (16.20%)</td>
<td>15 (14.71%)</td>
</tr>
<tr>
<td>31% - 40%</td>
<td>16 (11.27%)</td>
<td>8 (7.84%)</td>
</tr>
<tr>
<td>41% - 50%</td>
<td>7 (4.93%)</td>
<td>10 (9.80%)</td>
</tr>
<tr>
<td>51% - 60%</td>
<td>2 (1.41%)</td>
<td>9 (8.82%)</td>
</tr>
<tr>
<td>61% - 70%</td>
<td>6 (4.23%)</td>
<td>9 (8.82%)</td>
</tr>
<tr>
<td>71% - 80%</td>
<td>5 (3.52%)</td>
<td>5 (4.90%)</td>
</tr>
<tr>
<td>81% - 90%</td>
<td>1 (0.70%)</td>
<td>1 (0.98%)</td>
</tr>
<tr>
<td>91% - 100%</td>
<td>1 (0.70%)</td>
<td>4 (3.92%)</td>
</tr>
<tr>
<td>101% - 200%</td>
<td>15 (10.56%)</td>
<td>16 (15.69%)</td>
</tr>
<tr>
<td>Over 200%</td>
<td>6 (4.23%)</td>
<td>10 (9.80%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>142</strong></td>
<td><strong>102</strong></td>
</tr>
</tbody>
</table>
Table 7
Average two-day prediction errors on the announcement of Euroloans and domestic syndicated loans (1979-1987)

<table>
<thead>
<tr>
<th></th>
<th>Euroloan</th>
<th>Syndicated Loan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average 2-day Prediction Error</td>
<td>-0.16%</td>
<td>0.88%</td>
</tr>
<tr>
<td>Z-Statistics(^1)</td>
<td>-0.132</td>
<td>2.200(^*)</td>
</tr>
<tr>
<td>Fraction of Positive Reactions</td>
<td>47.2%</td>
<td>49.5%</td>
</tr>
<tr>
<td>Sample Size</td>
<td>144</td>
<td>103</td>
</tr>
</tbody>
</table>

\(^1\) The null hypothesis is that the prediction error is zero.
\(^*\) Significant at 5% level.
Table 8
Average Two-day prediction errors on the announcement of Euroloans and domestic syndicated loans classified by the usage of funds (1979-1987)

A. Euroloan (Total Sample : 144)

<table>
<thead>
<tr>
<th>Use</th>
<th>General</th>
<th>Capital</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use</td>
<td>Use</td>
<td>Expenditure</td>
<td>Other</td>
</tr>
<tr>
<td>Average 2-day Prediction Error</td>
<td>0.05%</td>
<td>-1.00%</td>
<td>-0.07%</td>
</tr>
<tr>
<td>Z-Statistics</td>
<td>0.370</td>
<td>-1.500</td>
<td>0.311</td>
</tr>
<tr>
<td>Fraction of Positive Reactions</td>
<td>50.0%</td>
<td>23.8%</td>
<td>52.1%</td>
</tr>
<tr>
<td>Sample Size</td>
<td>52</td>
<td>21</td>
<td>71</td>
</tr>
</tbody>
</table>

B. Domestic Loan (Total Sample : 103)

<table>
<thead>
<tr>
<th>Use</th>
<th>General</th>
<th>Capital</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use</td>
<td>Use</td>
<td>Expenditure</td>
<td>Other</td>
</tr>
<tr>
<td>Average 2-day Prediction Error</td>
<td>2.17%</td>
<td>0.10%</td>
<td>0.09%</td>
</tr>
<tr>
<td>Z-Statistics</td>
<td>3.619*</td>
<td>-0.175</td>
<td>0.073</td>
</tr>
<tr>
<td>Fraction of Positive Reactions</td>
<td>53.8%</td>
<td>42.1%</td>
<td>48.9%</td>
</tr>
<tr>
<td>Sample Size</td>
<td>39</td>
<td>19</td>
<td>45</td>
</tr>
</tbody>
</table>
Table 8 (continued)

1 This group includes funds raised for the general corporate use, working capital use, and for the future contingencies due to normal growth of the firm.

2 The capital expenditure group includes funds for general capital expenditure, project financing, as well as major asset purchase purposes.

3 This group includes cases without any statements regarding the usage of funds (60 cases for Euro, 37 cases for domestic) as well as other purposes such as back-up credits for commercial paper issues (2 cases for Euro, no cases for domestic), capital restructure (1 case for Euro, no cases for domestic), hedging currency exposure (1 case for Euro, no cases for domestic), and possible acquisitions of assets or other operations that are not planned at the time of announcements (7 cases for Euro, 8 cases for domestic).

4 The null hypothesis is that the prediction error is zero.

5 The null hypothesis is that the prediction error is zero.

* Significant at 1% level.
Table 9
Average Two-day prediction errors on the announcement of Euroloans and domestic syndicated loans classified by the type of arrangements (1979-1987)

### A. Euroloan (Total Sample : 144)

<table>
<thead>
<tr>
<th>New financing(^1)</th>
<th>Refinancing bank debt(^2)</th>
<th>Refinancing outside debt</th>
<th>Not specified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average 2-day prediction error</td>
<td>-0.38%</td>
<td>0.29%</td>
<td>-0.60%</td>
</tr>
<tr>
<td>Z-Statistics(^3)</td>
<td>-1.201</td>
<td>0.990</td>
<td>-0.646</td>
</tr>
<tr>
<td>Fraction of positive reactions</td>
<td>40.0%</td>
<td>50.0%</td>
<td>50.0%</td>
</tr>
<tr>
<td>Sample Size</td>
<td>40</td>
<td>46</td>
<td>12</td>
</tr>
</tbody>
</table>

### B. Domestic Syndicated Loan (Total Sample : 103)

<table>
<thead>
<tr>
<th>New financing(^1)</th>
<th>Refinancing bank debt(^2)</th>
<th>Refinancing outside debt(^2)</th>
<th>Not specified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average 2-day prediction error</td>
<td>0.16%</td>
<td>1.62%</td>
<td>-</td>
</tr>
<tr>
<td>Z-Statistics(^1)</td>
<td>0.321</td>
<td>3.121*</td>
<td>-</td>
</tr>
<tr>
<td>Fraction of positive reactions</td>
<td>43.2%</td>
<td>57.9%</td>
<td>-</td>
</tr>
<tr>
<td>Sample Size</td>
<td>37</td>
<td>57</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 9 (continued)

1 This group includes new financing as well as additional financing from a different group of banks.

2 The refinancing group includes credit arrangements with a primary purpose of repaying or replacing the existing debt as well as amendments to the existing bank credits.

3 The null hypothesis is that the prediction error is zero.

4 Since there were only one case of outside debt refinancing, we do not report the result of this category.

* Significant at 1% level.
Table 10
A cross-sectional regression analysis of prediction errors associated with loan announcements:
Using the market value of equity and the number of months listed on New York Stock Exchange and American Stock Exchange

A Model

\[ \text{SPE}_i = \beta_0 \cdot 1^* + \beta_1 \cdot \text{MV}_i^* + \beta_2 \cdot \text{NM}_i^* + \beta_3 \cdot \text{R}_i^* + \epsilon_t, \]

Panel A: Test results for the usage of funds

<table>
<thead>
<tr>
<th></th>
<th>General Use</th>
<th>Capital Expenditure</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \beta_0 )</td>
<td>-0.0191613</td>
<td>-0.0195225</td>
<td>-0.0072691</td>
</tr>
<tr>
<td></td>
<td>(-2.789)+++</td>
<td>(-2.296)++</td>
<td>(-1.744)+</td>
</tr>
<tr>
<td>( \beta_1 )</td>
<td>0.0000012</td>
<td>-0.0000014</td>
<td>-0.000000007</td>
</tr>
<tr>
<td></td>
<td>(0.673)</td>
<td>(-0.538)</td>
<td>(-0.104)</td>
</tr>
<tr>
<td>( \beta_2 )</td>
<td>0.0000714</td>
<td>0.0000758</td>
<td>0.0000380</td>
</tr>
<tr>
<td></td>
<td>(2.499)+++</td>
<td>(1.964)+</td>
<td>(1.981)+</td>
</tr>
<tr>
<td>( \beta_3 )</td>
<td>0.0141570</td>
<td>0.0005947</td>
<td>0.0020929</td>
</tr>
<tr>
<td></td>
<td>(2.682)+++</td>
<td>(0.126)</td>
<td>(0.638)</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.1803</td>
<td>0.2483</td>
<td>0.0503</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>61</td>
<td>34</td>
<td>90</td>
</tr>
</tbody>
</table>

+ Significantly different from zero at 5% level (one-tail)
++ Significantly different from zero at 2.5% level (one-tail)
+++ Significantly different from zero at 1% level (one-tail)
Table 10 (continued)

**Panel B: Test results for the type of arrangements**

<table>
<thead>
<tr>
<th></th>
<th>New Financing</th>
<th>Refinancing Bank debt</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_0$</td>
<td>-0.0109247</td>
<td>-0.0083361</td>
<td>-0.0177181</td>
</tr>
<tr>
<td></td>
<td>(-1.700)$^+$</td>
<td>(-1.528)</td>
<td>(-3.047)$^{++}$</td>
</tr>
<tr>
<td>$\beta_1$</td>
<td>-0.000000639</td>
<td>0.0000005448</td>
<td>0.0000000466</td>
</tr>
<tr>
<td></td>
<td>(-0.376)</td>
<td>(0.436)</td>
<td>(-0.737)</td>
</tr>
<tr>
<td>$\beta_2$</td>
<td>0.00003044</td>
<td>0.00004853</td>
<td>0.00008628</td>
</tr>
<tr>
<td></td>
<td>(1.111)</td>
<td>(2.028)$^{++}$</td>
<td>(3.196)$^{+++}$</td>
</tr>
<tr>
<td>$\beta_3$</td>
<td>0.00762126</td>
<td>0.0032498</td>
<td>-0.0148835</td>
</tr>
<tr>
<td></td>
<td>(1.710)$^+$</td>
<td>(0.776)</td>
<td>(-1.734)$^+$</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.0848</td>
<td>0.1094</td>
<td>0.2601</td>
</tr>
</tbody>
</table>

Number of Observation
- 59
- 73
- 53

$^+$ Significantly different from zero at 5% level (one-tail)
$^{++}$ Significantly different from zero at 2.5% level (one-tail)
$^{+++}$ Significantly different from zero at 1% level (one-tail)

$^1$ SPE$_i$ is the two-day standardized prediction error for the firm $i$, $\iota$ is a iota-vector of 1's, MV$_i$ is the market value of equity of the firm $i$, NM$_i$ is the number of months listed on either NYSE or AMEX, and I is a dummy variable with 1's for the domestic loan sample and 0's for the Euroloan sample. * represents corresponding variables multiplied by the weight ($1/s_{i,-1} + 1/s_{i,0}$), where $s_{i,t}$ is the square root of the variance of the prediction errors of the firm $i$ at time $t$ from the event date.
Table 11
A cross-sectional regression analysis of prediction errors associated with loan announcements:
Using the loan amount to market value of equity ratio

**A Model**

$$\text{SPE}_i = \beta_0 \cdot i^* + \beta_1 \cdot \text{LR}_i^* + \beta_2 \cdot I^* + \varepsilon_i,$$

**Panel A: Test results for the usage of funds**

<table>
<thead>
<tr>
<th></th>
<th>General Corporate Use</th>
<th>Capital Expenditure</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_0$</td>
<td>0.00090</td>
<td>-0.00067</td>
<td>0.00133</td>
</tr>
<tr>
<td></td>
<td>(0.378)</td>
<td>(-0.134)</td>
<td>(0.791)</td>
</tr>
<tr>
<td>$\beta_1$</td>
<td>0.00028</td>
<td>-0.00631</td>
<td>-0.00102</td>
</tr>
<tr>
<td></td>
<td>(0.106)</td>
<td>(-0.942)</td>
<td>(-0.684)</td>
</tr>
<tr>
<td>$\beta_2$</td>
<td>0.00799</td>
<td>0.00300</td>
<td>-0.00093</td>
</tr>
<tr>
<td></td>
<td>(1.934)</td>
<td>(0.498)</td>
<td>(-0.328)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.079</td>
<td>0.050</td>
<td>0.007</td>
</tr>
</tbody>
</table>

Number of Observation | 91 | 40 | 113 |

+ Significantly different from zero at 5% level (one-tail)
Table 11 (continued)

Panel B: Test results for the type of arrangements

<table>
<thead>
<tr>
<th></th>
<th>New Financing</th>
<th>Refinancing Bank debt</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_0$</td>
<td>-0.00257</td>
<td>0.00231</td>
<td>0.00185</td>
</tr>
<tr>
<td></td>
<td>(-0.975)</td>
<td>(0.776)</td>
<td>(0.991)</td>
</tr>
<tr>
<td>$\beta_1$</td>
<td>-0.00169</td>
<td>-0.00013</td>
<td>-0.00204</td>
</tr>
<tr>
<td></td>
<td>(-0.594)</td>
<td>(-0.058)</td>
<td>(-0.982)</td>
</tr>
<tr>
<td>$\beta_2$</td>
<td>0.00474</td>
<td>0.00277</td>
<td>-0.00639</td>
</tr>
<tr>
<td></td>
<td>(1.194)</td>
<td>(0.750)</td>
<td>(-1.000)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.029</td>
<td>0.043</td>
<td>0.035</td>
</tr>
</tbody>
</table>

Number of Observations
77 102 65

$^{1}$ SPE$_i$ is the two-day standardized prediction error for the firm $i$, $\iota$ is a iota-vector of 1's, LR$_i$ is the loan amount to the market value of the equity ratio for the firm $i$, and $I$ is a dummy variable with 1's for the domestic loan sample and 0's for the Euroloan sample. * represents corresponding variables multiplied by the weight ($1/s_{i,-1} + 1/s_{i,0}$), where $s_{i,t}$ is the square root of the variance of the prediction errors of the firm $i$ at time $t$ from the event date.
Table 12
Reserve requirements for domestic CD's and Eurocurrency liabilities in the United States
(from Jan. 1975 to present)

<table>
<thead>
<tr>
<th>Date</th>
<th>Domestic CD</th>
<th>Eurocurrency(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec. 12, 1974</td>
<td>Changed to 6%</td>
<td>8%</td>
</tr>
<tr>
<td>May, 1975</td>
<td>N/C(^2)</td>
<td>Changed to 4%</td>
</tr>
<tr>
<td>Aug., 1978</td>
<td>N/C</td>
<td>Changed to 0%</td>
</tr>
<tr>
<td>Nov. 2, 1978</td>
<td>Supplementary reserve requirement of 2% imposed</td>
<td>N/C</td>
</tr>
<tr>
<td>Oct. 25, 1979</td>
<td>Marginal reserve requirement(^3) of 8% imposed</td>
<td>Marginal reserve requirement of 8% imposed</td>
</tr>
<tr>
<td>Apr. 3, 1980</td>
<td>Marginal reserve requirement increased to 10%</td>
<td>Marginal reserve requirement increased to 10%</td>
</tr>
<tr>
<td>Jun. 12, 1980</td>
<td>Marginal reserve requirement drops to 5%</td>
<td>Marginal reserve requirement drops to 5%</td>
</tr>
<tr>
<td>Jul. 24, 1980</td>
<td>Eliminated all the supplementary and marginal reserve requirements</td>
<td>Eliminated all the supplementary and marginal reserve requirements</td>
</tr>
<tr>
<td>Nov. 13, 1980</td>
<td>Phase in of 3% reserve requirements</td>
<td>Phase in of 3% reserve requirements</td>
</tr>
</tbody>
</table>

Source of information:
Kreicher (1982)
Federal Reserve Bulletin
Encyclopedia of Banking and Finance

1 Reserve requirements on Eurocurrency are applied only to the net Eurocurrency liabilities.
2 N/C means "no changes".
3 Marginal reserve requirements was applied to managed liabilities in excess of a base amount.
Table 13
A test of structural change of the spread between Eurodollar deposits and domestic CD's\textsuperscript{1}

Model

\[ \begin{bmatrix} y_i \\ y_{i+1} \end{bmatrix} = \alpha_i \begin{bmatrix} 1 \\ 1_{i+1} \end{bmatrix} + (\alpha_{i+1} - \alpha_i) \begin{bmatrix} 0 \\ 1_{i+1} \end{bmatrix} + \beta_i \begin{bmatrix} x_i \\ x_{i+1} \end{bmatrix} + (\beta_{i+1} - \beta_i) \begin{bmatrix} 0 \\ x_{i+1} \end{bmatrix} + \begin{bmatrix} e_i \\ e_{i+1} \end{bmatrix} \]

where \( i = 1, \ldots, 6 \) represents different reserve requirement regimes.\textsuperscript{2}

Parameter Estimates and Test Statistics

<table>
<thead>
<tr>
<th></th>
<th>( \alpha_{i+1} - \alpha_i )</th>
<th>( \beta_{i+1} - \beta_i )</th>
<th>Autocorrelation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>d-stat\textsuperscript{3}</td>
</tr>
<tr>
<td><strong>Period 1 vs. 2</strong> (( T = 937, m = 5 ))\textsuperscript{6}</td>
<td></td>
<td></td>
<td>1.288</td>
</tr>
<tr>
<td>Estimate</td>
<td>-0.231917</td>
<td>0.035170</td>
<td></td>
</tr>
<tr>
<td>( \chi^2 )-stat</td>
<td>0.530</td>
<td>1.230</td>
<td></td>
</tr>
<tr>
<td><strong>Period 2 vs. 3</strong> (( T = 345, m = 4 ))</td>
<td></td>
<td></td>
<td>1.528</td>
</tr>
<tr>
<td>Estimate</td>
<td>-0.270384</td>
<td>0.020568</td>
<td></td>
</tr>
<tr>
<td>( \chi^2 )-stat</td>
<td>0.334</td>
<td>0.304</td>
<td></td>
</tr>
<tr>
<td><strong>Period 3 vs. 4</strong> (( T = 152, m = 3 ))</td>
<td></td>
<td></td>
<td>1.267</td>
</tr>
<tr>
<td>Estimate</td>
<td>1.883107</td>
<td>-0.095975</td>
<td></td>
</tr>
<tr>
<td>( \chi^2 )-stat</td>
<td>14.316*</td>
<td>7.143</td>
<td></td>
</tr>
<tr>
<td><strong>Period 4 vs. 5</strong> (( T = 77, m = 1 ))</td>
<td></td>
<td></td>
<td>0.969</td>
</tr>
<tr>
<td>Estimate</td>
<td>6.331435</td>
<td>-0.836645</td>
<td></td>
</tr>
<tr>
<td>( \chi^2 )-stat</td>
<td>22.485*</td>
<td>27.925*</td>
<td></td>
</tr>
<tr>
<td><strong>Period 5 vs. 6</strong> (( T = 105, m = 1 ))</td>
<td></td>
<td></td>
<td>1.093</td>
</tr>
<tr>
<td>Estimate</td>
<td>-6.549843</td>
<td>0.790565</td>
<td></td>
</tr>
<tr>
<td>( \chi^2 )-stat</td>
<td>24.787*</td>
<td>26.048*</td>
<td></td>
</tr>
<tr>
<td><strong>Period 6 vs. 7</strong> (( T = 1598, m = 6 ))</td>
<td></td>
<td></td>
<td>0.797</td>
</tr>
<tr>
<td>Estimate</td>
<td>-1.277892</td>
<td>0.084991</td>
<td></td>
</tr>
<tr>
<td>( \chi^2 )-stat</td>
<td>9.310*</td>
<td>4.877</td>
<td></td>
</tr>
</tbody>
</table>

Note: * significant at 5% significance level.
Table 13 (continued)

1. Daily observations for the period from January 1976 to December 1986. Eurodollar deposit rates are from "Federal Reserve Bank" and the domestic CD rates are from "Bank and Quotations Records".

2. Sub-periods are divided as follows.
   - Period 1: 760101-781101 - reserve requirement 6%
   - Period 2: 781102-791024 - supplementary reserve requirement of 2%
   - Period 3: 791025-800402 - marginal reserve requirement of 8%
   - Period 4: 800403-800611 - marginal reserve requirement to 10%
   - Period 5: 800612-800723 - marginal reserve requirement to 5%
   - Period 6: 800724-801112 - reserve requirement back to 6%
   - Period 7: 801113-861231 - phase in of 3% reserve requirement.

3. Durbin-Watson d-statistics

4. Number of observations

5. First order autocorrelation of residuals.

6. T stands for number of observations and m stands for number of significant lags for variance-covariance matrix estimation.
Table 14
Parameter estimates under the cost-based model and implied domestic CD reserve requirement ratios

Model
\[ R_{ED,t} = \alpha + \beta R_{CD,t} + e_t \]

<table>
<thead>
<tr>
<th>Period</th>
<th>( \beta )</th>
<th>Implied Reserve Requirements</th>
<th>Actual Reserve Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>760101-781101</td>
<td>1.067403</td>
<td>6.315%</td>
<td>6%</td>
</tr>
<tr>
<td>781102-791024</td>
<td>1.102573</td>
<td>9.303%</td>
<td>6% + SUP 2%</td>
</tr>
<tr>
<td>791025-800402</td>
<td>1.123141</td>
<td>10.964%</td>
<td>6% + SUP 2% + MAR 8%</td>
</tr>
<tr>
<td>800403-800611</td>
<td>1.027167</td>
<td>2.645%</td>
<td>6% + SUP 2% + MAR 10%</td>
</tr>
<tr>
<td>800612-800723</td>
<td>0.190522</td>
<td>-424.874%</td>
<td>6% + SUP 2% + MAR 5%</td>
</tr>
<tr>
<td>800724-801112</td>
<td>0.981087</td>
<td>-1.928%</td>
<td>6%</td>
</tr>
<tr>
<td>801113-861231</td>
<td>1.066078</td>
<td>6.198%</td>
<td>3%</td>
</tr>
</tbody>
</table>

Implied reserve requirements are calculated by inverting the coefficient estimates. That is, \( \hat{RR} = 1 - \frac{1}{\hat{\beta}_1} \).

1 "SUP" stands for supplementary reserve requirements and "MAR" stands for marginal reserve requirements.
Table 15

Changes in Eurodollar deposit rates due to changes in domestic CD rates

Model: $\Delta R_{ED,t} = \alpha + \beta \Delta R_{CD,t} + \varepsilon_t$

<table>
<thead>
<tr>
<th>Period</th>
<th>$\beta$</th>
<th>$\chi^2$</th>
<th>Autocorrelation</th>
<th>d-stat</th>
<th>Obs</th>
<th>Corr</th>
</tr>
</thead>
<tbody>
<tr>
<td>760101-781101</td>
<td>0.43687</td>
<td>30.04*</td>
<td>2.775</td>
<td>658</td>
<td>-0.418</td>
<td></td>
</tr>
<tr>
<td>781102-791024</td>
<td>0.26240</td>
<td>2.69</td>
<td>2.864</td>
<td>229</td>
<td>-0.469</td>
<td></td>
</tr>
<tr>
<td>791025-800402</td>
<td>0.47147</td>
<td>5.80*</td>
<td>2.515</td>
<td>95</td>
<td>-0.318</td>
<td></td>
</tr>
<tr>
<td>800403-800611</td>
<td>0.57057</td>
<td>16.82*</td>
<td>2.185</td>
<td>46</td>
<td>-0.126</td>
<td></td>
</tr>
<tr>
<td>800612-800723</td>
<td>0.13484</td>
<td>0.35</td>
<td>2.668</td>
<td>28</td>
<td>-0.359</td>
<td></td>
</tr>
<tr>
<td>800724-801112</td>
<td>0.75137</td>
<td>22.10*</td>
<td>2.525</td>
<td>72</td>
<td>-0.310</td>
<td></td>
</tr>
<tr>
<td>801113-861231</td>
<td>0.67599</td>
<td>151.30*</td>
<td>2.575</td>
<td>1448</td>
<td>-0.291</td>
<td></td>
</tr>
</tbody>
</table>

* significant at 5% significance level.

1 Durbin-Watson d-statistic.
2 Number of observations.
3 First order autocorrelation.
Figure 1

Domestic Prime Rates vs. Eurodollar Loan Rates
FIGURE 2
Domestic CD Rates vs. Eurodollar Deposit Rates

Difference between Eurodollar Deposit and domestic CD

Date


Domestic CD

Eurodollar Deposit

%
Figure 3

Interest Rates on Eurodollar Loans vs. Costs of Commercial Paper

The solid line represents the difference between Eurodollar loan rates and commercial paper rates. Two dotted lines are cost of maintaining lines of credit for commercial paper with upper bound line representing the cost of maintaining 100% line with all the line used (20% compensating balance) and the lower bound line representing the cost of maintaining 60% line with all the line unused (10% compensating balance)
Figure 4

The Difference between Domestic CD and Treasury-Bill Rates (from January 1982 to December 1986)
Figure 5
Autocorrelogram of Residuals from 780101 to 791024

Figure 6
Autocorrelogram of Residuals from 781102 to 800402
Figure 7
Autocorrelogram of Residuals
from 791025 to 800611

Figure 8
Autocorrelogram of Residuals
from 800403-800723
Figure 9
Autocorrelogram of Residuals
from 800612 to 801112

Figure 10
Autocorrelogram of Residuals
from 800724 to 861231
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