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Economic perspectives

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Economic
perspectives

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Stock margins and the conditional probability of price reversals

Paul Kofman and James T. Moser

Introduction and summary

The debate over the need for regulated stock margins is an old one. The argument that “low margins make speculation cheap” persuades some observers that low margin requirements lead to greater stock price volatility. One rebuttal to this argument is that low margins encourage greater stock market participation and that greater diversity of expectations actually lessens volatility.

It would seem that a look at stock prices should quickly settle the question. After all, one might argue, all that is needed is to look over the history of stock margins and see whether market volatility was high when margins were low and low when margins were high. This seemingly simple solution is fraught with problems. For example, suppose stock market volatility rises and falls cyclically but, absent any major news, tends to adjust toward some natural level. Then a trend-following margin authority will be lowering margin requirements as volatility declines and raising them as volatility rises. The result will be data showing a correlation between margin levels and stock price volatility. An incautious interpretation of these data might conclude that low margin levels lead to high stock price volatility, but by construction this interpretation would be incorrect.

Advanced statistical methods can solve this sort of problem, but the effectiveness of these methods relies on the data that are available. The fact is that in the U.S., changes in margin levels have been too infrequent for these methods to be conclusive. A good theory for the cause of systematic price changes reduces the need for more data, but our understanding of price volatility remains too primitive.[1]

This article takes another tack in examining this question. Our approach reframes the issue by focusing entirely on stock price reversals. By studying the frequency with which stock price changes in one direction are followed by changes in the opposite direction (reversals), we obtain a measure of the frequency with which prices may have overreacted to new information. Overreaction followed by price correction is a pattern that is consistent with what is termed *fad trading*. Fad trading is buying or selling based less on information about the value of assets than on the fact that buying or selling is the thing to do. The idea of fad-motivated trading is described as prices being the result of traders “getting on the bandwagon,” as opposed to independently arrived at judgements about the true value of these assets.

Specifically, we measure the relationship between the frequency of reversals and the level of margins. Thus, our article does not address whether stock margins control volatility. Instead, we ask whether stock margins affect the overreactions associated with *fad-motivated* transactions. The merit of this approach is to sidestep the problems associated with directly studying volatility. We look instead for evidence supporting the claim that low margins increase the diversity of expectations, thereby lowering volatility. An absence of evidence for low margins mitigating volatility is not the same as “proving” low margins cause volatility, but disproving a reasonable linkage, especially one with an opposing effect on volatility, does add credibility to the remaining explanations.

The ideal data set for the tests we perform in this article would be the numbers of stock market participants throughout the history of margin levels for the period we study. In previous drafts of this work, a number of researchers commented that we should look at trading volume data to get at this issue. However, we

Paul Kofman is a professor in the Quantitative Finance Research Group, University of Technology, Sydney, Australia. James T. Moser is a senior economist and research officer at the Federal Reserve Bank of Chicago.

conclude that trade volume data say very little about the extent of market participation. So, we again find ourselves one step removed from the ideal and rely on evidence that is consistent with variations in market participation.

We first examine whether margin levels affect trading activity. Lo and MacKinlay (1990) show that a partial explanation for why a stock's return might be correlated with its previously occurring returns is the probability of nontrading during the return computation period. High nontrading probabilities would be encountered were trading activity concentrated in short time frames and, therefore, more likely motivated by similar information. We find that autocorrelations of stock index returns are positively related to levels of margin. This suggests that higher margin levels increase the probability of nontrading, a result that is consistent with the cost of transacting influencing the decision to trade.

Next, we examine stock return reversals to determine their responsiveness to changes in margin levels. We interpret evidence that price reversals decrease at higher levels of margin as indicative of a relative decrease in fad-based trading. We use three approaches to investigate this question. The answers we obtain from these procedures are consistent. First, frequency graphs of price reversals demonstrate that the percentage of reversals is *negatively* related to margin levels. Second, mean times between reversals are also *negatively* related to margin levels. Third, our *logit specifications* concur that reversal probabilities are *negatively* related to margin levels. We conclude that the evidence consistently rejects the null of no association between margin levels and stock price reversals.[2]

Below, we introduce the stock return data and estimate nontrading probabilities for various levels of required margin. Then, we develop our measure of price reversals and discuss our results in detail.

Linkage between trading costs and volatility

We begin with a brief review of the literature linking serial dependence in stock returns to transactional considerations. Following this literature review, we introduce a model in which prices are determined by two investing clienteles: *informed* investors and *noise-trading* investors.

The relevance of transactional considerations for markets

Niederhoffer and Osborne (1966) report that stock price reversals occur two or three times more often than price continuations. Fama (1970) suggests reversals are induced by the presence of orders to buy or sell that are conditioned on the price of the stock. More recently, researchers have been considering the possibility that the presence of these reversals is indicative of noise trading, that is, trading by investors who tend to participate in trading *fads* and whose trading activity is *not information based*. Summers (1986) suggests that the presence of a fad component in the determination of stock prices implies that stock prices will reverse as fads dissipate. Some have suggested introducing trading frictions as a means of mitigating the influence fads may have on stock price volatility. The transactions-tax proposal of Summers and Summers (1989) is a straightforward example of this rationale. Transactions taxes raise trading costs, thereby reducing the benefits derived from participating in fads. It has also been suggested that stock margins can serve a similar function inasmuch as they also introduce frictions through their effect on trading costs for levered strategies. In general, as trading-cost levels increase, the extent of fad-motivated trading activity can be expected to decline, thereby diminishing any effects from these trades.

Contradicting this view is the recognition that the introduction of frictions can have other consequences. Especially important, trading-cost levels affect the benefit that can be derived from any trading activity, not only those that are fad induced. This view suggests that higher trading costs lessen liquidity, increasing price volatility. Thus, the social usefulness of introducing trading frictions depends on the *net* effects from affecting both fad trading and liquidity.

The argument that underlies a linkage between price volatility and transaction costs is that the relative size of positions taken by noise-trading investors is influenced by the costs they incur when entering into stock positions. For the same reason that demand curves are downward sloping, the motivation to enter into stock positions declines as the cost of entering rises. All investors can be expected to invest less as their per-transaction fees rise. For a variety of reasons, the incidence of these costs may have different effects on investment decisions. The question we are framing here is whether these effects can be ascribed to whether the investor is trading on information or on noise.

The number of noise traders taking positions *and* the total number of investors taking positions determine the impact of noise trading activity. The proponents of a linkage between margin levels and stock price volatility appear to have in mind a difference in the elasticity of investment with respect to margin levels. Specifically, their prediction stems from a response to margin changes at low levels by noise-trading investors that is greater than the response of informed investors. This may be the case, but if so, it is an expression of the preferences of the two groups rather than an inherent property linking transactions costs to price volatility.

Suppose every dollar invested by a noise-trading investor generates a constant amount of noise. From the perspective of informed investors, this noise can be a profit opportunity. Lower margins enable investment of more dollars by noise traders—we do not know why they trade, but if their trading costs decline, all else the same, it is reasonable to predict they will trade more, so *ceteris paribus* lower margins increase noise.

With respect to informed investors, we have a somewhat better understanding of their decisions to trade—they can observe mispricing and buy or sell accordingly so as to earn profits. From the perspective of informed investors, mispricing induced by the noise-trading activity can be a profit opportunity. It is a profit opportunity if the amount of mispricing due to noise trading can be corrected by trades made by informed investors (we will assume it can), and if the revenue from trades by informed investors exceeds the cost of making the trade. As in the case of noise-trading investors, a lower margin requirement implies a lower cost of trading for informed investors. Thus, it is entirely plausible to expect that any noise created will be offset by the trading activity of informed traders. It is also plausible that informed investing is not sufficient to eliminate the noise.

The point of the above is that analytic determination of the linkage between stock price volatility and margin levels requires greater specificity about the characteristics of informed and noise-trading investors than is given here. These are not questions that are readily amenable to analysis, but we might gain some insight into these questions by examining data.

Margin levels and the probability of nontrading

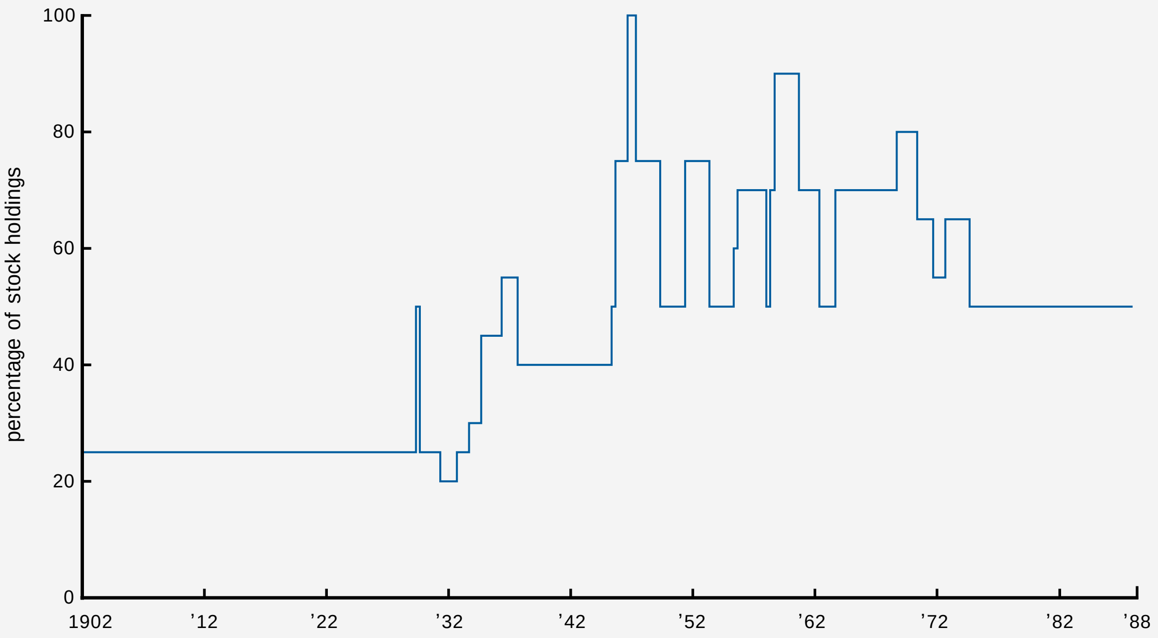
Next, we introduce our data sample and report on some preliminary tests to determine if margin levels affect trading activity. We find evidence of greater nontrading during periods of high margin.

Our sample of daily returns is for a broad stock index over the period January 1, 1902, through December 31, 1987.[3] The data, described in Schwert (1990), combine the returns of several stock indexes to obtain a continuously reported index of stock returns dating from 1886. Schwert's study of the statistical attributes of the spliced data series concludes they are homogenous; that is, seasonal patterns appear similar across various sample periods.

Guiding our sample-period choice is the need to include all changes in required margin by U.S.

FIGURE 1

Required initial stock margins, 1902–87



Notes: Required margins prior to 1934 are from news sources. After 1934 initial margins were set by the Federal Reserve Board of Governors.
Source: Hardouvelis (1990).

regulators (see figure 1)—the first being in 1935, the last in 1975. In addition, we include observations for the pre-regulatory period to differentiate from any regulatory effects. Observations after 1982 include those effects stemming from trading in stock index futures contracts. Finally, we chose the sample end date to include 1987, a year of unprecedented volatility.

We examine the relationship of *autocorrelations* in the return series with levels of required margin to make inferences about the effect of margin on nontrading of stocks within our sample portfolio. Lo and MacKinlay (1990) demonstrate that nontrading of stocks within sample portfolios induces positive autocorrelation in the time series of returns for stock portfolios.[4] If investors condition their trading activity on trading costs, then nontrading is likely to increase when required-margin levels increase. Suppose, for example, that traders restrict their trading activity to stocks whose returns are expected to exceed their cost of trading. Under these circumstances, any changes in trading costs implied by changes in margin levels would lead to changes in the number of stocks traded. Thus, margin levels are a plausible determinant of the nontrading probabilities: Nontrading probabilities increase as the costs of maintaining margin deposits rise.

A further result of Lo and MacKinlay (1990) permits interpretation of the first-order autocorrelation coefficient as an estimate of the probability of nontrading of stocks within an index. Thus, we can investigate the nontrading effect by estimating autocorrelation coefficients conditional on their contemporaneous levels of required margin. We employ the following specification:

$$1) \quad R_t = \delta_0 + \sum_{i=1}^{14} \delta_i D_i^{t-1} R_{t-1} + \varepsilon_t,$$

where R_t are stock returns at time t and D_i^{t-1} are indicator variables, one for each of the 14 levels of required margin during the sample period ordered from lowest to highest. Each of these indicator variables is set to one when the required margin at $t-1$ is at level i; otherwise, they are set to zero.

The estimates are reported in table 1. The second column of the table lists the margin level associated with each coefficient. Generally, the coefficients on margin levels interacted with lagged returns are larger at higher levels of required margin. For example, the sum of the coefficients at the highest seven levels of margin (the last seven coefficients listed) is 1.40973, while the sum of coefficients for the lowest seven levels of margin (the first seven coefficients listed) is 0.16889. This difference implies that the autocorrelation coefficient is positively related to levels of margin and indicates that the probability of nontrading increases with margin levels. We analyze the significance of this difference in summed coefficients with an F test for their equality.[5] The F statistic is 36.4, easily rejecting the equality of these coefficient sums. The result, therefore, implies an increase in nontrading probabilities at higher levels of margin, suggesting that margin levels do affect trading activity. In the following two sections, we examine price reversals to see if these changes in trading activity are more pronounced among noise traders.

Preliminary examination of stock-price reversals

As noted above, we find a positive relationship between margin levels and the likelihood of nontrading. If the incidence of nontrading by noise traders increased more than that of informed traders, this would lend support to the case that margin levels can affect mispricing. Here, we report on price reversal patterns that suggest that the cost of margined positions discourages noise-trading activity.

Consider a class of traders with a propensity to participate in trading fads. Their trades are not information-based in the sense of Black (1986), so we refer to them as noise traders. The presence of these noise traders increases the chance that trading overreactions will affect prices and that price changes will deviate from fundamental values.[6] These deviations increase the value of informed trading, motivating trades by information-based traders. Informed trades bring prices back toward their fundamental values, so that subsequent price changes can be expected to reverse the changes induced by noise trading. Black (1971) refers to the speed of price adjustment following noise-induced shocks as *price resilience*. This characterization of markets implies that prices can be expected to reverse following price shocks stemming from noise-trading activity. The frequency of noise-trading shocks and, consequently, the frequency of reversals will be related to the extent of trader participation in fads. Specifically, price reversals can be expected to occur more frequently when participants in fads make up a relatively large proportion of the market.

Some suggest that the cost of placing margin deposits has a role in determining the relative importance of these two categories of traders. Such costs play a role similar to the transactions taxes suggested by Summers and Summers (1989). If low margins encourage a relative increase in the number of noise traders, then prices reverse more often. Conversely, if high margins cause a relative decrease in the number of noise traders, prices reverse less often. Thus, an association between margin levels and reversals implies a relation between the level of margin and the proportion of trading by noise traders. A negative association suggests that margins raise trading costs and that these higher costs deter participation in fads. We compute reversals, denoted r_t, for the stock return sample, as follows:

$$2)\quad r_t = \begin{cases} 1 \; if \; \tilde{\varepsilon}_t \cdot \tilde{\varepsilon}_{t-1} < 0 \\ 0 \; otherwise \end{cases},$$

where $\tilde{\varepsilon}_t = \tilde{R}_t - E(\tilde{R}_t | \phi_t)$.

Equation 2 specifies an indicator variable assigned a value of one on sample dates when the unanticipated portion of the return at time t has the opposite sign as that of the unanticipated return at $t-1$; on other dates, the indicator variable is set to zero. Unanticipated returns, denoted ε_t, are defined as deviations of actual returns from expectations. Expected returns are generated according to three characterizations of the market. The first assumes that stock prices can be described by a *martingale*; that is, the price observed today is an unbiased predictor of the price that can be expected to be observed tomorrow. Hence, the expected return on stock purchased today is zero or $E_{t-1}(R_t) = 0$. The second assumes that stock prices are a submartingale with constant expected returns; that is, $E(R_t) = \alpha$. The third assumes that stock prices are a submartingale with time-varying expected returns; that is, $E(R_t) = \alpha\sigma_t$. The third approach estimates σ_t using the iterative method suggested by Schwert (1989) and extended in Bessembinder and Seguin (1993).

This iterative method first regresses the time series of stock returns on a constant. We use the absolute values of the residuals from this regression as risk estimates at each date in the sample. We then regress the returns on ten lags of these risk estimates. This generates risk-adjusted expected returns. Inclusion of the residuals from this second regression of returns on lagged-risk estimates incorporates temporal variation of risk into the expected-return metric.

We then classify these reversals according to their corresponding levels of required margin and study the relative frequencies within these classifications. Stating the frequency of reversals as a fraction of the number of observations provides a means of estimating the probability of a reversal possibly conditional on category i; that is,

$$3)\quad \hat{P}_i = \frac{r_i}{n_i},$$

where r_i is the number of reversals in margin category i; and n_i is the number of observations in margin category i.

TABLE 1

Autocorrelation coefficients interacted with required margin levels

	Margin level	Coefficient	t statistic
δ_0	n.a.	0.00033	4.95
δ_1	20	0.02334	1.35
δ_2	25	0.02405	2.24
δ_3	30	–0.07724	–2.46
δ_4	40	0.03527	1.90
δ_5	45	0.02995	0.60
δ_6	50	0.16991	10.36
δ_7	55	–0.03639	–1.14
δ_8	60	0.14610	1.09
δ_9	65	0.33593	7.52
δ_{10}	70	0.13267	4.33
δ_{11}	75	0.12949	3.26
δ_{12}	80	0.36414	4.90
δ_{13}	90	0.17883	2.22
δ_{14}	100	0.12257	2.54

Notes: $R_t = \delta_0 + \sum_{i=1}^{14} \delta_i D_i^{t-1} R_{t-1} + \varepsilon_t$, where R_t is the return on date t; and D_i^{t-1} are indicator variables for the 14 levels of margin during the sample period 1902 to 1987 ordered from lowest to highest. n.a. indicates not applicable.

Figure 2 illustrates this approach. We compute reversals according to the martingale assumption, then classify them by their year of occurrence and their relative frequencies calculated based on equation 3. The figure graphs these relative frequencies. Bar heights illustrate the relative frequency of stock reversals for each year of the sample. The graph suggests a modest but permanent decline in reversal probabilities occurring in the mid-1930s. Comparing pre- and post-1934 reversals, reversal occurrences averaged 48.4 percent of trading dates prior to 1934. After 1934, average reversal occurrences declined to 43.3 percent of trading dates.[7]

Figure 1 (on page 4) gives margin requirements over this sample period. Initial margin requirements prior to October 15, 1934, were set by the industry. These were obtained from press accounts. After October 1934, the Board of Governors of the Federal Reserve System set margin requirements. We obtained these requirements and their effective dates from Hardouvelis (1990). The higher margin requirements subsequent to their determination by regulatory authority do correspond to the lower reversal probabilities illustrated in figure 2. However, the decline also corresponds to the increased regulation of the stock market through the provisions of the Securities and Exchange Commission (SEC). Alternatively, one might conclude that innovations such as those in trading or communications technology led to a change in the occurrence of reversals. We examine these possibilities more rigorously in the next section.

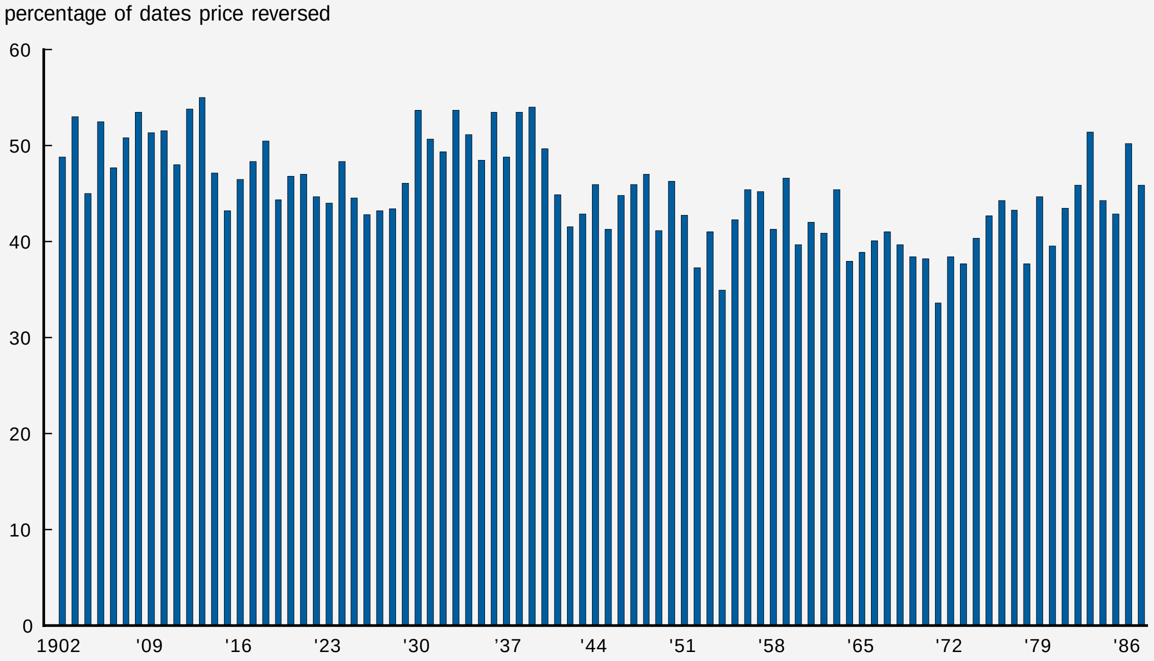
Table 2 reports the standard deviation of returns and percentages of reversal occurrence at each level of required margin.[8] The table does suggest a relationship between the conditional probability of a reversal and margin requirements. The last row of the table gives the unconditional probability of a reversal for each of the expected-return models. Comparing these unconditional probabilities with the conditional probabilities in the corresponding columns, the conditional probabilities exceed the unconditional probability at each of the five lowest margin categories. For the remaining nine categories, the unconditional probability is exceeded at the 55 percent margin level and at the 100 percent level for the martingale series. This result suggests that, with few exceptions, margin levels are negatively related to the odds of observing stock-price reversals.

The standard deviations of stock returns reported in table 2 are generally higher at low margin levels; correspondingly, they are higher when price reversals are more likely. The evidence suggests that low margin levels are associated with a higher likelihood of price reversals and increased levels of stock price volatility.

An alternative measure of reversal frequency is the time between stock price reversals. Let $T_t(r_t = 1)$ be the date of a reversal that occurs at time t, then $\tau_t = T_t(r_t = 1) - T_{t-k}(r_{t-k} = 1)$ gives the number of days since a reversal that occurred k periods previously. These intervals can be measured in calendar units or in trading-day units. Measured in calendar time, the average time between reversals prior to October 15, 1934, was 2.49 days.[9] After this date, the average time between reversals increased to 3.11 days. This calendar time measure is dependent on the length of any intervening nontrading intervals and the presumption that reversals are uncorrelated with trading frequency. To avoid dependence on nontrading intervals, we also use a trading time measure: the number of trading days between reversals.[10] The mean number of trading days between reversals is 2.03 days prior to October 15, 1934, and 2.26 days after that date. Both measures indicate an increase in the time between reversals following the introduction of regulatory oversight. Thus, reversals occur less often after this date. This is consistent with the decline in the relative frequency of reversals depicted in figure 2.

FIGURE 2

Yearly percentages of stock price reversals, 1902–87



Notes: Reversals are calculated as in equations 2 and 3 assuming that stock prices are a martingale. Reversal occurrences are stated as a percentage of the trade dates of that year.

TABLE 2

Initial margin requirements and stock price reversals, 1902–87

Initial margin (percent)	Observations	Standard deviation of return	Percentage of observations in which stock index reversed: $E(R_t) = 0$	$E(R_t) = \alpha$	$E(R_t) = \alpha\sigma_t$
20	206	2.97	50.24	50.24	50.24
25	8,944	1.01	48.21	48.75	48.96
30	326	1.83	53.68	52.15	52.76
40	2,182	1.20	47.48	48.81	48.26
45	390	1.04	50.00	51.80	50.26
50	5,137	0.89	43.33	44.16	44.16
55	770	1.17	46.75	47.92	48.18
60	77	0.86	40.26	37.66	40.26
65	679	0.89	35.94	36.97	36.38
70	2,382	0.69	41.52	42.15	42.11
75	1,298	0.73	42.68	43.99	44.30
80	454	0.66	38.11	38.11	38.99
90	448	0.60	44.20	43.30	42.41
100	307	1.23	45.93	45.28	43.97
All levels	23,803	1.04	45.54	46.22	46.23

To relate this effect to margin regulation, we regress τ_i on the percentages of required initial margin at t. This specification considers the relationship of margin with the mean time between reversals.[11] Measuring the dependent variable in calendar units, the coefficient is .0175; and measured in trading time units it is .0066. Standard distributional assumptions about the errors of this regression imply that the coefficients of both regressions differ significantly from zero at better than the 1 percent level.[12] These coefficients imply that higher levels of margin increase the mean time between reversals. In terms of the primary focus of this article, higher levels of margin decrease the relative frequency of reversals. Thus, these statistics, the average times between reversals and the regression coefficients, offer an alternative means of stating the results indicated by figures 1 and 2: margin levels rose in 1934 and reversals declined after that date. In the next section, we restate these preliminary results in terms of their effects on conditional probabilities.

Logit specification

Estimating reversal probabilities conditional on margin level

Let Z_i represent an index, which measures the propensity of the market to produce a reversal. Under the null hypothesis that low margins encourage overreactions as demonstrated by stock price reversals, then the index should be negatively related to levels of required margin. Linearizing this relationship, we can write

4) $$Z_i = \beta_0 + \beta_1 M_i,$$

so that levels of the index are predicted by the product of β and the level of margin. The overreaction null predicts that β_1 will be less than zero. The level of this index can also be described as determining the probability of encountering a reversal at the ith level of margin. We can write this as $P_i = F(Z_i)$. Taking $F()$ to be the cumulative *logistic probability function*, then the probability of a reversal is given by

5) $$P_i = F(Z_i) = \frac{1}{1+e^{-z_i}} = \frac{1}{1+e^{-(\beta_0+\beta_1 M_i)}}.$$

Taking logs and rearranging gives the following logit specification:

6) $$\log\left[\frac{P_i}{1-P_i}\right] = \beta_0 + \beta_1 M_1 + \varepsilon_i.$$

We estimate equation 5 using the method of *maximum likelihood.* Matrix notation simplifies exposition of the likelihood function. Note that the expected value of Z_i can now be written $x_i'\delta$, so that the expression for the log likelihood is

7) $$\log l = \sum_{i=1}^{T} r_t \log\left[F(x_i'\beta)\right] + (1-r_t)\log\left[1-F(x_i'\beta)\right].$$

It is useful to compare our approach to studying reversals with that used by Stoll and Whaley (1990). Their measure of reversals signs the return at t based on the return at $t-1$: They multiply the return at t by –1 when the previous return is positive and by +1 when the return at $t-1$ is negative. Thus, their measure is positive when a reversal occurs and negative otherwise. Tests of hypotheses employing the Stoll and Whaley measure examine associations between explanatory variables and the expected portion of the reversal measure. Confirmation or rejection of these hypotheses requires the explained portion to exceed a quantity proportional to the estimated residual variance. Thus, their approach is subject to *heteroskedasticity* when the underlying return series is heteroskedastic. The *logit* approach introduced here uses only the sign of subsequent returns; this avoids dependence on the stationarity of the return distribution.

Table 3 reports our estimates of the logit specification given in equation 6. For each of the expected-return models, conditional probabilities are negatively related to initial margin requirements. We use the likelihood ratio test to evaluate the specifications. The null of no effect is rejected for each of the return-generating models at better than the 5 percent level. The impact of a 1 percent change in required margin on the probability of a reversal is obtained from the expression

$$8)\quad \Delta PROB \approx \beta_0 \left[\hat{P}_i(1-\hat{P}_i)\right].$$

To obtain the effect of margin on reversal probabilities, we evaluate this expression at the unconditional probabilities given in the last row of table 2. In each case, the effect of margin on reversal probabilities, while statistically significant, is economically small.

Results reported in table 3 indicate that an increase in required margin from the present 50 percent to 60 percent would reduce reversal probabilities by less than 1 percent, a very modest impact. The magnitude of this effect should be compared with the change in trading costs. Holding rates constant, the conjectured increase in required margin would increase the interest cost of placing margin deposits by 20 percent. Thus, a relatively large increase in the cost of carrying margined positions appears to have a small effect on reversal probabilities. However, table 1 of Salinger (1989, p. 126) indicates that margined positions seldom exceed 2 percent of the market value of outstanding stock.[13] Thus, since relatively few positions are affected by the cost increase, the magnitude of the effect from a cost increase can also be expected to be small. While this explanation is consistent with the small magnitude we report, it also increases the importance of investigating alternative possibilities. One might, for example, conclude that the higher margin levels observed after 1934 are capturing impacts that are more properly attributable to other changes coming after that date. We explore this possibility next.

TABLE 3

Maximum likelihood estimates of price reversal variable on margin

	Expected return method		
	$E(R_t) = 0$	$E(R_t) = \alpha$	$E(R_t) = \alpha\sigma_t$
β_0	0.061594 (0.02213)	0.087633 (0.01226)	0.090183 (0.01148)
β_1	−0.005387 (0.00049)	−0.005355 (0.00035)	−0.005515 (0.00034)
ΔPROB	−0.00134	−0.00133	−0.00137

Notes: $\log\left[\frac{P_i}{1-P_i}\right] = \beta_0 + \beta_1 M_i + \varepsilon_i$, where P_i are the ratios of reversals observed during each margin-level regime to the number of trading dates during that interval; and M_i are the levels of initial margin in percent. Standard errors are in parentheses. All coefficients are significant at the 1 percent level.

Possibility that margin proxies for other effects

To control for the possibility that margin levels proxy for other explanations of reversal probabilities, we augment the logit specification with several additional variables. Campbell, Grossman, and Wang (1993) find that return autocorrelations are negatively related to lagged trading activity. This implies that reversals are more likely in periods following heavy trading activity. We use indicator variables as controls for differences in regulation in the pre- and post-1934 periods, for the effects of Monday trading,[14] for the effects of stock index futures since their introduction in 1982, and as a means of conducting a "Salinger" test for market volatility differences before and after 1946. Finally, we add the observation year to capture innovations in information and trading technology occurring during the sample period. Information technology might be expected to increase the speed at which information is disseminated and, thereby, impounded into stock prices. In particular, one might expect thin trading to decline over the sample period.

These considerations suggest the following specification:

$$9)\quad \log\left[\frac{P_i}{1-P_i}\right] = \beta_0 + \beta_1 M_i + \beta_2\, Year_i + \beta_3\, REG_i + \varepsilon_i,$$

where $Year_i$ is the year the reversal occurred, and REG_i is an indicator variable set to unity following the introduction of stock market regulation by the SEC on October 15, 1934, and to zero on the prior dates. As in the previous specification, the relevance of the classifying variables is indicated by a nonzero coefficient.

Table 4 reports results from this specification. As before, we use maximum likelihood procedures. The magnitude of the coefficients on margin levels declines but remains significantly less than zero. We reject the explanation that the margin coefficients of the previous specification are capturing the effects of regulatory oversight or innovations in trading and information technologies. Thus, we reject the possibility that margin levels proxy for these other explanatory variables. As the focus of this article is on the relevance of margin, we only summarize the remaining coefficients here. The coefficients on year variables are significantly less than zero. This is consistent with the proposition that reductions in reversals can be attributed to innovations in information or trading technology during the sample period. On the other hand, the coefficient on regulatory oversight is reliably positive, suggesting that regulation has increased the odds of reversals.

Conclusion

Autocorrelations of the returns for a broad index are higher in periods when required margin is high. This implies an increase in the probability of nontrading and is suggestive of a negative relationship between margin and stock market participation. To see if the participation of fad-based trading is more or less sensitive to changes in trading costs, we examine return reversals for a stock index for the period 1902 through 1987. Preliminary evidence suggests that reversal frequencies decreased substantially after 1934. This coincides with higher levels of required margin and with increased regulatory oversight of the stock markets. The results of our logit specifications imply that margin levels are negatively related to the probability of reversals. This permits us to reject the null that margin levels are unrelated to reversals. We also investigate alternative explanations for this result. We find that controls for time and for the introduction of regulatory oversight in 1934 do not explain changes in reversal probability. Also, our logit specifications appear to be robust to day-of-the-week effects.

Our statistical results indicate that high margins increase the extent of nontrading, and that margin levels are negatively related to the probability of stock price reversals. Rejection of the null of no association implies that margin levels do influence the observed distribution of stock returns. These results are consistent with the conclusion of Summers and Summers (1989): The cost of placing margin deposits acts as a tax. At low levels of this “tax,” noise traders enter the market, increasing the odds that prices will diverge from their fundamental levels. Reversals occur when prices return to their fundamental levels. At high levels of the “tax,” noise traders find it costly to participate and overreactions occur less often. Our findings suggest that information traders are less sensitive to these trading costs.

Do the results indicate that low margins lead to higher volatility? We think not. What we can say is that margin levels do appear to be positively related to the price reversals we would expect to observe were fads a frequent and pervasive motive for trading. But this is inadequate support for a change in margin policy. Further research is needed for two reasons. First, to rule out other causes for our observed association between margin levels and price reversals. Second, to more firmly establish a link between fad trading and the extent of volatility that might result. With clearer evidence on these matters in hand, policymakers would then face a question of which instrument is best suited to managing volatility. It may be the case that a transactions tax would be a more effective instrument for this purpose than controlling margins.

TABLE 4

Maximum likelihood estimates for the augmented regression

	Expected return method		
	$E(R_t) = 0$	$E(R_t) = \alpha$	$E(R_t) = \alpha\sigma_t$
β_0	7.838990 (0.02420)	7.907148 (0.01903)	8.156308 (0.02336)
β_1	–0.003882 (0.00081)	–0.004756 (0.00077)	–0.004186 (0.00077)
β_2	–0.004068 (0.00002)	–0.004083 (0.00002)	–0.004217 (0.00002)
β_3	0.100239 (0.02294)	0.145948 (0.01935)	0.115890 (0.01913)
ΔPROB	–0.000963	–0.001182	–0.001040

Notes: $\log\left[\frac{P_i}{1-P_i}\right] = \beta_0 + \beta_1 M_i + \beta_2\, Year_1 + \beta_3 REG_i + \varepsilon_i$, where P_i are the ratios of reversals observed during each margin-level regime to the number of trading dates during that interval; M_i are the levels of initial margin in percent; and *Year* is the year that the reversal occurred. Standard errors are in parentheses. All coefficients are significant at the 1 percent level.

NOTES

[1]Hsieh and Miller (1990) provide a technical explanation for this point.

[2]We also examine the robustness of these logit specifications. We augment the specification with various controls. Introduction of these controls does not alter our primary conclusion that the probability of price reversals is negatively related to the level of margin.

[3]We are grateful to Bill Schwert who supplied the stock return data.

[4]The rationale is that nontraded stocks within the index are affected by market-wide events; however, the price implication of that news is evidenced after its impact on the stock index. This induces a positive correlation in the observed returns of an index.

[5]We also ran regressions allowing for shifts in the intercept. The coefficients on margin interacted with lagged returns are substantially the same as those reported here.

[6]Other characterizations of noise-trading activity can also produce price reversals. Admati and Pfleiderer (1988) and DeLong, Shleifer, Summers, and Waldmann (1990) describe some alternative modes of noise trading.

[7]A Student's t test adjusted for unequal variances rejects the equality of these means. The statistic is 5.61, indicating a reliable difference in the means of annual pre- and post-1934 reversal percentages at better than the 5 percent level.

[8]Reversals occurring at $t + 1$ are classified by the level of margin at t. Classifying by the level of margin at $t + 1$ does not alter our conclusions. This is not unexpected; as figure 2 demonstrates, required margin changes occur infrequently.

[9]At the beginning of World War I, trading was suspended on the New York Stock Exchange. Thus, the first observation (a reversal dated December 12, 1914) at the resumption of trading is excluded from the calculation of this mean.

[10]Dependence of reversals on the occurrence of a nontrading interval is suggested by evidence that expected returns vary by day of the week. DeGennaro (1993) summarizes the literature for day-of-the-week effects in stock prices. We introduce a control for this effect in the next section.

[11]Changes in margin are much less frequent than reversals; thus, relatively few observations are affected by a change of required margin during the period between reversals.

[12]However, Cox (1970, chapter 3) suggests this may be a strong assumption. The logit specifications of the next section avoid this criticism.

[13]Moser (1992, p. 9) reports similar percentages of margined positions through 1988.

[14]DeGennaro (1993) summarizes extensive evidence that stock returns vary by day of the week.

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Private school location and neighborhood characteristics

Lisa Barrow

Introduction and summary

Publicly funded elementary and secondary education has played an important role throughout much of U.S. history in ensuring that the population is among the most educated in the world. (See Goldin, 1999, for a brief history of education in the U.S.) At the same time, privately funded elementary and secondary schools have steadily coexisted, largely giving parents the opportunity to provide their children with a religious education in a country believing in the importance of the separation of church and state. In 1900, 8 percent of students enrolled in kindergarten to grade 12 were enrolled in private schools, while today roughly 11 percent of children are enrolled in private schools. The percentage enrolled in private schools has remained relatively constant since 1990; however, private school enrollment rates have been higher in the intervening years, reaching nearly 14 percent in the late 1950s and early 1960s and nearly 13 percent in the 1980s (U.S. Department of Education, National Center for Education Statistics, 2000). The current public school reform debate has focused much on the idea of providing parents with education vouchers, and adopting such a program is likely to lead to an increase in private school enrollment. More specifically, such a program is likely to increase enrollment at schools traditionally defined as private, while blurring the distinction between public and private schools due to the public source of the voucher financing.

Universal and limited education vouchers have played a role in the public school reform debate for many years. The strongest proponents argue that while one may justify the role of the government in financing education, one cannot justify the role of the government in running the schools. More generally, proponents of education vouchers claim that vouchers are a way to increase the competition faced by schools by enabling parents to choose among alternative public schools, as well as enabling more parents to send their children to private schools. The increase in competition is expected to increase public and private school quality as individual schools compete for students. Subsequently, if private schools are more efficient at providing quality education than public schools, then one would expect to see a shift under a universal voucher program from publicly financed public education to publicly and privately financed private education.

Any voucher program that is going to have a major impact on the public education system is likely to require an expansion of private schools in order to accommodate increased demand; however, very little is known about where private schools open and, therefore, how a major voucher program might affect private school availability in various communities. The goal of this article is to examine the relationship between the location of private schools and the local public school and neighborhood characteristics, such as public school test score performance and average household income. To the extent that private schools respond to area characteristics in their location decisions, I hope to shed some light on how changes in the demand for private schooling, arising from an education voucher program, might change the private school composition of local markets. Using data from the Chicago metropolitan statistical area (MSA), I examine the relationship between the number of private schools in a zip code and the characteristics of the public schools and population of the zip code.

Lisa Barrow is an economist in the Research Department at the Federal Reserve Bank of Chicago. *The author would like to thank Daniel Sullivan, Joseph Altonji, and the microeconomics research group at the Federal Reserve Bank of Chicago for helpful comments. She is also grateful to Erin Krupka for research assistance.*

I find statistically significant positive relationships between the number of private schools in 1997 and the percent of the population that is Asian and the percent of persons over 55 years of age. In addition, I find a statistically significant negative relationship between the number of private schools and average household income and a statistically significant positive relationship between the number of private schools and the dispersion of household income within the community.

The article also includes some extensions to the basic results, in which I examine private religious and non-religious schools separately, as well as looking more specifically at entry and exit of private schools. With these extensions, I find some interesting differences in the relationships between the number of schools and community characteristics for non-religious and religious schools, while I find that few community characteristics have statistically significant net effects on the count of private schools when looking at entry and exit more directly.

Previous research

Much of the previous research on private schools has focused on the effect of private schools on public school quality, the relative quality of private and public schools, and the determinants of private school attendance, rather than on the supply side of private school provision. For example, Hoxby (1994) examines the effect of private school competition on public school quality and finds that where public schools face greater competition from private schools, the public school students achieve higher educational attainment, graduation rates, and future wages. Sanders (1996) and Neal (1997) look at the effect of Catholic school attendance—elementary and secondary, respectively—on various measures of achievement and find some positive effects of Catholic school attendance relative to public school attendance. At the same time, Catholic school attendance has a negligible effect on suburban students' achievement (Neal, 1997) and science test scores (Sanders, 1996). Several other studies examine the determinants of private school enrollment, looking both at socioeconomic characteristics of the family associated with private school attendance, such as income and education, and the influence of public school characteristics, such as public school quality, public school finance, or the degree of public school choice. See Clotfelter (1976), Long and Toma (1988), Schmidt (1992), and Downes (1996), for example.

Among the empirical work looking at private schools, Downes and Greenstein's (1996) study is a notable exception in looking more specifically at the supply-side decisions of private schools. Similar to the goals of this article, the Downes and Greenstein (1996) study examines the relationship between counts of private schools and public school and population characteristics of the location. Instead of Chicago MSA zip codes, they use school districts in California in 1979 as the area unit of observation. For results comparable to work in this article, the authors find statistically significant positive relationships between the number of private schools and the public school student–teacher ratio, the percentage of public school students on public assistance, and the percentage of public school sixth graders with limited English proficiency (LEP). They find that the number of private schools is positively related to the percentage of the adult population who are high school graduates, college graduates, Hispanic, and Asian. They find no relationship between the number of private schools and mean family income.

For this study, standardized test scores are available as a measure of school quality in addition to the student–teacher ratio. Standardized test scores are not an ideal measure of school quality because they confound measures of both peer and school quality; however, they may well reflect perceived school quality by parents which may be a more important measure of school quality from the perspective of a private school competitor. I am also able to match private school data over time in order to explore the relationships between private school entry and exit and the local public school and location characteristics.

Data and descriptive statistics

Information on private schools in the Chicago metropolitan area comes from the U.S. Department of Education National Center for Education Statistics (NCES), *Private School Universe Survey, 1997–98* (1999b). From these data, I identify the zip code location, as well as religious affiliation and grade level for each private school. I eliminate schools located in zip codes outside the Chicago MSA, schools in zero population zip codes, and schools for which the program is ungraded or for which kindergarten is the highest grade offered. The breakdown of private school affiliation is presented in figures 1 and 2, while descriptive statistics for the private schools are presented in table 1, panel A.

In 1998, 753 private schools existed in the Chicago metropolitan statistical area. Just over half of the private schools are Roman Catholic (54 percent) and roughly 14 percent are non-religious (see figure 1). These affiliation percentages are not weighted by enrollment, however, and when looking at the enrollment-weighted shares in figure 2, the Catholic schools are much larger on average than other private school types. Nearly three-quarters of the private school enrollment is in Catholic schools, while only 6.6 percent of the enrollment is in non-religious schools. Compared with national statistics, private schools in the Chicago area are much more likely to be Catholic and are less likely to have no religious affiliation. Nationally, roughly 30 percent of private schools are Catholic and 22 percent are non-religious, while 50 percent of private school students are enrolled at Catholic schools and 16 percent are enrolled in non-religious schools.[1]

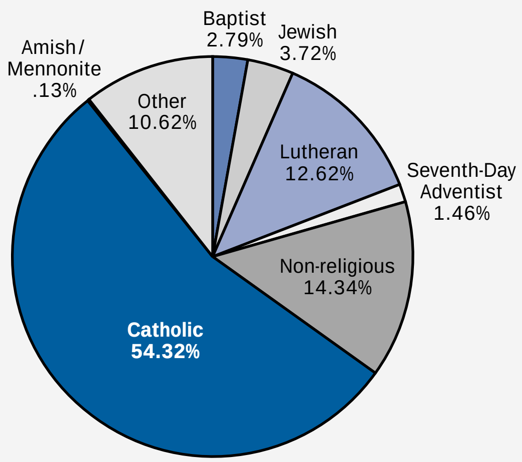
The average private school has roughly 278 students; 62 percent are white, 21 percent are African-American, and 13 percent are Hispanic (see table 1, panel A). The average student–teacher ratio is 16.9, and the majority of private schools have elementary grades, 78 percent, while 13 percent offer only secondary grade levels. Similar characteristics for public schools in the Chicago MSA from the NCES Common Core of Data, 1997–98, are presented in panel B of table 1. In comparison, the public schools are much larger, on average, with 662 students, and more diverse, with an average of 51 percent of the students being white, 27 percent African-American, and 16 percent Hispanic. The average student–teacher ratio is higher in the public schools at 18 pupils per teacher. Note that the table 1 statistics are not weighted by school size and, therefore, reflect the characteristics of the average school, not the characteristics of the school experienced by the average public or private school student.

To examine the relationship between the number of private schools and local area characteristics, I combine the data into zip-code-level observations. For each zip code, I construct the count of private schools in the zip code, the number of private schools existing in 1997 that did not exist in 1980 (defined as entry), the number of private schools that existed in 1980 and no longer existed in 1997 (defined as exit), the average public school characteristics in the zip code using Illinois 1997 school report card data, the average 1990 census characteristics of people in the zip code, and the 1980 to 1990 change in census zip code characteristics.

Table 2 (on page 17) presents summary statistics for the zip codes for the 281 of 284 zip codes in the Chicago MSA I use in the following analysis. (The three excluded zip codes had zero population in 1990.) Each zip code has an average of 2.68 private schools, most of which have some religious affiliation. The zip code public schools have an average student–teacher ratio of 17.9, with 9 percent of the sixth grade students not meeting Illinois Goal Assessment Program (IGAP) standards and 28.6 percent exceeding IGAP standards. People in Chicago MSA zip codes have a relatively low incidence of difficulty with the English language. Only 2.65 percent are limited English proficient as defined by the U.S. census, compared with 2.9 percent for the U.S. as a whole; however, in some zip codes more than 20 percent of the population is

FIGURE 1

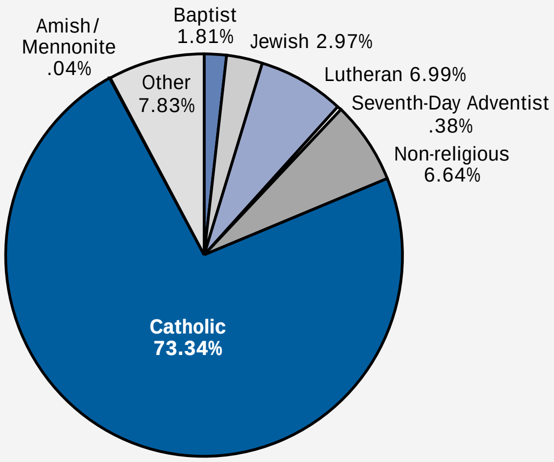
Chicago MSA private school affiliations



Source: Author's calculations based on data from the U.S. Department of Education, National Center for Education Statistics (1998b).

FIGURE 2

Chicago MSA private school affiliations weighted by enrollment



Source: Author's calculations based on data from the U.S. Department of Education, National Center for Education Statistics (1998b).

TABLE 1

Descriptive statistics of Chicago MSA private and public schools

	Mean	Standard deviation	Minimum	Maximum
A. Private schools				
Enrollment	278.26	248.05	7	2,050
White, percent	61.98	36.77	0	100
African-American, percent	20.55	33.68	0	100
Asian, percent	4.12	10.39	0	100
Hispanic, percent	13.09	22.18	0	99.15
Student–teacher ratio	16.89	12.67	1.67	289.14
Elementary, percent	78.49			
Secondary, percent	13.01			
Coeducational, percent	92.96			
All-female, percent	3.45			
Number of schools	753			
B. Public schools				
Enrollment	662.27	474.27	24	4,217
White, percent	51.24	37.43	0	100
African-American, percent	27.16	37.08	0	100
Asian, percent	3.57	6.07	0	58
Hispanic, percent	16.33	24.24	0	100
Student–teacher ratio	18.11	3.31	5.70	42.00
Elementary, percent	73.34			
Secondary, percent	11.85			
Number of schools	1,823			

Notes: All means are unweighted. The student–teacher ratio is missing for 12 public schools due to missing data on full-time equivalent classroom teachers. For school level, the omitted categories are junior high and combined elementary and secondary. None of the public schools fall into the "combined" category. Elementary schools are defined as having a low grade from pre-kindergarten to sixth grade and a high grade from first to ninth grade. Secondary schools are defined as having a low grade between fifth and tenth grade and a high grade between tenth and twelfth grade.

Sources: Panel A—Author's calculations based on data from the U.S. Department of Education, National Center for Education Statistics (1998b); Panel B—Author's calculations based on data from the U.S. Department of Education, National Center for Education Statistics (1998a).

LEP. The majority of people in the Chicago MSA are white, 82 percent, with roughly 12 percent African-American and 3 percent Asian. The area population is relatively well educated; just under 20 percent of persons 25 years and older have less than a high school diploma and 25 percent have a bachelor's degree or higher. On average, 19 percent of the zip code population is over 55 years of age, while 18 percent falls in the school-aged range of 5 to 17 years of age. Average household income is $64,826 in real 1999 dollars, 5 percent of households receive some public assistance income, and the constructed measure of the standard deviation of household income is nearly $50,000 in real 1999 dollars. Finally, the zip code school-aged population averages 4,800 people.

Private school location and neighborhood characteristics

Although little is understood about how private schools make location decisions, a reasonable starting point is to hypothesize that private schools generally choose to locate where there is demand for private schooling. Therefore, it is useful to consider what characteristics likely affect demand for private schooling. Most obviously, one would expect to see more private schools in areas with a larger school-aged population, because greater population is likely to be associated with greater numbers of students desiring enrollment in private schools. Considering the role of public schools in the private school/public school choice, on the one hand, one might expect poor-quality public schools to be associated with greater numbers of private schools, as the value of the net increase in school quality from switching to private school would exceed the cost of private schooling. On the other hand, to the extent that private schools provide competition for public schools as suggested in some of the education literature, greater numbers of private schools may be associated with better performing public schools.

TABLE 2

Descriptive statistics of Chicago metro area zip codes

	Mean	Standard deviation	Minimum	Maximum
Private school counts				
Total schools	2.68	2.90	0	16
Non-religious schools	0.38	0.73	0	4
Religious schools	2.30	2.57	0	14
Total schools entering, 1980 to 1997	0.66	1.06	0	9
Total schools exiting, 1980 to 1997	0.68	1.41	0	10
Non-religious schools entering, 1980 to 1997	0.26	0.53	0	2
Non-religious schools exiting, 1980 to 1997	0.11	0.40	0	2
Religious schools entering, 1980 to 1997	0.41	0.82	0	8
Religious schools exiting, 1980 to 1997	0.57	1.23	0	8
Public school characteristics				
Average student–teacher ratio	17.88	2.02	11.90	24.13
Zip codes without student–teacher ratio data, percent	9.25			
Sixth graders not meeting IGAP standards, percent	9.12	9.34	0	45.11
Sixth graders exceeding IGAP standards, percent	28.55	15.73	1.61	69.68
Zip codes without sixth grade IGAP scores, percent	14.59			
Population characteristics				
Limited English proficiency, percent	2.65	3.76	0	22.33
White, percent	82.00	24.40	0.48	100.00
African-American, percent	11.73	23.10	0	99.20
Asian, percent	2.77	3.51	0	21.37
Hispanic, percent	6.90	10.32	0	67.27
Less than high school diploma, percent	19.81	11.99	0	62.42
Bachelor's degree or higher, percent	25.04	17.37	0	89.29
Over 55 years of age, percent	19.46	7.77	0	70.42
Households receiving public assistance, percent	5.10	7.05	0	46.72
Average household income	64,826	31,051	13,522	270,653
Standard deviation of household income	49,541	22,166	320	136,520
Zip codes without income data, percent	0.71			
Number of school-aged children	4,774	4,680	0	28,098

Notes: There are 281 zip codes. All dollar values are in 1999 dollars.
Sources: Author's calculations from the U.S. Department of Education, National Center for Education Statistics (1998b), Illinois State Board of Education (1998), and U.S. Department of Commerce, Bureau of the Census (1990).

Demographic characteristics of the zip code population may also be correlated with demand for private schooling and, hence, the numbers of private schools. For example, Hispanics are on average more likely to be Catholic and, therefore, are likely to have a greater preference for Catholic education. In addition, people may prefer that their children attend school with other children of the same race, which might lead to racial segregation between private and public schools. Further, education and income characteristics of the community may also be associated with differences in demand for private schools. Higher education may be correlated with greater preference for higher quality education than is offered in the public schools. Alternatively, education is positively correlated with income, which is likely to be correlated with greater demand for high quality education, so one would expect both education and income to be associated with demand for private schooling. Lastly, Tiebout sorting (the sorting of households into communities with similar public good preferences) or rather the lack of Tiebout sorting may also relate to the demand for private education. If households with very different demands for high quality education live in the same community, one might expect greater demand for private schools in order for the different demands to be met. For example, assuming household income is positively correlated with demand for high quality schools, communities with large variance in household income may have greater demand for private schools as households sort into public and private schooling based on their different demands.

Correlations

For a first look at the relationship between the number of private schools and public school quality and neighborhood characteristics, table 3 presents simple correlation coefficients along with p-values for the correlations between the count of private schools and various zip code characteristics that might influence private school location (column 1). P-values ≤0.01 imply a statistically significant correlation at the 1 percent level of significance, and p-values ≤0.05 imply a statistically significant correlation at the 5 percent level of significance. Columns 2 and 3 present similar correlations between the zip code characteristics and the counts of non-religious and religious schools. As expected, the number of private schools is positively correlated with the number of school-aged children;

TABLE 3

Correlations between counts of private schools and characteristics of public schools and population

	Private schools	Non-religious private schools	Religious private schools
School-aged population	0.7191 (0.0000)	0.3971 (0.0000)	0.6983 (0.0000)
Student–teacher ratio	0.1164 (0.0513)	–0.0279 (0.6411)	0.1391 (0.0197)
Public school sixth graders failing standards, percent	0.3674 (0.0000)	0.2664 (0.0000)	0.3388 (0.0000)
Public school sixth graders exceeding standards, percent	–0.2611 (0.0000)	–0.0842 (0.1594)	–0.2705 (0.0000)
Limited English proficiency, percent	0.4381 (0.0000)	0.1750 (0.0032)	0.4443 (0.0000)
White, percent	–0.3977 (0.0000)	–0.3428 (0.0000)	–0.3513 (0.0000)
African-American, percent	0.2801 (0.0000)	0.2981 (0.0000)	0.2313 (0.0001)
Asian, percent	0.2066 (0.0005)	0.1273 (0.0329)	0.1969 (0.0009)
Hispanic, percent	0.3774 (0.0000)	0.1509 (0.0113)	0.3828 (0.0000)
Less than high school diploma, percent	0.3630 (0.0000)	0.0853 (0.1537)	0.3851 (0.0000)
Bachelor’s degree or higher, percent	–0.0872 (0.1449)	0.1332 (0.0256)	–0.1360 (0.0226)
Over 55 years of age, percent	0.1941 (0.0011)	–0.0155 (0.7963)	0.2231 (0.0002)
Households receiving public assistance, percent	0.3431 (0.0000)	0.2444 (0.0000)	0.3176 (0.0000)
Average household income	–0.2068 (0.0005)	–0.0305 (0.6101)	–0.2245 (0.0001)
Standard deviation of household income	–0.1058 (0.0767)	0.0702 (0.2406)	–0.1391 (0.0196)

Notes: There are 281 observations; p-values are in parentheses. All dollar values are in 1999 dollars.

that is, generally speaking, communities with greater numbers of school-aged children also have more private schools. The school quality measures are correlated with the counts of private schools in a negative direction; that is, higher public school quality is associated with lower numbers of private schools. Lower student–teacher ratios (usually assumed to reflect higher school quality) are associated with fewer total private schools. There are more private schools in communities with larger shares of students failing to meet IGAP standards, and there are fewer private schools in communities with larger shares of students exceeding the IGAP standards.

Looking at race and ethnicity, communities that are less white, more African-American, more Asian, and more Hispanic have fewer private schools. Also, areas in which larger shares of the population are high school dropouts or over the age of 55 have more private schools. Finally, a greater share of households receiving public assistance income is associated with more private schools, higher average household income is associated with fewer private schools, and higher community standard deviation of household income is associated weakly with fewer total private schools. This last result is somewhat surprising. Higher income standard deviation is assumed to be associated with greater differences in demand for public goods, such as public schooling, which might translate into greater private school enrollment to accommodate different demands for schooling in the community. Of course, these simple bivariate correlations do not control for multiple community characteristics. This is particularly important in the case of household income, because areas with higher average household income are likely to have greater income dispersion as well. As I explain below, the standard deviation of household income is positively associated with the number of private schools once average household income is also taken into account.

Results from Poisson regression

The correlation results above provide bivariate descriptions of the data, but they do not let us consider more complex, multivariate relationships in the data that may paint a somewhat different picture of private school location due to correlations between the covariates themselves, as well as between the covariates and counts of private schools. The results below utilize Poisson regression analysis in order to consider these more complex relationships in the data (see box 1). However, due to the small number of data points, the specifications below control for only a few covariates at any one time. In consequence, there may still be biases in the coefficient estimates due to omitted variables that are correlated with the included variables.

First, I present the results that focus on the relationship between total counts of private schools and community characteristics. Next, I highlight some interesting differences between religious and nonreligious private school counts and community characteristics. Finally, I consider the more difficult question of how private school entry and exit are related to location characteristics and changes in location characteristics over time.

Counts of private schools

Estimation results from Poisson regression of the counts of private schools on the logarithm of the school-aged population and various school quality measures are presented in table 4. With the exception of the school-aged population coefficient, the coefficient estimates can be interpreted as the proportional change in the expected number of private schools associated with a one-unit change in the variable of interest. The school-aged population coefficient

BOX 1

Poisson regression

The random variable of the number of occurrences of a particular event (in this case the number of private schools in a zip code) is assumed to have a Poisson distribution with parameter λ_i, where i indexes the zip code. For a random variable with a Poisson distribution with parameter λ, the expected value of the random variable equals λ, and the variance of the random variable equals λ.

The probability that the number of private schools in zip code i, denoted Y_i, equals y can be written as follows:

$$\Pr(Y_i = y) = \exp(-\lambda_i)\frac{(\lambda_i)^y}{y!}.$$

Next, I parameterize λ_i by specifying that the natural logarithm of λ_i is a linear function of the explanatory variables, that is,

$$\ln \lambda_i = \alpha + \sum_{j=1}^{J} \beta_j x_{ij}.$$

Poisson regression then estimates parameter values for α and β_j using maximum likelihood estimation (see Maddala, 1983, for a more complete discussion of Poisson regression). Throughout the article, I report results for the estimates of β_j without reporting the estimates of α.

TABLE 4

Relationship between counts of private schools and public school quality estimated by Poisson regression

Log of school-aged population	0.817*** (0.049)	0.832*** (0.049)	0.823*** (0.062)	0.788*** (0.053)
Student–teacher ratio	—	–0.024 (0.023)	—	—
Public school sixth graders failing standards, percent	—	—	–0.002 (0.004)	—
Public school sixth graders exceeding standards, percent	—	—	—	–0.002 (0.003)
Log-likelihood	–505	–504	–504	–504

***Significantly different from zero at the 1 percent level.
Notes: Standard errors are in parentheses. The dependent variable is the number of private schools in the zip code in 1997. There are 281 observations in each estimation. Each column also includes a dummy variable indicating whether the logarithm of the school-aged population is missing and a dummy variable indicating whether the variable of interest is missing.

reflects the percentage change in private schools associated with a 1 percent change in the school-aged population. Since I expect the number of private schools to be highly related to the size of the market (population of school-aged children), all estimates control for the logarithm of the school-aged population. Column 1 of table 4 controls only for the logarithm of the population of school-aged children, while the remaining estimates control for the logarithm of the number of school-aged children and at least one additional covariate.

Looking at the school-aged population result, communities with 1 percent larger school-aged populations have 0.8 percent more private schools on average. Combined with the fact that the share of school-aged children attending public school is unrelated to the number of school-aged children in Chicago zip codes, a school-aged population coefficient estimate less than 1 indicates that larger communities have larger private schools on average. Throughout the specifications in tables 4 and 5, the school-aged population coefficient estimate ranges from 0.775 to 0.901 and is always statistically different from 1.0 at the 1 percent level of significance.

The remaining specifications in table 4 control for public school quality measures. For all three school quality measures—average student–teacher ratio, percentage of students failing to meet IGAP standards, and percentage of students exceeding IGAP standards—there is no statistically significant relationship with private school counts. This finding is not altogether surprising, given that the expected direction of the relationship between private schools and public school quality is uncertain.[2]

In table 5, I present estimates of the relationship between private school counts and a select set of neighborhood characteristics of the zip codes, namely, language, race, ethnicity, and education in specifications 1 through 6. Neither English proficiency nor population education levels—percentage without a high school diploma and percentage with at least a bachelor's degree—are statistically related to the number of private schools in a zip code. In contrast, zip codes with 1 percentage point more Asians have 2.4 percent more private schools; however, neither the percentage of the population that is African-American nor the percentage of the population that is Hispanic is statistically related to the number of private schools in the zip code.

Finally, table 5 also includes estimates of the relationships between private school counts and age and income of the neighborhood that are presented in specifications 7 through 11. The percentage of the population over 55 years is positively related to the number of private schools in the zip code. A 1 percentage-point increase in the percentage of persons over 55 years of age is associated with a 5.2 percent increase in the expected number of private schools. The wealth of a community, as reflected by the percent of households receiving public assistance income, is negatively related to the number of private schools, while wealth as measured by average household income has no statistical relationship with the number of private schools. The standard deviation of household income also has no statistically significant relationship with the number of private schools.

TABLE 5

Relationships between counts of private schools and location characteristics estimated by Poisson regression

	Specification										
	1	2	3	4	5	6	7	8	9	10	11
Log of school-aged population	0.775*** (0.061)	0.844*** (0.054)	0.816*** (0.050)	0.810*** (0.060)	0.807*** (0.060)	0.841*** (0.051)	0.901*** (0.049)	0.883*** (0.061)	0.808*** (0.053)	0.836*** (0.052)	0.780*** (0.054)
Limited English proficiency, percent	0.014 (0.009)	—	—	—	—	—	—	—	—	—	—
African-American, percent	—	–0.002 (0.002)	—	—	—	—	—	—	—	—	—
Asian, percent	—	—	0.024* (0.013)	—	—	—	—	—	—	—	—
Hispanic, percent	—	—	—	0.001 (0.003)	—	—	—	—	—	—	—
Less than high school diploma, percent	—	—	—	—	0.001 (0.003)	—	—	—	—	—	—
Bachelor's degree or higher, percent	—	—	—	—	—	0.004 (0.003)	—	—	—	—	—
Over 55 years of age, percent	—	—	—	—	—	—	0.052*** (0.005)	—	—	—	—
Households receiving public assistance, percent	—	—	—	—	—	—	—	–0.010** (0.005)	—	—	—
Average household income ($10,000s)	—	—	—	—	—	—	—	—	–0.008 (0.020)	—	–0.203*** (0.053)
Standard deviation of household income ($10,000s)	—	—	—	—	—	—	—	—	—	0.025 (0.022)	0.274*** (0.055)
Log-likelihood	–503	–504	–501	–505	–505	–503	–461	–502	–504	–504	–491

***Significantly different from zero at the 1 percent level.
**Significantly different from zero at the 5 percent level.
*Significantly different from zero at the 10 percent level.
Notes: See notes for table 4.

Perhaps the most interesting results are presented in specification 11. In this specification, I control for both average household income and the standard deviation of household income within the community. In contrast to the two previous specifications, the specification 11 estimates indicate that both average household income and standard deviation of household income are statistically related to the number of private schools. A $10,000 increase in average household income decreases the number of private schools by 20 percent, while an increase in the standard deviation of household income by $10,000 increases the number of private schools by 27 percent. The standard deviation of income result is consistent with the notion that communities with greater heterogeneity in their demand for public school quality may have greater demand for private schools. Communities with a larger standard deviation of household income are more likely to have households with very different demands for public school quality. Thus, higher income households who are likely to demand better school quality than lower income households may opt for private schooling for their children instead.

Religious versus non-religious private school counts

Generally speaking, private schools may be viewed as distinguishing themselves along two dimensions: academic quality and religion. As such, religious school location decisions may be very different from the location decisions of non-religious schools. For example, one might think that schools offering no religious affiliation may be more responsive to public school quality. Similarly, Catholic schools may tend to be located in areas with larger Catholic populations, for example, areas with more Hispanics. The results presented in tables 6 and 7 provide separate estimates for the relationships between counts of non-religious and religious schools and certain location characteristics.

Once again, I control for the logarithm of the number of school-aged persons in the zip code in each specification, but these coefficient estimates are not shown in the tables. On average, 1 percent more school-aged children is associated with 0.8 percent more private schools, with coefficient estimates ranging from 0.7 to 1.0. Turning to the school quality results in table 6, non-religious private schools are less prevalent in areas in which the public school student–teacher ratio is higher. The estimate suggests that one more student per teacher on average is associated with 16 percent fewer private, non-religious schools. None of the other school-quality to private-school count relationships are statistically significant. The student–teacher result is more consistent with the notion that private schools improve public schools through competition; however, this conclusion is a bit strong given the lack of evidence from the other school quality measures.

The results presented in table 7 indicate some interesting statistical differences between counts of private non-religious schools and religious schools and community characteristics. Contrary to speculation above, the percentage of the population that is Hispanic, and thus likely to be more Catholic, has no statistically significant relationship with either the number of non-religious private schools or the number of religious schools. Instead, the percentage of the population that is African-American, and thus less Catholic, on average, is positively related to the number of non-religious private schools and negatively related

TABLE 6

Relationship between counts of private schools and public school quality by non-religious and religious private schools

	Non-religious schools			Religious schools		
Student–teacher ratio	–0.157** (0.070)	—	—	–0.002 (0.024)	—	—
Public school sixth graders failing standards, percent	—	0.006 (0.010)	—	—	–0.003 (0.004)	—
Public school sixth graders exceeding standards, percent	—	—	0.006 (0.008)	—	—	–0.004 (0.003)

**Significantly different from zero at the 5 percent level.

Notes: Standard errors are in parentheses. Each column represents a separate specification. The dependent variable in columns 1, 2, and 3 is the number of non-religious private schools in the zip code in 1997. The dependent variable in columns 4, 5, and 6 is the number of religious private schools in the zip code in 1997. There are 281 observations in each estimation. Each column also includes the logarithm of the 1990 school-aged population of the zip code, a dummy variable indicating that the school-aged population is missing, and a dummy variable indicating that the variable of interest is missing.

to the number of religious schools (see specification 2 in table 7). The education level of the community is significantly related to the number of private, non-religious schools, but is not statistically related to the number of private, religious schools. Higher percentages of persons with less than a high school diploma are negatively associated with the number of private, non-religious schools, and higher percentages of persons with a bachelor's degree or higher education are positively associated with the number of private, non-religious schools. These education results likely reflect differences in the demand for school quality associated with either preferences or income.

Finally, the age and income results show that the positive relationship between the percentage of the population over 55 and the number of private schools reflects the positive relationship between the percentage of persons over 55 years of age and the number of private, religious schools. The income results mostly confirm the education results of specifications 5 and 6, although higher average household income is associated with greater numbers of private, non-religious schools without controlling for income dispersion. The significant relationship between percentage of households receiving public assistance income and the number of religious schools suggests a relationship between religious private school location and income as well. Lastly, unlike the overall results, the number of non-religious private schools is positively associated with the standard deviation of household income even without controlling for average income. Controlling for both average income and standard deviation of income yields similar results for both religious and non-religious schools: Communities with greater income heterogeneity, controlling for average household income, have more private schools.

Entry and exit

There are at least two reasons why one might be skeptical of the relevance of the above results. First, the relationship between school counts and area characteristics, other than school quality, is based on private school locations in 1998 and census data

TABLE 7

Relationships between counts of private schools and location characteristics by non-religious and religious schools

Specification	Non-religious private schools	Religious private schools
1 Limited English proficiency, percent	–0.014 (0.023)	0.018* (0.010)
2 African-American, percent	0.005* (0.003)	–0.003* (0.002)
3 Asian, percent	0.027 (0.018)	0.023 (0.014)
4 Hispanic, percent	–0.008 (0.009)	0.002 (0.003)
5 Less than high school diploma, percent	–0.021** (0.008)	0.004 (0.003)
6 Bachelor's degree or higher, percent	0.029*** (0.006)	–0.001 (0.003)
7 Over 55 years of age, percent	0.011 (0.018)	0.058*** (0.005)
8 Households receiving public assistance, percent	–0.003 (0.010)	–0.012** (0.005)
9 Average household income ($10,000s)	0.067* (0.039)	–0.024 (0.020)
10 Standard deviation of household income ($10,000s)	0.152*** (0.049)	–0.001 (0.022)
11 Average household income ($10,000s)	–0.365*** (0.136)	–0.175*** (0.054)
Standard deviation of household income ($10,000s)	0.614*** (0.151)	0.211*** (0.063)

***Significantly different from zero at the 1 percent level.
**Significantly different from zero at the 5 percent level.
*Significantly different from zero at the 10 percent level.
Notes: Standard errors are in parentheses. The dependent variable for each estimate in column 1 is the number of non-religious private schools in the zip code in 1997. The dependent variable for each estimate in column 2 is the number of non-religious private schools in the zip code in 1997. There are 281 observations in each estimation. Specifications 1 through 10 each control for only the location characteristic listed in addition to the logarithm of the 1990 school-aged population of the zip code, a dummy variable indicating that population is missing, and a dummy variable indicating that the variable of interest is missing. Both average household income and the standard deviation of household income are included in specification 11, in addition to the logarithm of the 1990 school-aged population of the zip code, a dummy variable indicating that population is missing, and a dummy variable indicating that the household income data are missing.

TABLE 8

Relationships between private school entry and exit and public school quality estimated by Poisson regression

Specification	Entry	Exit	Combined effect
1 Log of 1990 school-aged population	0.688*** (0.105)	1.371*** (0.127)	–0.683*** (0.171)
1980 to 1990 change in log school-aged population	–0.211 (0.253)	–1.789*** (0.455)	1.578*** (0.495)
2 Student–teacher ratio	0.024 (0.043)	0.036 0.059	–0.012 (0.067)
3 Public school sixth graders failing standards, percent	0.002 (0.008)	0.016* (0.009)	–0.014 (0.012)
4 Public school sixth graders exceeding standards, percent	–0.003 (0.005)	–0.017*** (0.006)	0.014* (0.007)

***Significantly different from zero at the 1 percent level.
*Significantly different from zero at the 10 percent level.
Notes: The dependent variable is the count of private school entrants and exits in each zip code. Standard errors are in parentheses. Results are reported for four specifications. There are 281 zip codes used in the estimation. For each specification, the effects of covariates on private school entry and exit are estimated simultaneously. The results in the "entry" column correspond to the effects of the various covariates on private school entry; the results in the "exit" column correspond to the effects of the various covariates on private school exit; and the results in the "combined effect" column represent the net effect of the covariates on entry. In addition to the covariates listed in the second column, specifications 2 through 4 also control for the change in the log school-aged population between 1980 and 1990 and the logarithm of the school-aged population in 1990. Specification 1 includes only the school-aged population controls. All specifications include the appropriate set of dummy variables indicating missing observations for included variables.

from 1990. Second, current counts of private schools by location may be based largely on past location decisions. An alternative approach is to examine the relationships between changes in the number of private schools and changes in location characteristics. I do this by matching private schools in 1980 with private schools in 1997 to determine how many schools have entered and exited the community on aggregate over the 17 years. The results presented in tables 8–13 look at the relationships between counts of private school entry or exit and changes in location characteristics from 1980 to 1990.

The results in tables 8 and 9 focus on the number of private schools entering or exiting a zip code from 1980 to 1997. Each covariate is allowed to have a different effect on entry than on exit, but the relationships are estimated simultaneously. Each numbered row in the table represents one specification. Estimates of the effect of covariates on private school entry are presented in the "entry" column, estimates of the effect of covariates on private school exit are presented in the "exit" column, and estimates of the net effect on numbers of private schools are presented in the last column. If the net effect equals zero, then the effects of the covariate on entry and exit cancel each other out. If the net effect is either positive or negative, then the effect of the covariate on entry must dominate the effect on exit or vice versa, implying that there will be a net change in the number of private schools in the zip code between 1980 and 1997. In each specification I control for the logarithm of the school-aged population in 1990, as well as the change in the logarithm of the school-aged population from 1980 to 1990. These results are presented only for the first specification (rows labeled 1 in table 8), which includes no other covariates.

As seen in specification 1, the 1990 level of the school-aged population has a statistically significant relationship with entry, exit, and net entry. Additionally, the growth in the school-aged population between 1980 and 1990 has no statistically significant relationship with the number of schools entering the zip code but is significantly related to exit and net entry. Zip codes with larger numbers of school-aged children have both more entries and more exits of private schools from 1980 to 1997. However, the positive effect of the number of school-aged children on the number of schools exiting outweighs the positive effect on entry, such that on net, areas with 1 percent more school-aged population in 1990 have 0.7 percent

TABLE 9

Relationships between private school entry and exit and location characteristics estimated by Poisson regression

Specification	Entry	Exit	Combined effect
1 Limited English proficiency, change in percent	0.021 (0.073)	0.083 (0.052)	–0.063 (0.072)
2 African-American, change in percent	0.004 (0.009)	0.002 (0.008)	0.002 (0.013)
3 Asian, change in percent	0.116* (0.062)	0.020 (0.067)	0.095** (0.042)
4 Hispanic, change in percent	–0.024 (0.015)	0.046*** (0.015)	–0.070*** (0.021)
5 Less than high school diploma, change in percent	0.011 (0.026)	–0.043* (0.023)	0.054* (0.031)
6 Bachelor's degree or higher, change in percent	0.032* (0.017)	0.019 (0.020)	0.013 (0.028)
7 Over 55 years, change in percent	–0.046 (0.032)	–0.107*** (0.026)	0.060 (0.037)
8 Households receiving public assistance, change in percent	0.0002 (0.0003)	–0.0001 (0.0003)	0.0003 (0.0005)
9 Change in average household income ($10,000s)	–0.030 (0.046)	–0.157 (0.098)	0.127 (0.107)
10 Change in standard deviation of household income ($10,000s)	0.027 (0.056)	–0.093 (0.098)	0.120 (0.109)
11 Change in average household income ($10,000s)	–0.385*** (0.135)	–0.631** (0.272)	0.245 (0.295)
Change in standard deviation of household income ($10,000s)	0.478*** (0.155)	0.580** (0.286)	–0.101 (0.324)

***Significantly different from zero at the 1 percent level.
**Significantly different from zero at the 5 percent level.
*Significantly different from zero at the 10 percent level.
Notes: The dependent variable is the count of private school entrants and exits in each zip code. Standard errors are in parentheses. Results are reported for 11 specifications. There are 281 zip codes used in the estimation. For each specification, the effects of covariates on private school entry and exit are estimated simultaneously. The results in the "entry" column correspond to the effects of the various covariates on private school entry, and the results in the "exit" column correspond to the effects of the various covariates on private school exit. The results in the "combined effect" column represent the net effect of the covariates on entry. In addition to the covariate(s) listed in the second column, each estimate also controls for the change in the logarithm of the school-aged population between 1980 and 1990 and the logarithm of the school-aged population in 1990. Specifications 1 through 10 control for only one location characteristic other than the school-aged population measures, while both the change in average household income and the change in the standard deviation of household income are included in specification 11. All specifications include the appropriate set of dummy variables indicating missing observations for included variables.

fewer private schools in 1997. This estimate averages –0.62 across specifications, ranging from –0.70 to –0.54. Not surprisingly, larger growth in the school-aged population between 1980 and 1990 is associated with fewer private school exits over the period and a significant positive net effect on the number of private schools in 1997. A 1 percentage-point greater increase in the number of school-aged children from 1980 to 1990 is associated with a net 1.6 percent more private schools in 1997.

Public school quality measures have few statistically significant relationships with private school entry and exit. Average school quality measures are unavailable for 1980, so the public school quality measures are 1997 measures of school quality as used in the previous estimates. A higher percentage of sixth graders failing to meet the IGAP standards is associated with greater private school exit; however, the net effect of entry and exit is not statistically significant. A higher percentage of sixth graders exceeding the IGAP standards is associated with fewer private school exits from 1980 to 1997—1 percentage point more students exceeding is associated with 1.7 percent fewer exits—and a net positive effect on the change in the number of private schools. A 1 percentage point increase in the percentage of students exceeding the standards is associated with a net positive increase in the number of private schools of 1.4 percent.

Turning to the census characteristics results in table 9, we find statistically significant relationships with entry, exit, or the net effect on the number of private schools only among control variables that show some statistical significance in the overall results looking at private school counts in 1997. A 1 percentage-point greater increase in the percentage of the population that is Asian is associated with nearly 12 percent more private school entries. Taking into account the positive, but statistically insignificant, effect of the change in percentage Asian on exits, I find that a 1 percentage-point greater increase in the percentage of Asians is associated with a net increase of nearly 10 percent more private schools. The percentage of the population that is Hispanic has nearly the opposite effect on private schools. An increase in the percentage of Hispanics is associated with more private school exits from 1980 to 1997 and, thus, on net fewer private schools in 1997. A 1 percentage-point greater increase in the percentage of Hispanics is associated with a net 7 percent fewer private schools in 1997.

A larger increase in the percentage of adults with less than a high school education is somewhat surprisingly associated with fewer private school exits and an, on net, positive effect on private school counts. A 1 percentage-point greater increase in the percentage of adults without a high school degree is associated with a 5 percent increase in the net additions to private school counts. An increase in the percentage of the population that has a bachelor's degree or more education is positively related to the number of private school entrants. A 1 percentage-point greater increase in this variable is associated with 3 percent more entrants. However, the net effect on additions to private school counts is statistically insignificant.

Once again, a greater percentage of the population over 55 years of age is associated with greater numbers of private schools. As seen in specification 7 in table 9, this operates through the negative relationship between percentage over 55 and the number of private school exits. A 1 percentage-point change in the percentage of persons over 55 is associated with an 11 percent decline in the number of exits; the net effect is statistically insignificant. Finally, the effects of

TABLE 10

Relationships between private, non-religious school entry and exit and public school quality estimated by Poisson regression

Specification	Entry	Exit	Combined effect
1 Log of 1990 school-aged population	0.905*** (0.144)	1.080*** (0.209)	–0.176 (0.248)
1980 to 1990 change in log school-aged population	–0.216 (0.329)	–3.116*** (1.184)	2.900** (1.171)
2 Student–teacher ratio	–0.129* (0.066)	–0.011 (0.107)	–0.119 (0.116)
3 Public school sixth graders failing standards, percent	–0.005 (0.013)	–0.002 (0.020)	–0.003 (0.022)
4 Public school sixth graders exceeding standards, percent	0.011 (0.008)	0.002 (0.014)	0.009 (0.015)

***Significantly different from zero at the 1 percent level.
**Significantly different from zero at the 5 percent level.
*Significantly different from zero at the 10 percent level.
Notes: See notes to table 8. The dependent variable is the count of private, non-religious school entrants and exits in each zip code.

TABLE 11

Relationships between private, non-religious school entry and exit and location characteristics estimated by Poisson regression

Specification	Entry	Exit	Combined effect
1 Limited English proficiency, change in percent	–0.064 (0.086)	0.012 (0.078)	–0.075 (0.103)
2 African-American, change in percent	–0.0003 (0.016)	0.002 (0.009)	–0.002 (0.018)
3 Asian, change in percent	0.030 (0.048)	–0.024 (0.083)	0.053 (0.086)
4 Hispanic, change in percent	–0.037 (0.024)	–0.036 (0.042)	–0.001 (0.046)
5 Less than high school diploma, change in percent	0.026 (0.037)	–0.028 (0.028)	0.054 (0.044)
6 Bachelor's degree or higher, change in percent	0.086*** (0.025)	0.112*** (0.033)	–0.026 (0.041)
7 Over 55 years of age, change in percent	–0.031 (0.040)	–0.062 (0.048)	0.031 (0.059)
8 Households receiving public assistance, change in percent	0.0003 (0.0004)	0.0004 (0.0007)	–0.0001 (0.0008)
9 Change in average household income ($10,000s)	0.096* (0.050)	0.111 (0.090)	–0.014 (0.092)
10 Change in standard deviation of household income ($10,000s)	0.202*** (0.073)	0.222* (0.119)	–0.020 (0.121)
11 Change in average household income ($10,000s)	–0.393** (0.201)	–0.387 (0.534)	–0.006 (0.588)
Change in standard deviation of household income ($10,000s)	0.699*** (0.251)	0.706 (0.635)	–0.007 (0.712)

***Significantly different from zero at the 1 percent level.
**Significantly different from zero at the 5 percent level.
*Significantly different from zero at the 10 percent level.
Notes: See notes to table 9. The dependent variable is the count of private, non-religious school entrants and exits in each zip code.

income on private school entry and exit are very similar when controlling for both average household income and standard deviation of household income. As such, the net effect on the number of private schools is not statistically different from zero. Controlling for income standard deviation, an increase in average household income by $10,000 is associated with 39 percent fewer entries and 63 percent fewer exits. Similarly, a $10,000 increase in the standard deviation of household income is associated with a 48 percent increase in private school entries and a 58 percent increase in private school exits. This similarity in the effects of the average income and standard deviation of income across entries and exits suggests that these results may not be consistent with a lack of Tiebout sorting story as discussed in the initial results.

Tables 10, 11, 12, and 13 present entry, exit, and net effect results estimated separately for non-religious and religious schools. For non-religious schools, only the change in the percentage of the population that is school-aged has a significant net effect on the number of private schools. A 1 percentage-point increase in the percentage of the population between 5 and 17 years old is associated with a net increase in the number of private schools of 2.9 percent. This result is also statistically significant for religious private schools, for which a 1 percentage-point increase in the percentage of the population that is school-aged is associated with

TABLE 12

Relationships between religious school entry and exit and public school quality estimated by Poisson regression

Specification	Entry	Exit	Combined effect
1 Log of 1990 school-aged population	0.566*** (0.116)	1.435*** (0.142)	–0.870*** (0.186)
1980 to 1990 change in log school-aged population	–0.206 (0.315)	–1.532*** (0.492)	1.326** (0.559)
2 Student–teacher ratio	0.106** (0.052)	0.048 (0.058)	0.058 (0.075)
3 Public school sixth graders failing standards, percent	0.004 (0.010)	0.019** (0.009)	–0.015 (0.013)
4 Public school sixth graders exceeding standards, percent	–0.011** (0.006)	–0.022*** (0.007)	0.010 (0.009)

***Significantly different from zero at the 1 percent level.
**Significantly different from zero at the 5 percent level.
Notes: See notes to table 8. The dependent variable is the count of private, religious school entrants and exits in each zip code.

a net increase in the number of private schools of 1.3 percent. The other statistically significant results are fairly consistent with the other results reported in table 9. A 1 percentage-point increase in the percent of the population that is Asian is associated with a net 13 percent increase in the number of religious private schools. A similar increase in the percentage of the population that is Hispanic is associated with an 8 percent decline in the number of religious private schools.

Conclusion

The results in this article reveal some interesting relationships between private school location and neighborhood characteristics. In particular, the relationship between the number of private schools and household income dispersion in the community is consistent with predictions and somewhat different from the findings of the Downes and Greenstein (1996) study, which does not include a measure of community heterogeneity. Zip code neighborhoods in which households are less well sorted by income, that is, zip codes with higher income dispersion, have more private schools on average than neighborhoods that are more homogenous in terms of household income. This is consistent with expectations that households with similar income levels will have similar demands for education quality; and thus neighborhoods with greater income homogeneity will have less demand for private schooling and, therefore, fewer private schools.

The entry and exit results are more difficult to interpret and, as such, make it difficult to draw conclusions about how a universal voucher program might change the private school composition of various neighborhoods. I plan to explore the entry/exit results in more detail in future work, as well as considering other dimensions of private school supply, namely increasing enrollment and offering more grade levels. These are likely to be dimensions on which schools may respond more easily to changes in private school demand and, thus, may yield more informative results. Also, increasing the information on the changes in public school quality over time will help clarify whether there is a link between private school location and public school quality.

NOTES

[1]Broughman and Colaciello (1999).

[2]One way to use test scores to better measure school quality is to control for some measure of how well the students might perform on the test without the school's input. Using the percent of adults with a bachelor's degree or higher to control for differences in the expected test scores of the students, there is a significant, negative relationship between the number of private schools and the percent of students exceeding the IGAP standards. Including the education variable does not affect the other test score result.

TABLE 13

Relationships between religious school entry and exit and location characteristics estimated by Poisson regression

Specification	Entry	Exit	Combined effect
1 Limited English proficiency, change in percent	0.069 (0.090)	0.106* (0.059)	–0.037 (0.087)
2 African-American, change in percent	0.006 (0.011)	0.003 (0.012)	0.004 (0.016)
3 Asian, change in percent	0.159** (0.070)	0.029 (0.074)	0.130*** (0.046)
4 Hispanic, change in percent	–0.015 (0.020)	0.060*** (0.017)	–0.075*** (0.025)
5 Less than high school diploma, change in percent	0.003 (0.033)	–0.049* (0.025)	0.052 (0.035)
6 Bachelor's degree or higher, change in percent	0.001 (0.021)	–0.016 (0.031)	0.017 (0.039)
7 Over 55 years of age, change in percent	–0.053 (0.037)	–0.115*** (0.027)	0.062 (0.040)
8 Households receiving public assistance, change in percent	0.0001 (0.0004)	–0.0002 (0.0003)	0.0004 (0.0005)
9 Change in average household income ($10,000s)	–0.135** (0.067)	–0.289** (0.138)	0.154 (0.152)
10 Change in standard deviation of household income ($10,000s)	0.095 (0.071)	–0.205* (0.124)	0.110 (0.145)
11 Change in average household income ($10,000s)	–0.439** (0.173)	–0.789*** (0.268)	0.351 (0.278)
Change in standard deviation of household income ($10,000s)	0.389** (0.190)	0.593** (0.279)	–0.204 (0.309)

***Significantly different from zero at the 1 percent level.
**Significantly different from zero at the 5 percent level.
*Significantly different from zero at the 10 percent level.

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The credit risk-contingency system of an Asian development bank

Robert M. Townsend and Jacob Yaron

Introduction and summary

During the recent financial and economic crisis in Asia, financial institutions were often found wanting. There is little question that many financial institutions in Asia were mismanaged and poorly regulated prior to the onset of the crisis in the late 1990s. Yet the standards used to make such judgments have been standards appropriate for conventional banks, brought in from the outside, and applied as international best practice more or less uniformly across a variety of local and national institutions. As a result, some institutions have been closed. Alternatively, those same standards have been used to rationalize government intervention in the private sector or greater government subsidies.

Against the backdrop of the Asian financial crisis, we offer an analysis of one financial institution, a government-operated bank in Thailand, the Bank for Agriculture and Agricultural Cooperatives (BAAC). The BAAC offers an example of one of the relatively rare state-owned specialized financial institutions complying with politically mandated lending objectives without recourse to unfettered subsidies, while achieving unprecedented outreach to its target clientele of small-scale farmers. Furthermore, the BAAC has been operating an unconventional and relatively sophisticated risk-contingency system. Indeed, complementary evidence from micro data suggests that this risk-contingency system has had a beneficial impact on the semi-urban and rural Thai households that the bank serves. Unfortunately, the accounts that document the BAAC system, including newly recommended standards from the crisis, are more appropriate for a counterfactual conventional bank, a bank making relatively simple loans with provisions for nonperformance, not for the actual bank, which collects premia from the government if not the households themselves and pays indemnities to households experiencing adverse shocks.

This article ties the actual BAAC operating systems to the theory of an optimal allocation of risk bearing. We recommend accordingly a revised and more appropriate accounting of BAAC operations. That in turn would allow an evaluation of the magnitude of the government subsidy, something that could be compared with the insurance benefit the BAAC offers to Thai farmers, as derived from panel data. The bottom line, and the main policy implication of the article, is a new system for the evaluation of financial institutions, including state development banks which should not be assessed merely on their financial profitability grounds.

Specifically, we proceed as follows. First, we provide a brief review of the theory being used in this type of evaluation of financial institutions and of empirical work in developing and developed economies using that theory. Then, we provide some background information on the BAAC, in the specific context of Thailand. Next, we describe the BAAC risk-contingency system, that is, its actual operating system and how it handles farmers experiencing adverse events. Then, we elaborate via a series of examples on appropriate ways to provision against possible nonpayment, given that underlying risk. We also tie provisioning and accounting standards to the optimal allocation of risk bearing in general equilibrium, inclusive of moral hazard problems. Next, with the costs of insurance well measured, we turn to a more detailed discussion of BAAC accounts and how they might be improved, so as to measure and evaluate better the portion of

Robert M. Townsend is a professor of economics at the University of Chicago and a consultant at the Federal Reserve Bank of Chicago. Jacob Yaron is a senior rural finance advisor at the World Bank. *Townsend gratefully acknowledges research support from the National Institute of Health and the National Science Foundation.*

the Thai government subsidy that is effectively the payment of an insurance premium for farmers.

We want to emphasize at the outset that our method of evaluation allows us to attach specific numbers both to the insurance benefit the BAAC may be providing to Thai farmers and to the specific value of the subsidy the government pays to the BAAC. The difference is the bottom-line assessment of the financial institution. In particular, as an illustrative example, Ueda and Townsend (2001) generalize and calibrate a model of growth in which financial institutions provide insurance against idiosyncratic risk, and they estimate the lump sum welfare losses of restrictive financial sector policies that impeded that function at an average of 7 percent of household wealth, up to 10 percent for the middle class. If we take 876,000 baht as the average value of land and agriculture assets for nonbusiness households, thus excluding other sources of wealth and richer households with businesses, and use the lower 7 percent number, the gain would be about 61,000 baht. Thus, a conservative assumption of a compounded interest rate at 4 percent per year and a production lifetime of 40 years, during which such forgone wealth would have to be recovered, gives us a cost recovery factor of 5.05 percent. When applied to the target population of 4.5 million households that benefit from BAAC services, there would be an overall gain of about 13.86 billion baht. This could be used to balance against any subsidy given to a financial institution attempting to facilitate access and improve its policies.[1] The BAAC annual subsidy (explicit and implicit) as calculated under Yaron's *Subsidy Dependency Index* (discussed in detail in a later section) is approximately 4.6 billion baht,[2] so the estimated gain would more than rationalize the BAAC annual subsidy, that is, the gain amounts to almost three times the BAAC annual subsidy. Clearly some nonzero subsidy could be justified. The larger point, again, is that in principle one can evaluate the subsidy based on the estimated welfare-insurance gain.

However, the BAAC accounts as currently constructed do not reflect as well as they could the likelihood of eventual loan recovery and the operation of the bank's (implicit) insurance system. In particular, the costs of provisioning as reflected in the accounts are somewhat ad hoc, and the income transfer that is intended to cover those costs is unclear and commingled with other kinds of government subsidies. These are among the findings we present in this article. However, we do provide constructive suggestions for improvement.

Perhaps political pressures have distorted what might have been otherwise a more conventional system. The government of Thailand is valued for its ability to "bail out" farmers experiencing difficulties, and the BAAC does operate in the context of an agrarian environment with much risk. But we do not argue for going back to any such simpler conventional system, that is, simple loans with provision for default. We do argue for the use of accounting and financial reporting standards appropriate for insurance companies and consistent with the theory of an optimal allocation of risk bearing. By that more appropriate standard, the operation and accounts of the BAAC could be much improved. Again, we include some recommendations here.

Given the pejorative press given to Asian banks, we draw an ironic conclusion: With improvements, the BAAC could serve as a role model for private and public financial institutions in the rest of the world.[3]

The lessons we draw in this article from our analysis of the BAAC are not peculiar to the BAAC and Thailand alone. They apply more generally to institutions in other emerging market economies and in industrialized, developed economies such as the U.S. Overly stringent and ill-conceived regulations of financial institutions that discourage exceptions and contingencies in their otherwise standard loan contracts can have welfare-reducing effects. In earlier work published in this journal, for example, Bond and Townsend (1996) and Huck, Bond, Rhine, and Townsend (1999), we drew the tentative conclusion that lack of flexibility and inappropriate financial instruments may be limiting demand for small business credit in the U.S. More generally, a set of narrow financial institutions with clear accounts and reasonable profit margins may fail nevertheless to provide desirable financial services. Likewise, financial institutions in developing countries that allow exceptions and delayed repayment should not be judged a priori to be inefficient, as was the BAAC, and, hence, closed or bailed out with a government subsidy. Rather, the de facto operating systems of such financial institutions need to be understood and made explicit, then integrated into more appropriate accounting and financial reporting systems and modified regulatory frameworks. In this way, both the costs and benefits of more flexible systems and risk contingencies can be made clear.

Literature review

Recent work on the optimal allocation of risk has stressed the ability of theory to provide a benchmark that can be used to assess the efficiency of a financial system or a particular financial institution. Using household and business data, one can test whether household or business owner consumption co-moves with village, regional, or national consumption, as a measure of aggregate risk, and does not move with household or business income, as a measure of idiosyncratic risk. This benchmark standard is hard to achieve and tests for full risk sharing do fail. But, we learn something about the risk-bearing capabilities of actual financial systems and about potential barriers to trade. Thus, for example, three villages in India surveyed by International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and 31 villages in Pakistan surveyed by International Food Policy Research Institute (IFPRI) do surprisingly well when taken one at a time (see Townsend, 1994, and Ogaki and Zhang, 2001). The regional and national level systems of Cote D'Ivoire and Thailand display some co-movement in consumption but also an array of surprisingly divergent local shocks that remain "underinsured" (see Deaton, 1990, and Townsend, 1995, respectively). Similarly, Crucini (1999) has measured the extent of risk sharing across states in the U.S., provinces in Canada, and among Organization for Economic Cooperation and Development (OECD) countries. But households in the U.S. seem underinsured against illness or substantial periods of unemployment (see Cochrane, 1991), and wage laborers seem underinsured against occupational-specific economic fluctuations, as shown in Attanasio and Davis (1996) and Shiller (1993).

Less work has been done to determine the actual mechanism that is used in the provision of insurance, limited though it may be. Self-insurance strategies include migration and remittances, as studied by Paulson (1994); savings of grain and money as buffers, as studied by Deaton and Paxon (1994); and sales of real capital assets and livestock, as studied by Rosenzweig and Wolpin (1993), for example. Lim and Townsend (1998) find more communal, collective mechanisms at work as well, but in this there is some stratification by wealth—the relatively rich use grain and credit, while the relatively poor use currency. Murdoch (1993) finds that these poorer, credit-constrained households are more likely to work fragmented land in traditional varieties and less likely to engage in high-yield, high-risk activities. Asdrubali, Sorensen, and Yosha (1996) use gross domestic product (GDP) data to decompose the difference between GDP and consumption; they conclude for states in the U.S. that credit markets smooth about 24 percent of fluctuations.

Even less work has been done to integrate these tests of risk bearing and possible response mechanisms with an empirical assessment of a particular financial institution. Commonly used standards for the evaluation of financial institutions include profitability, capital adequacy ratios, or administrative costs as a percent of assets or loan portfolio. Typically, these are stand-alone metrics, and the evaluation of a particular financial institution is not done with socioeconomic data that support a full cost–benefit analysis. Indeed, the requisite socioeconomic data are frequently not available. But researchers can take some steps.

Building on the premise that financial institutions (credit and savings) exist to smooth the idiosyncratic shocks of participants and that those outside financial institutions must smooth on their own, one can try to explain aggregated data—for example, the growth of income with increasing inequality and uneven financial deepening we have seen in data from Thailand. Growth is higher for those in the system because more of available savings can be put into risky, high-yield assets, and information on diverse projects can be pooled. Fixed costs and transaction fees can endogenously impede entry to the financial system for low-wealth households and businesses. But in Thailand, the political economy of segmentation and regulation appears to have impeded entry exogenously. As noted in the introduction, Ueda and Townsend (2001) generalize and calibrate this model of growth and estimate the lump sum welfare losses of restrictive policies at an average of 7 percent of household wealth, up to 10 percent for the middle class.

There are more direct tests of efficiency with micro data combined with knowledge of the use of particular financial institutions. Combining two data sets from Thailand, household level income and consumption data from the *Socio-Economic Survey* (SES) and village level institutional access data from the Community Development Department (CDD), Chiarawongse (2000) shows that there is some insurance, that is, a negative correlation between access to certain financial institutions—commercial banks, traders, or the BAAC—and the sensitivity of county-level consumption to county-level income shocks. The result for the BAAC seems particularly robust (possibly because the bank's clientele consists mainly of middle- and small-income farmers). The positive role of commercial banks is lessened when joint membership with the BAAC is taken into account. Related, utilizing the Townsend et al. (1997) Thai data financed by the National Institute of Child Health and Human Development, the National Science Foundation, and the Ford Foundation, collected during three years of the recent Thai financial crisis, Townsend (2000) shows that the use of credit accounts at the BAAC has helped smooth shocks to some extent, in two of four provinces of the survey. In contrast, the use of savings accounts at commercial banks was helpful in only the initial downturn and the use of credit from the informal sector is seemingly perverse—such users achieve less insurance as they seek loans from moneylenders after all else fails. Relative to these financial alternatives, therefore, the BAAC appears to be playing a beneficial societal role, though there remains room for improvement.

BAAC background

The BAAC was established in 1966 as a state-owned specialized agriculture credit institution (SACI) to promote agriculture by extending financial services to farming households. In effect, the BAAC replaced the former Bank for Cooperatives, which suffered from poor outreach and low loan repayment. The BAAC operates currently under the supervision of the Ministry of Finance, though it is soon to be transferred to the central bank, and is governed by a board of directors with 11 members appointed by the Council of Ministers.

The BAAC provides loans at relatively low interest rates to farmers, agricultural cooperatives, and farmers associations. The BAAC also lends to farmers for agriculturally related activities, for example, cottage industries, and more recently for nonagricultural activities, subject to not exceeding 20 percent of its total lending and provided that the borrowers are farming households. The BAAC is also engaged in supporting a number of government "development" projects through lending operations. The mobilization of savings has also become an important BAAC activity in recent years, and such saving has become the fastest growing category in the BAAC balance sheet.

Performance

The BAAC's performance in lending to low-income farmers has been spectacular in terms of outreach to the target clientele in the past few years. The BAAC's customer base has grown from 2.81 million household accounts in 1989 to 4.88 million in 1998, an increase of 2 million accounts. The BAAC claims that it currently serves more than 80 percent of Thailand's farming households, a share that is unprecedented in the developing world. The bulk of BAAC lending goes to individual farmers (88 percent) and follows a deliberate policy of reducing the share of lending to cooperatives because of repayment problems. Interest rates are 1 percent to 2 percent below commercial bank rates. The BAAC practiced a cross-subsidization interest rate policy until 1999, under which higher interest rates were charged on larger loans, subsidizing low lending rates to small farmers. This resulted in meager or negative profitability for small loans and created incentives that subsequently reduced the share of small loans in BAAC's total loan portfolio. This cross-subsidization policy was changed in 1999 and differential lending interest rates reflecting past collection performance of borrowers were introduced, in a range of 9 percent to 12 percent, with an additional 3 percent penalty rate if loans are willingly defaulted.

Overall, the Subsidy Dependence Index (SDI)—a measure of the BAAC's financial sustainability—was 35.4 percent in 1995. (Calculation of the SDI is explained in box 1.) This means that raising lending interest rates by 35 percent in 1995, from 11.0 percent to about 14.89 percent, would have allowed the full elimination of all subsidies, if such an increase did not increase loan losses or reduce the demand for loans. More specifically, the SDI is a ratio that calculates the percentage increase in the annual yield on the loan portfolio that is required to compensate the financial institution for the full elimination of subsidies in a given year, while keeping its return on equity (ROE) close to the approximate nonconcessional borrowing cost. In 1995, the BAAC's average yield on its loan portfolio was 11.0 percent and the SDI was 35.4 percent. This means that the BAAC could have eliminated subsidies if it had obtained a yield of 14.89 percent on its portfolio. The total value of the subsidy in 1995 amounted therefore to about 4.6 billion baht.[4]

The SDI computation of the BAAC's subsidy dependence over the past decade reveals an interesting pattern: The SDI rose when the level of inflation rose (see figure 1). The SDI also moved in the opposite direction to the ROE. A plausible explanation for this outcome is that the BAAC, as a price taker, has had to pay competitive interest rates on deposits when inflation has risen, but it has been unable to adjust its lending interest rates sufficiently upward, due mainly to political pressures to maintain unchanged nominal interest rates on agricultural loans. In contrast, when inflation rates have declined, BAAC operating margins have improved because the agricultural lobby focused on nominal interest rates rather than on real ones. The "money illusion" created by this asymmetry has enabled the BAAC to cover a larger share of its costs and to achieve a smaller dependence on subsidies, as well as increasing its ROE when inflation decreases.

Over the period 1985–95, the BAAC's SDI oscillated within a modest range of 10 percent to 55 percent. There is no declining trend in the BAAC's subsidy independence, but it is evident that the BAAC has displayed a lower level SDI than most other SACIs.[5] Evidently, it is possible to run a government

BOX 1

The Subsidy Dependence Index (SDI)

The SDI is a user-friendly tool designed to assess the subsidy dependence of a specialized agriculture credit institution (SACI). The objective of the SDI methodology is to provide a comprehensive method of measuring the total financial costs of operating a development financial institution and of quantifying its subsidy dependence. The SDI can offer a clearer picture of a financial institution's true financial position and reliance on subsidy than is revealed by standard financial analysis (Yaron, 1992).

The SDI can be expressed as follows:

$$SDI = \frac{\text{Total annual subsidies rec}}{\text{Average annual interest incc}}$$

$$= \frac{A(m-c)+[(E*m)-P]+K}{(LP*i)}$$

A = annual average outstanding loans received;

m = interest rate the SACI would probably pay for borrowed funds if access to concessionally borrowed funds were to be eliminated. This is generally the market reference deposit interest rate, adjusted for reserve requirements and the administrative costs associated with mobilizing and servicing additional deposits;

c = weighted average annual concessional rate of interest actually paid by SACI on its average annual outstanding concessionally borrowed funds;

E = average annual equity;

P = reported annual profit before tax (adjusted for appropriate loan loss provision, inflation, and so on);

K = sum of all other annual subsidies received by SACI (such as partial or complete coverage of the SACI's operational costs by the state);

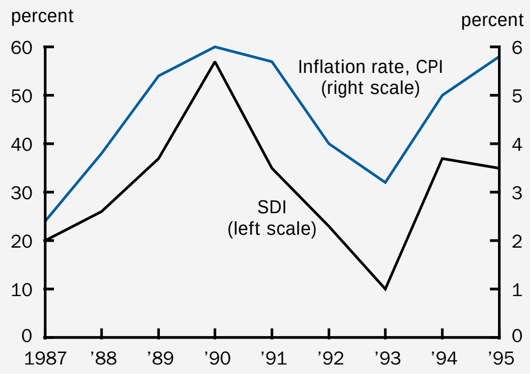
LP = average annual outstanding loan portfolio of the SACI; and

i = weighted average on lending interest rate of the SACI's loan portfolio.

Source: Yaron, Benjamin, and Pipreck (1997).

FIGURE 1

Subsidy Dependence Index of BAAC and inflation rates in Thailand, 1987–95



bank without recourse to enormous subsidies. Thailand has thus far resisted political pressures that have led to the eventual collapse of SACIs in Latin America and elsewhere.

Source of funds

The BAAC's sources of funds have shifted over the past few years. Deposits from the general public (private individuals and public sector entities) accounted for more than 60 percent of operating funds in 1998. Bond issues represented 14 percent of total funds in 1998. The BAAC can issue bonds without a mandated government guarantee. Commercial bank deposit accounts with the BAAC have been declining as its outreach and lending to farmers have increased.

The BAAC had an asset base of 265.29 billion baht ($6.4 billion) in 1998, and its outreach has been remarkable. Between 1989 and 1998, its outstanding loan portfolio increased from $1.22 billion to $4.86 billion. Its loan portfolio measured in baht grew at an average annual rate of 18 percent between 1994 and 1998. The BAAC reaches primarily small farmers, many of whom have no access to other formal credit. The bank's average loan size was $1,100 in 1995, nine times lower than the average commercial bank loan to the agricultural sector.

Since mid-1997, the financial and economic crisis in Thailand has been an issue of concern. However, the BAAC has been much less affected by the Asian crisis than commercial banks and finance companies. The BAAC's loan recovery has declined; by 1998 the outstanding value of overdue loans had increased to about 13 percent of its portfolio. This figure is still lower than in the rest of the banking sector, where bad loans are estimated to have reached 40 percent to 50 percent of the total loan portfolio. Furthermore, deposits from individuals continued to grow at the BAAC even in 1997 and 1998. To some extent, the BAAC seems to have benefited from the shift of depositors out of private banks, offering a legal comparative advantage as a safer, government-owned institution, as discussed in Fitchett (1999).

The BAAC risk-contingency system—Lending procedures

We begin with a schematic display of BAAC operating procedures. Figure 2 describes the contingent repayment system. It reads from top to bottom as a time line or sequence of events. First, at the top is the amount scheduled to be paid. The loan may then be repaid on time, as the chain of events on the far left of the figure indicates. But, if a client borrower does not repay on time, this triggers a procedure and decision by the branch. A credit officer goes into the field to verify the actual situation of the borrower. (Occasionally that situation would have been communicated in advance of the due date). The credit officer draws a conclusion as to whether the nonrepayment is justified, writing into the client loan history one of numerous possible causes (for example, flood, pest, drought, or human illness). At this point, the loan can be restructured, for example, extended for another cycle. Otherwise, if, as on the far right of figure 2, it is judged that there has been a willful default, a penalty rate of 3 percent per annum can be imposed—an increase of about 30 percent of the original lending interest rate. The exact terms for restructuring depend on the underlying situation, in particular on whether the adverse shock is large and regional in character, for example, a flood or plant disease. In such situations, clients may be given exceptions in terms of the amount eventually due, from deferred noncompounded interest to partial relief of principal, and the BAAC receives a compensating transfer from the Government of Thailand (GOT). Because individual and regional episodes are decided on a case-by-case basis, we are left to scrutinize the balance-sheet and income accounts for the impact of these episodes and the resulting orders of magnitude.

The amount not repaid can be divided into two categories: first, justified nonrepayment, that is, according to the BAAC's assessment, the client could not pay due to *force majeur*; and second, non-justified nonrepayment or willful default. Category one is usually *rescheduled,* principal and/or interest, and may be restructured up to three times. Category two entails an interest penalty of 3 percent. Still, any shortfall of income in either category requires an explicit income line, either from BAAC operations or from the GOT.

Government projects

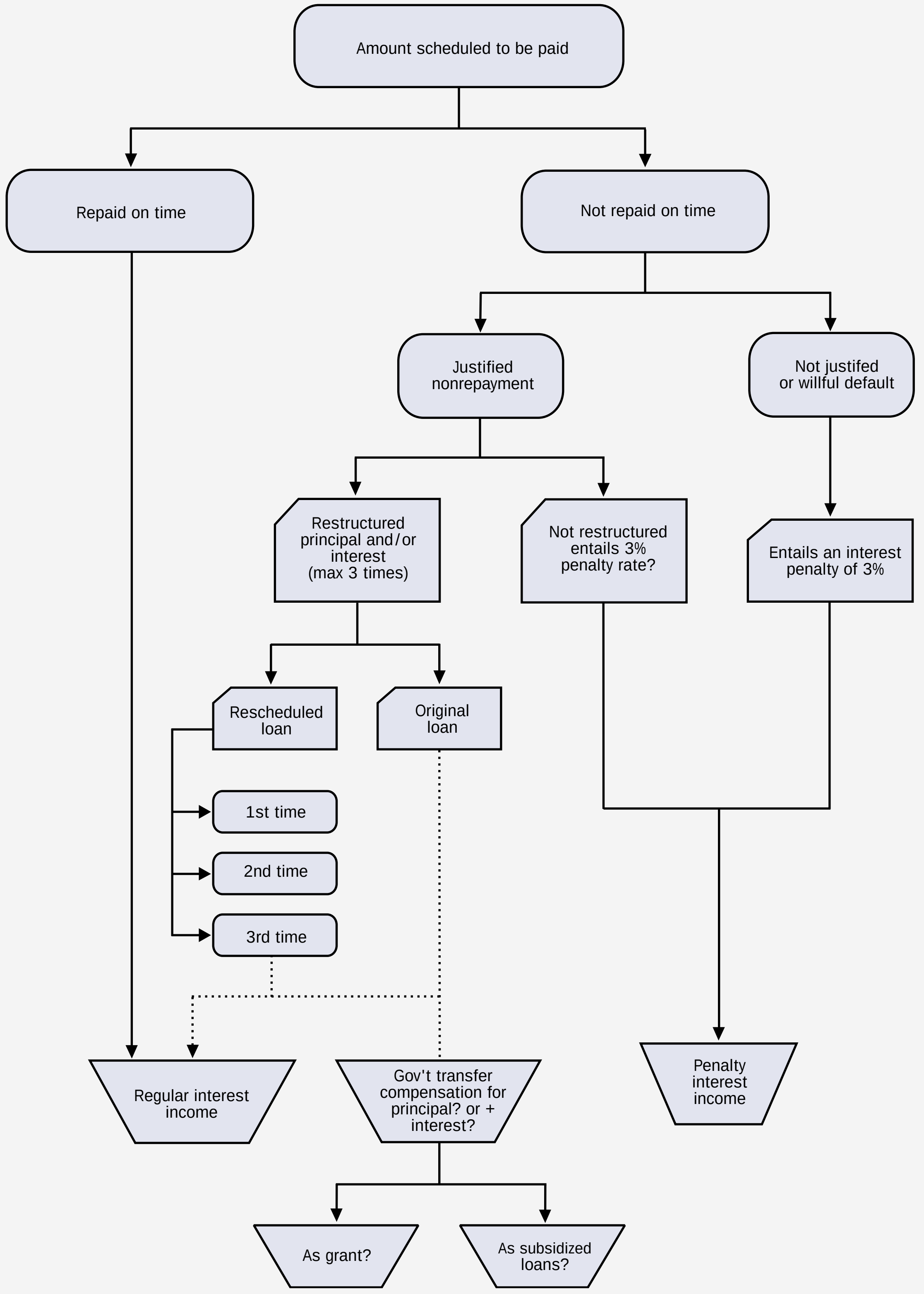
Further clouding the picture in the bank's accounts is its role as an implementing agency for "government projects" (usually, socially oriented long gestation, and often low-yield, loans and projects), obtaining fees in the extreme cases where the GOT is supposed to fully cover the cost involved in implementation. Indeed, to the BAAC's credit, details on the magnitude, nature, and repayment of these projects are in the annual reports. Low repayment rates are listed. Full disclosure of the actual costs and income associated with these government special "developmental programs" carried out by the BAAC are important for the bank's financial sustainability and efficiency (Muraki, Webster, and Yaron, 1998). But, at present, these projects are not transparent, and there is no clear way to verify what the costs are and to what extent they are covered by the GOT. Moreover, in several cases the negotiations between the BAAC and the GOT on how these costs are to be shared between the two entities take place only after the project is launched. This also might introduce disincentives with respect to efficiency and cost savings, in addition to having an adverse impact on the clarity of the bank's real annual profitability. Reported profitability plays a role in the negotiations. More generally, there is no way to assess cross-subsidization, either ex ante or ex post, between projects financed with the full discretion of the BAAC, using the creditworthiness of its clients under the framework of the risk-contingency system, and projects financed because of a GOT decision, reflecting a likely reliance on subsidies.

Head office versus branch accounts

A "transfer price" is an interest rate decided upon by BAAC management to calculate the cost and income on the amount of funds transferred between the branches and head office. This rate enables the branches to price their products in a way that conforms to the overall pursuit of cost minimization (and also to prepare a more complete profit and loss statement). The BAAC uses the tentative results from the measured operational performance in terms of profit (loss) of the branches for better financial management during the year and for evaluation of the branches' performance at the end of the year. Formerly, the calculation of the transfer price was done ex post at the end of the fiscal year, and the rate was announced to branch management, as applicable for the following fiscal year. With the onset of the financial and economic crisis in late 1997, the method was adjusted to an ex ante one in 1998, using as a basis the interest rate offered on 12-month fixed deposits plus a margin or markup for the BAAC.

FIGURE 2

BAAC operating procedures



To gain some insight into branch operations, we visited several branches and interviewed BAAC staff. One branch had experienced the 1995 flood. The staff of the branch had gone out into the local tambons (subcounties), not all of which were badly affected, to assess the damage. The staff reported that there were false or unjustified claims of damage in only four out of 1,200 cases. Those with false reports were not penalized, but they were not given relief.[6]

The BAAC's normal policy on loans is to lend up to 60 percent of expected future crop income, reflecting costs of inputs to be utilized, based on a Ministry of Agriculture formula. In this case, the BAAC made an exception and increased the amount up to 80 percent. This amount included all previous debts due and additions. The branch reported the total outlay to the head office, and the government said it would pay for the farmers in the interim. The process of assessment took two to three months.

Does the head office, relative to the branch, have an explicit ex ante or implicit ex post transfer system? In this case, the branch staff felt that the process was more one of ex post negotiation with a somewhat uncertain outcome. The branch also claimed that head office had not yet paid for 1995, and that the branch was borrowing from the head office to cover its costs at the transfer price.

Typically, if a farmer's loan is rescheduled or extended, it is assigned a code and entered into the client history and the computer. Data in the BAAC system supposedly includes information on how much was paid, how much was extended, and any new interest rate. However, based on the data we have received from the BAAC system, it appears that the ability to track past due loans is somewhat limited, and nonperforming loans may be treated as new loans. That is not like an insurance company that carefully tracks its policies.

Provisioning is decided at the head office and the branch is obliged to go along. According to the branch in our case study, the amount they had to provide for eventual loan losses was higher than necessary; that is, according to the branch staff only 4 percent was necessary, not the amount that the head office required and certainly less than under the new BAAC system.[7] There is, of course, a great danger in assuming that late loans are more likely to default than is actually the case. Provisioning would be excessive, raising costs, thus understating profitability, and so making it appear that the BAAC is more reliant on GOT's transfer that it actually is. Alternatively, excess provisioning and the search for compensating revenue may force more timely repayment in case of *force majeur*, and this would be a cost in the form of loss of insurance to farmers, limiting the social value of contingent contracts. The branch in the case study expected to get the lion's share of arrears paid belatedly, based on past experience.

How to provision—Some examples and the general theory of risk bearing

Our purpose in this section is to examine the risk of unpaid loans, how to account for them properly, what to enter as a cost in the accounts, where to look for compensating income from within the institution itself, and otherwise how to assess properly the magnitude of any government subsidies. We do this by tracing through a series of simple to increasingly complicated scenarios, starting with full repayment with interest rates to cover the cost of funds and other operating costs, then with anticipated partial default of one customer, or more realistically, of a fraction of customers, requiring increased interest rates or premia to cover credit guarantees. Indeed, the fraction of borrowers experiencing repayment difficulties may be random, a function of the aggregate, economy-wide state, and if that loss is to be provisioned properly and covered with interest or premia, then the appropriate, economy-wide event-contingent prices are required. It is more expensive to buy insurance for events that hit many borrowers.

In addition, later in this section, we place financial institutions like the BAAC in the context of a general equilibrium model in which there are borrowers and savers, and then allow for a government making transfers from taxpayers to specified groups, namely farmers at risk of experiencing losses. In that context, we can review the connection between the optimality of a laissez-faire competitive equilibrium, one without government intervention, and the welfare theorem that other optimal allocations can be attained through appropriate (lump-sum) government transfers.[8] Most familiar is the imagined world with complete ex ante markets for financial contracts, that is, with risk contingencies and perfect insurance, but that is not required—we extend the analysis to allow for limited insurance, moral hazard, and other impediments to trade.

Now, suppose a financial institution is to make a conventional loan of $100. It has to acquire these funds, either compensating shareholders or external lenders at the end of the loan cycle, at a cost of $12. Suppose in addition, there are within-period administrative costs associated with servicing the loan (without provision for losses) at a cost of $3. Therefore, the financial institution should get back $115 at the end of the period. If there is no uncertainty regarding full repayment, this loan at an interest rate of 15 percent would cover its costs and there would be no necessity to provide against loan losses. No provisioning would be necessary here.

However, commercial banks and other financial institutions face default risk. They lend with a clear perception that some of the loans will not be repaid. So, to begin with an extreme example, suppose the financial institution lends $100 as above but, based on past experience, it knows that only $90 will be repaid; in addition, the $10 of default on principal repayment entails nonpayment of interest of (15 percent × 10) = $1.50. In this case, it requires that the financial institution should, at the beginning of the period, provision $10, reflecting the cost to the entity of not being able to collect sufficient principal (and interest), ensuring that profits of the entity are realistic. A commercial banker would normally try to cover this cost through its price structure, that is, an increased interest rate to 27.8 percent on the loan portfolio would obtain the 15 percent desired overall return (adjusted to nonrepayment of 10 percent of principal and related interest[9]). Alternatively, state-owned banks may benefit from credit guarantee indemnity or crop insurance schemes (from a separate institution) or may benefit from an ad hoc direct bailout from the state. Usually, but not always, state-owned banks are loss-making institutions. The more subtle point is that the $10 of uncollected principal, plus $1.50 unearned interest, represents an expenditure to the entity, but not necessarily to the economy—it could be considered as a transfer or part of an income redistribution scheme.

In the above example, there is no uncertainty regarding the lender's clientele, based on long-term past performance. We can reinterpret the situation as one where the lender has many customers who may experience a loss or adverse idiosyncratic shocks. Imagine, based on past performance, that the financial institution knows with certainty that 90 percent of customers will repay their loans fully, including the interest charge. But 10 percent will pay neither interest nor principal. Neither the bank nor the customers know a priori who will fall into the 10 percent group. Overall, though, the return on the $100 loan is certain and is equal to $103.50.[10] The difference between $115 and $103.50 is $11.50. Hence, the bank should provision the $10 of nonpayment of principal as a cost and not accrue interest on these nonperforming loans (NPL). If it did already accrue interest, then the bank should reverse the accrual by reducing the interest earned both in the income statement and in the accrued interest line of the balance sheet. To ensure that the return on initial resources amounts to $15 at the end of the period, the bank can build into the interest structure a factor that compensates for the risk it assumes, charging an interest rate of 27.8 percent. This covers its administrative costs, finance costs, and the risk of default, and thus it breaks even in the end. The $10 provision made and the increase in the lending interest rate from 15 percent to 27.8 percent[11] both reflect the compensation that is needed for the lender to remain "as well as" it was at the start of the period, including the required 15 percent return on assets. From the clients' point of view, the increase in lending rate from the original 15 percent to 27.8 percent represents an insurance premium for the "indemnity" of nonpayment (reflecting probability of failure) that the financial institution has factored into the lending formula. Again, the apparent increase in gross revenue is balanced on the cost side by provisioning against loan losses and the loss of interest earned on NPL.

Suppose now that there is, in addition to the given financial institution, a second entity that ensures loan repayment, for example, a credit guarantee scheme (CGS). The CGS guarantees to the bank 100 percent of the value of loans with interest. In turn, the CGS charges a premium. That is, the CGS pays the bank an indemnity for the full amount of principal and interest for any default, as in the example $10 in principal and $1.50 in interest. The premium charged for this nonstochastic certainty example should thus be $11.50 (which can be converted to a percent of loans outstanding at the beginning of the period). The premium enters, of course, as an expense.

However, suppose that the bank does not build in higher rates to compensate for costs and there is no CGS. The financial institution still needs to provision against loan losses so as to reflect realistically the collection performance. Suppose it does this properly. But now the important if obvious point is that with an added cost and no corresponding revenue, the financial institution shows a loss. How does it cover the loss? Many state-owned development finance institutions are subsidized routinely by governments and also are bailed out frequently in cases of nonrepayment by their clients. Or they benefit from subsidies granted to a CGS and, hence, are (indirectly) subsidy dependent. That is, the loss is paid by the state and, hence, by the taxpayer. This then becomes the compensating income. The overall picture requires an analysis of the consolidated financial statements of the SACI and the CGS. The picture is not necessarily inconsistent with a *Pareto optimal allocation* of resources (see note 8, page 46, for a definition), as if the government were administering an income transfer scheme to bank customers.

Now, suppose, in addition, that the financial institution is not certain about the fraction of its clients who will not be able to repay. Let's say there are two *aggregate* states—one under which 90 percent will repay as above and a second under which only 50 percent will repay. A banker who needs to buy insurance from a CGS would have to pay a yet larger premium than above. Basically, the bank is buying claims to be paid in two states of the world; in one of these there are fewer resources because there is a relatively poor return on economy-wide investment. Logically, the price of this insurance is relatively high. This analysis thus assumes that nonpayments are due to idiosyncratic and aggregate events in nature associated with project failure, and that risk contingencies can be priced as if in complete markets. This analysis does preclude the possibility of willful default, but that too can be priced if it is constant or varies systematically with idiosyncratic and aggregate states.

Despite this modification, the accounting principles remain intact. If the financial institution operates independently, it must both add to costs by provisioning against losses and get revenue. If there is a CGS, then the bank does not have extra costs beyond premium costs. Still, we are assuming the CGS does the insurance exactly as the bank would have to do it if it were on its own and that the CGS needs to remain solvent, recovering from fees the costs of its resources and its risk. (We are however, for expository purposes, abstracting from additional administrative cost of the CGS.) Without a CGS, the financial institution needs additional revenue for its accounts to balance. Certainly, it may gain additional revenue in its interest rate structure. Otherwise, it could show a loss, the order of magnitude of which is exactly the subsidy.

In the more formal language of Arrow (1964), Debreu (1959), and McKenzie (1959), any risk in the economy is priced in equilibrium. A financial institution maximizes return to capital (that is, the present value, risk-adjusted profit, the valuation in units of account at an initial date of the contract it has entered into) subject to constraints (that is, financial and legal obligations to honor all its liabilities). One group contracting with the bank would be the client borrowers we have been discussing. A second group would be a set of investors (or taxpayers). Each group would maximize its expected utility subject to budget constraints expressed in units of account, that net expenditure be nonnegative. In a competitive equilibrium with many potential intermediaries, the risk-adjusted net present value for an intermediary would be zero, and the distribution of resources between clients and investors or taxpayers would be Pareto optimal.

We could, however, imagine ex ante transfers of resources to client borrowers from investors or taxpayers directly. Any Pareto optimum can be supported with such lump-sum grants, as in the second welfare theorem as mentioned earlier. Or again, the transfers could take place indirectly through the intermediaries. That is, client borrowers would begin, even before engaging in financial transactions, with a positive net present value budget and the intermediary would begin with an equivalent negative one. If this were so, then the intermediary would need to gain that missing revenue from taxpayers or investors.

In practice in actual economies, this concept is more difficult to achieve. In particular, not everything is contracted for unit of account prices at the initial period. Rather, the allocation of resources is achieved through a blend of contracts and spot market trades. Related, an income statement has revenue from previously contracted loans balanced with provision for future loan losses. Thus, ex ante profit maximization as in the theory seems to be replaced by period maximization, and profits are measured to a large extent as a residual item in the income statement itself. Finally, more generally, there is a danger that transfers are targeted to those actually experiencing losses, whereas the goal is the provision of *ex ante* insurance and, if necessary, a lump-sum transfer. The danger is that the likelihood of *ex post* transfers would lower the ex ante interest rate, causing a price distortion on the margin.

Still, the basic principles would carry over. Insurance is desirable, but risk assessment requires provisions to be made against doubtful accounts, at appropriate ex ante prices, and entered as an explicit cost, funded with fees or some ex ante revenue or income transfer.

The reader may note that we assume in the above examples that all financial transactions go through primary financial institutions or through the CGS. In an Arrow–Debreu world, households or businesses can enter into the market on their own, do their own insurance, and hence, fulfill their more narrow obligations (paying off noncontingent loans). This does not change the arithmetic; the marginal cost of loans applies as well at the individual level. But, in many economies, markets are incomplete and the ability to access insurance on one's own may be limited. Insurance is precisely one of the obvious services offered through intermediaries.

The theoretical framework we emphasize is one of full insurance, but that framework can be extended. There can be moral hazard on the part of potential borrowers when effort and the capital input may not be observed. Each borrower would choose a financial contract that implicitly recommends effort and a mix of capital (financial) inputs and stipulates the amount of repayment contingent on observed output. Each contract is incentive compatible, in the sense that its provisions for repayment and insurance induce the recommended effort and input use. Each contract carries a price in units of account, and the collection of contracts the intermediary buys net of any it sells must have valuation zero in equilibrium. That is, an intermediary can buy and sell contracts in such a way as to maximize profits subject to a clearing constraint, that it takes in enough resources so as to honor all beginning- and end-of-period claims. Competition among intermediaries will ensure that claims are priced in equilibrium at their actuarial fair value, as before (Prescott and Townsend, 2000).

In extensions to costly verification of project returns, the lender may at some expense verify the actual adverse situation of the borrower; see Townsend (1979), Gale and Hellwig (1984), and Bernanke and Gertler (1989). With interim communication of privately observed states, borrowers file claims about their underlying situation, triggering the resulting contingencies; see Prescott (2001). Ex ante observable diversity among clients changes the nature of incentive-compatible contracts and the mechanism of implementation but changes nothing essential as regards the accounting. Essentially, different clients are charged different interest rates or select from a different array of contingencies. Conceivably, certain groups could be subsidized ex ante and others not. Extensions to adverse selection where individual risk characteristics are not known a priori are less trivial and can cause a divergence between the outcomes of *competitive* markets and those achieved with intermediaries; see Rothschild and Stiglitz (1976) and Prescott and Townsend (1984). Bisin and Gottardi (2000) describe a possible decentralization, but we do not pursue this last difficult topic here.

BAAC accounts in practice and how they might be improved

As we have learned in the previous sections, we need to look at the BAAC accounts in search of provisioning against nonpayment, how that is done in practice, and possible government transfers or other income being used to cover provisioning and insurance costs.

In the asset–liability statement, we see in the balance sheet shown in table 1 that loans outstanding are by far the biggest BAAC asset, and deposits plus borrowing are the biggest liability. Loan loss provision reflects the integrals of all past provisions against doubtful accounts, net of write-offs. There is also a nontrivial and increasing capitalization from the Ministry of Finance to prevent the deterioration of the equity–asset ratio. Otherwise, capital provisioning would be inadequate. The SDI, however, computes the opportunity cost of the BAAC capital (net worth) as a cost from which annual profit (or loss) is subtracted (or added). Both reserves and government capitalization are symptomatic of potential and actual loan losses.

In the income statement, table 2, note the “other income” line in revenue. This includes transfers from the GOT to cover loan losses, deferred interest, and the costs of provisions among other things—a revenue item that shapes the final profitability picture. We note in particular, from note 2.20 in the 1998 BAAC audited financial statements annual report, that of other income reported there, 55 percent represents income from recompense-services. Similarly, an amount of 423 million baht is included as income from recompense-cost of funds.

The issue at stake is a material one, as demonstrated by the fact that the GOT income transfer to the BAAC oscillated around 1 billion baht in 1997 and 1.1 billion baht in 1998, or 5.3 percent and 5.6 percent of gross revenue in these years, respectively. These assessed, arbitrarily negotiated GOT transfers to the BAAC, which were recorded as part of “other income” in the bank’s financial statements, exceeded its profits in both 1997 and 1998. (This is true when reported profit is adjusted to include among the costs, as required by accounting standards, the bonuses to employees and directors, in contrast to the BAAC’s practice, which presents such bonuses as appropriations of earnings and not as expenditures. This practice was changed in 1999). We did acquire from the BAAC some further information on GOT transfers during fiscal year 1995 through fiscal year 1997. Transfers intended as compensation for interest income payable to the bank on behalf of its clients were as follows for these fiscal years: in 1995, 896 million baht; in 1996, 995 million baht; and in 1997, 1.08 billion baht.

Note that these GOT transfers constitute the bulk of “other income” in the profit and loss statement. We also infer, however, that the residual in the other income line item is for something else.

In response to our questions, the BAAC informed us that even the interest income part of the transfer could be broken down differently in the following two cases:

- Case 1—The farmers participated in a government-directed project to promote and develop certain types of agriculture. The farmers received an incentive for participating, namely, lower interest

TABLE 1

BAAC balance sheet

	March 31, 1999		March 31, 1998		March 31, 1997	
	baht	**%**	**baht**	**%**	**baht**	**%**
Assets						
Cash and deposits at banks	4,026	1.46	9,890	3.73	3,414	1.45
Investment in securities						
Government bonds	30,580	11.05	32,300	12.18	25,430	10.80
Other securities	113	0.04	123	0.05	125	0.05
Net loans	225,962	81.67	204,509	77.09	185,812	78.93
Net accrued interest receivable (not yet paid)	9,279	3.35	10,578	3.99	8,404	3.57
Properties foreclosed	—	—	—	—	5	—
Net land, buildings, and equipment	4,977	1.80	5,205	1.96	5,429	2.31
Other assets	1,743	0.63	2,684	1.01	6,792	2.89
Total assets	276,680	100.00	265,290	100.00	235,411	100.00
Liabilities and shareholders' equity						
Deposits	180,564	65.26	165,007	62.20	131,841	56.00
Interest-bearing interbank accounts	—		45	0.02	3,611	1.53
Borrowing	60,283	21.79	67,157	25.31	79,614	33.82
Other liabilities	15,279	5.52	15,369	5.79	13,354	5.67
Total liabilities	**256,126**	**92.57**	**247,578**	**93.32**	**228,720**	**97.16**
Shareholders' equity						
Capital fund						
Authorized share capital						
200,000,000 shares of 100 baht per share	30,000		20,000		20,000	
Issued and paid-up share capital						
93,815,098 shares of 100 baht per share					9,382	3.99
111,721,440 shares of 100 baht per share	22,761	8.23	11,172	4.21		
Surpluses						
Increase in capital from government	34	0.01	10,034	3.78	1,034	0.44
Surplus from donation	1,036	0.37	1,030	0.39	1,015	0.43
Deferred gains (losses) due to						
Exchange rate fluctuations	–6,918	–2.50	7,954	3.00	–9,003	–3.82
Retained earnings						
Reserves	735	0.27	693	0.26	622	0.26
Unappropriated retained earnings	2,900	1.05	2,737	1.03	3,641	1.55
Total shareholders' equity	**20,555**	**7.43**	**17,712**	**6.68**	**6,691**	**2.84**
Total liabilities and shareholders' equity	**276,680**	**100.00**	**265,290**	**100.00**	**235,411**	**100.00**

Note: Amounts are bahts in millions. Tentative figures prior to certification by the Office of the Auditor General of Thailand. Columns may not total due to rounding.
Source: Bank for Agriculture and Agricultural Cooperatives (1999).

rates. The GOT compensates for the difference between the rates charged on the farmers' loans and the normal BAAC lending rates.

- Case 2—When there is a natural calamity covering large areas and a large number of farmers are affected, then the GOT assists them. Such assistance is given to enable them to immediately rehabilitate their agricultural production. A lower interest rate is offered. The GOT compensates for the differences in the interest rates similar to case 1.

We could not identify or obtain a breakdown for the two cases in the "other income" amounts. A basic question then is whether the GOT transfer is not to a large extent compensation for the BAAC's administrative handling of "state projects."

Potential improvements

An accounting and financial reporting procedure that separates the accounts to reflect the outcome of government-project operations would help to display the real cost of these government projects and, thereby, disclose the full extent of the cross-subsidization. This, in turn, when the full benefits are estimated, would facilitate a better assessment of whether these government projects are socially warranted. The SDI could and should be computed separately for the GOT projects. This would also separate those projects and

TABLE 2

BAAC profit and loss statement

	March 31, 1999		March 31, 1998		March 31, 1997	
	baht	%	baht	%	baht	%
Revenues						
Interest earned on loans to client farmers	19,768	82.33	21,187	86.98	19,704	79.88
Interest on loans to farmers' institutions	1,497	6.23	1,723	6.34	1,191	4.83
Interest on deposits with other banks	32	0.13	143	0.53	124	0.50
Interest on government bonds and promissory notes	542	2.26	2,266	8.34	2,040	8.27
Other income[a]	2,173	9.05	1,850	6.81	1,607	6.52
Total revenues	**24,011**	**100.00**	**27,170**	**100.00**	**24,665**	**100.00**
Expenses						
Salaries, wages, and fringe benefits	3,291	13.87	3,123	11.58	3,177	13.64
Interest paid on deposits	6,055	25.52	10,035	37.21	9,325	40.04
Interest on commercial bank deposits	—	—	261	0.97	280	1.20
Interest on borrowing and promissory notes	3,987	16.80	5,321	19.73	5,221	22.42
Loan expenses	31	0.13	27	0.10	163	0.70
Travel and per diem expenses	126	0.53	120	0.44	133	0.57
Provision for doubtful accounts	5,665	23.87	4,833	17.92	2,751	11.81
Bad debts written off	7	0.03	9	0.03	27	0.12
Other expenses	1,179	4.97	1,287	4.77	1,054	4.52
Depreciation on assets and leasehold amortization	592	2.50	616	2.29	600	2.57
Losses due to exchange rate fluctuation	1,983	8.36	550	2.04	557	2.39
Total expenses	**23,731**	**100.00**	**26,967**	**100.00**	**23,289**	**100.00**
Net profit	**280**		**203**		**1,377**	

[a]Other income includes government transfers among other items.
Note: Amounts are bahts in millions. Columns may not total due to rounding.
Source: Bank for Agriculture and Agricultural Cooperatives (1999).

that assessment from the assessment of the risk-contingent income transfers on the bank's regular loan operations that is the focus of this article.

More specifically, the accounts need to clarify whether the transfer from the GOT reflects administrative costs that the BAAC incurs in implementing the government projects; or the difference between the lending interest rates paid by the beneficiaries of such projects and the BAAC's opportunity cost in lending to other clients when the loans are from the bank's own resources; or compensation for low repayment rates on these special projects; or, as we focus on in this study, compensation for ex post loan losses generated by normal operations. The point is that at present all these types of transfers are commingled.

The income statement does not provide separate information on "regular" interest income and penalty interest income. This distinction would be necessary to handle separately BAAC income that is generated directly from clients in various ways versus "indirect" income from the GOT. In response to our questions, the BAAC reports that penalty interest income cannot be easily subtracted from the regular interest income presented, because the BAAC's policy does not emphasize imposing the penalty rate on nonrepaid loans. That is, the BAAC emphasizes assistance to clients affected by *force majeur* factors. The income from these penalties is minimal in any event. However, the condition of entailing a penalty rate is stated in the loan document and can be audited in the individual client's loan account.

We also need clarification with respect to loans that were recognized as "justified nonrepayment" but for which the borrower refused to sign a new "restructured" loan agreement (or has not yet signed it). How is this loan balance classified? How are belated repayments of such a loan to be classified? Will such belated repayments require payment of the penalty interest rate?

Furthermore, in tables of arrears, we see a related version of the risk-contingency story—litigation debt is a small part of annual arrears, for example, 3.1 percent in 1997 and 3.5 percent in 1998. Apparently, then, the bulk of arrears fell under the well-established risk-contingency system and, hence, these clients were not subject to ex post litigation. However, it would be useful to know how much of the nonrepayment amount each year belongs to category one versus category two, that is, justified or non-justified delay. Furthermore, data on nonrepayment could include a breakdown of how much belongs to loans already rescheduled (one, two, or up to three times).

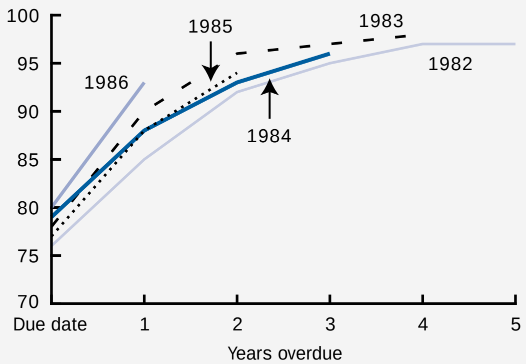
Ideally, data on repayments of loans that fell in arrears but were repaid belatedly should be reported as well, with appropriate reference to the original loan's maturity, so as to verify, over time, the state of loans that result in eventual loss. This information is essential to allow the bank to make appropriate annual provisions for loan losses and realistic cash flow projections.

To its credit, the BAAC reports an analysis of arrears by age related to their original maturity dates in its audited financial statements (see figure 3, for example). This type of information is only seldom disclosed by other financial institutions. Notwithstanding the availability of such data, the BAAC is now provisioning for loan losses more conservatively (see table 3), based on new guidelines, noted in the BAAC annual reports. Previously, provisioning for loan losses was made against the original total, spreading it evenly over ten years (10 percent per annum). Ideally, however, provisions should not be based on some conventional formula but rather on the analysis of arrears by age, adjusted for the likelihood of macroeconomic shocks and, of course, any estimated changes in future repayment stemming from altered policy and assessment of changes in the capacity of borrowers to repay.

The 1998 annual report provides further information by subitems on doubtful accounts as of the end-of-the-accounting periods for 1997 and 1998, as well as the amount provisioned against these subitems in those years. We note, in particular, the explicit mention of natural disaster victim accounts, that is, the magnitude of doubtful accounts associated with southern storms in 1989 and the floods of 1995 (as in the earlier branch example) and 1996. While the 1989 southern storm doubtful accounts are apparently expensed in 1997 and 1998, the 1995 and 1996 flood accounts are associated with positive income in 1997 and 1998. It is not clear if this latter income is associated with overprovisioning in earlier years or if it is a GOT transfer. More generally, the text of the 1998 annual report notes that 350,200 farmers have had debts postponed as victims of natural disasters, permitting one year free of interest. It does seem that interest is not accrued on these accounts, though as argued earlier, other income seems to compensate for loss of interest, as for transfers from the GOT. However, the point remains that the GOT transfers to compensate for loss of interest and the provisioning of the principal of doubtful accounts from the 1989 storm and the 1995–96 flood are not readily apparent in the income accounts themselves.

FIGURE 3

Percentage of original loan amount paid on time and belatedly against original maturity



Source: Yaron, Benjamin, and Piprek (1997).

TABLE 3

BAAC provisioning for loan losses

Age of principal overdue	Loan loss provision rate (%)
< 1 year	10
> 1–2 years	30
> 2–3 years	50
> 3–4 years	70
> 4 years	100

Source: Data from Bank for Agriculture and Agricultural Cooperatives.

Table 4 presents more recent information that reflects the financial crisis. Of the amount of one-year arrears in 1997, 4.49 billion baht, about 41 percent, of that was repaid by 1998, leaving 2.67 billion baht; 25 percent of that (two years in arrears) was repaid by 1999, leaving a little over 2 billion baht. Other rows in table 4, for example, two years arrears in 1997, illustrate similar geometric patterns, with the percentage of the residual repaid positive and declining. Linear rules are potentially too conservative in early years. A comparison of 1997 and 1998, that is, columns 3 and 5 of table 4, shows that the repayment rate on many age categories deteriorated between the two years. Also, total arrears increased for most age categories, and overall by 53 percent. This reflects the impact of the macroeconomic and financial crisis on the Thai economy. These and other shocks need to be factored into expectations in setting future provisioning rates.

Conclusion

In this article, we put forward a new integrated method for the evaluation of a financial institution. Specifically, we identify a risk-reduction or insurance

TABLE 4

Changes in arrears by age, BAAC, 1997–99

Years in arrears (age)	Amount in arrears, 1997	Percent change 1997–98	Amount in arrears, 1998	Percent change 1998–99	Amount in arrears, 1999	Average percent change, 1997–99
1	4,488	–40.53	6,272	–49.35	3,938	
2	1,246	–22.95	2,669	–25.03	3,177	
3	509	–22.00	960	–20.10	2,001	–33.23
4	295	–22.71	397	–20.40	767	–21.54
5	224	–20.98	228	–19.74	316	–21.21
6	73	–20.55	177	–17.51	183	–21.24
7	45	–17.78	58	–17.24	146	–19.27
8	29	–17.24	37	–18.92	48	–18.91
9	15	–16.56	24	–17.33	30	–18.35
10	136		126		124	–17.00
Total	7,060	55.07	10,948	–1.99	10,730	23.28
Outstanding from FY 1997	7,060	–33.77	4,676	–22.69	3.615	–28.44
Outstanding from FY 1998	—	—	10,948	–37.96	6,792	—

Note: Amounts are bahts in millions.
Source: Bank for Agriculture and Agricultural Cooperatives (1999).

role for the BAAC in Thailand. Microeconomic data on consumption and income fluctuations and the BAAC's own operating system both suggest potential substantial benefits from a risk-contingency system that is embedded in the operation of an otherwise standard credit-generating bank. However, the costs of operating that risk-contingency system and the magnitude of the subsidy granted by the government of Thailand to this state-operated financial institution are difficult to estimate, given the way that the BAAC is keeping its accounts. Accordingly, we recommend some changes in the operating procedures, accounts, and managerial information system that would improve the BAAC's financial performance. Specifically, when an individual farmer or small business owner experiences an idiosyncratic or aggregate shock, for example, individual-specific losses such as house fire or aggregate losses such as flood or cyclone, the reason for difficulty is identified at some expense by loan officers in the field. In principle, the reason for nonpayment is recorded in the borrower's credit history, but apparently, these are not systematically coded into a data management system, either at the level of the branch or the head office. Doing this would allow an analysis of the frequency of adverse events, providing a clearer, more direct measure of the insurance functions of the bank. Further, these data would allow an assessment of the likelihood of eventual default on extended or rolled over loans, thus allowing improved provisioning and more accurate cost analysis. Indeed, because interest on late payment may not be compounded (that is, interest is not accrued), concessional interest rates are sometimes offered, and even the principal due may be reduced. As for the case of aggregate shocks, there are other direct costs associated with these various adverse events. It is important to identify and record separately all these costs and enter them as line items under expenses in the financial accounts. Provisions based on assessments of future events and eventual repayments should take into account variations in risk by event and by branch and possibly include low covariation across events and branches.

Although the BAAC provides an excellent presentation of the age of arrears, it does not make the best use of these data, apparently, in the determination of current provisioning rates. What might be rationalized as international best practice is in fact not that at all, but rather conventional norms that may be inappropriate for the BAAC, given the data already available. For example, BAAC loans should be broken down by whether they are rescheduled and provisioned accordingly. Related, nontrivial discrepancies between needed provisions and actual provisions would be associated with necessary adjustments to income later on. However, these are hard to find in the accounts.

In turn, any transfer from the GOT that is intended to compensate the BAAC for these various costs should be identified and broken down into subcategories in the "other income" line item. Currently, the "other income" line in the income statement is aggregated over a variety of potential subsidies, including government funding of special projects, something that is potentially quite inefficient and in any event has nothing to do with the risk-contingency system. More generally, it is sometimes difficult to tell if a farmer has repaid a loan or if the government has done so on the farmer's behalf. Likewise, the branch accounts need to keep track of the timing of transfers from the head office and price them appropriately. With these changes, we could estimate that part of the government subsidy that covers the costs of the risk-contingency system. These results could then be compared with the estimates of welfare benefits coming from the micro data.

As the magnitude of the total subsidy seems nontrivial, we would also recommend ways for the BAAC to increase income and recover costs that are not subsidy reliant. The most obvious of these is to charge borrower clients a fee, which would cover the costs of implicit indemnities. Indeed, even if the government is determined to transfer income to farmers and others in rural areas, the more efficient form of the transfer would be a lump sum, for example, provide a given amount to all villagers, then let households decide whether to borrow, and if they do borrow, let them pay the insurance premium if they wish to do so. Otherwise, they would forfeit the future indemnities listed above. Similarly, the premia would be based on actuarial fair values, using the historical data generated under the new system (or as can be surmised from SES survey data). Costs could also be recovered from higher fees charged to households displaying willful default, and this income should be identified as a separate item. Finally, costs could be reduced by less comprehensive, random checks of claimed adverse events, still allowing client borrowers to make verbal or written claims.

NOTES

[1]Ideally, the benefits would be measured as a function of observed characteristics, for example, wealth, and then compared with the cost financed by indirect or direct taxes, again as a function of observed characteristics. A subsidy is not necessarily redistributive.

[2]The annual average yield on the loan portfolio is 118,500 million baht, the yield obtained on a loan portfolio at 11 percent per annum, so with a Subsidy Dependence Index of 35.4 percent, this equals about 4.6 billion baht. For an explanation of the Subsidy Dependence Index (SDI), see box 1, page 35. All data are from 1995.

[3]We are not apologists for all Asian financial institutions. Indeed, by our more appropriate standards, the commercial banks of Thailand do not do so well. As nearly as one can tell from the limited information provided, the nonperforming loans of commercial banks would seem to be genuinely problematic, nor do micro data provide overwhelming evidence for a beneficial role. The larger point is that our methods of evaluation are objective and yet respect the local variation one might suspect would be contained in a country-specific, indigenous system. Such indigenous systems need to be assessed and that requires the appropriate accounts and the integration of those improved accounts with the theory of risk bearing and measurements from micro data.

[4]The value of the subsidy can be calculated by computing the yield rate of the subsidy against the value in baht of the yield on the loan portfolio—(14.89 percent – 11 percent) × 118,500 million baht = about 4.6 billion baht.

[5]Disclosure of BAAC financial data is somewhat limited and the measure of its subsidy dependence therefore may not be fully precise. However, it is more likely to reflect trends in the BAAC's subsidy dependence over time. Data that are required for more accurate computation of the SDI are monthly balances of the major items of the BAAC's financial statements, to compute more accurately than with annual averages, and the specific financial cost of each financial resource, as information often is available only in the aggregate.

[6]One might question the optimality of checking everyone. In lieu of this, one could check randomly as in the costly state-verification framework. Still, the BAAC does have relatively low administrative costs compared with other SACIs.

[7]The new BAAC system introduced in 2000 requires that nonperforming loans be amortized in five years, so there is an even higher requirement to provision in the first year.

[8]An allocation is said to be *Pareto optimal* if no one can be made better off without making someone else worse off. The first fundamental welfare theorem of economics is that under certain assumptions any competitive equilibrium is Pareto optimal. The second welfare theorem is that any Pareto optimal allocation can be supported as a competitive equilibrium with appropriate taxes and transfers.

[9]The calculation $(100 - 10) \times (1 + x) = 100 \times 1.15$ implies $x = 27.8$ percent.

[10]This can be calculated $90 \times 1.15 = 103.50$.

[11]Again, to realize $115, an interest rate of 27.8 percent is needed as $1.278 \times (100 - 10) = 100 \times 1.15 = 115$.

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The value of using interest rate derivatives to manage risk at U.S. banking organizations

Elijah Brewer III, William E. Jackson III, and James T. Moser

Introduction and summary

Commercial banks help their customers manage the financial risks they face. Of the risks that banks help to manage, one of the most important is interest rate risk. For example, suppose that we obtain a fixed rate mortgage from our bank. From our perspective, we have eliminated most of the interest rate risk associated with this mortgage. In reality the risk is shifted from us to the bank. Now, the bank that approved our fixed rate mortgage loan is subject to losses from changes in interest rates. These changes affect the costs to the bank of providing the mortgage. For example, if market interest rates rise, our mortgage payment to the bank is not affected because we have a "fixed" rate mortgage. However, the cost to the lending bank does increase unless it actively manages its cost. This rise in market interest rates increases the bank's funding costs, that is, the interest rate the bank pays on the money it uses to "fund" our mortgage loan.

Changes in funding costs are considered part of the interest rate risk associated with a fixed rate mortgage loan. Managing this interest rate risk is very important to the bank as it lessens the likelihood of extreme fluctuations in the bank's financial condition and thus decreases the probability of the bank becoming insolvent. Lessening the likelihood of insolvency allows the bank to hold less capital, as capital is the bank's first line of defense against insolvency. However, capital is expensive. Thus, interest rate risk management is valuable because it lessens the amount of expensive capital that a bank must hold.

A typical bank has several methods available to manage interest rate risk. For the purposes of this article, we focus on the use of certain interest rate derivative instruments (for example, interest rate swaps) to offset the inherent interest rate risk in fixed rate lending. An interest rate swap is a financial contract that allows one party to exchange (swap) a set of interest payments (say, fixed rate) for another set of interest payments owned by another party (say, floating rate).

This article examines the major differences in the financial characteristics of banking organizations that use derivatives relative to those that do not. Specifically, we address six research questions.[1] First, do banks that use derivatives also grow their business loan portfolio faster than banks that do not use derivatives? Our results suggest that they do. So, derivative usage appears to foster greater business lending, or financial intermediation.

Second, do banks that use derivatives to manage interest rate risk also have different risk profiles than nonusers? Our results suggest that they do. They tend to hold lower levels of (expensive) capital. This implies that derivative usage (and interest rate risk management in general) allows banks to substitute (inexpensive) risk management for (expensive) capital. Derivative users have higher balance-sheet exposure to interest rate risk. This is reasonable because interest rate derivatives provide them with an opportunity to hedge this balance-sheet exposure. Users tend to have lower insolvency risk, suggesting that derivative activity allows banking organizations to lower their risk or that low risk banking organizations are more likely to use derivatives.

Third, are large banks more likely to use derivatives? Our results strongly suggest that large banking organizations are much more likely than small banking organizations to use derivatives. This is in agreement with the idea that there is a fixed cost associated with initially learning how to use derivatives. Large banks

Elijah Brewer III is an economic adviser and assistant vice president at the Federal Reserve Bank of Chicago. William E. Jackson III is an associate professor of finance and economics at the Kenan-Flagler School of Business of the University of North Carolina at Chapel Hill. James T. Moser is a senior economist and research officer at the Federal Reserve Bank of Chicago.

are more willing to incur this fixed cost because they will more likely use a larger amount of derivatives. Thus, this fixed cost can be spread across more opportunities to actually use derivatives and thereby lower the average usage cost.

Fourth, does derivative usage negatively affect banking organizations' performance? Our results suggest that the performance of users is not better or worse than that of nonusers. Accounting-based measures of performance suggest that returns on assets and book equity are roughly the same for derivative users and nonusers. However, net interest margins are higher for nonusers than for users. A part of this margin could be nonusers' compensation for bearing interest rate risk. Banks charge their loan and deposit customers for providing interest rate intermediation services and assuming the associated interest rate risk. This fee is included in the difference between the loan rate charged and the deposit rate paid.

Fifth, are derivative users more efficient than nonusers? The results here are mixed. In the two smallest groups, users are less efficient than nonusers, while in the large banking organization category, users are not more efficient than nonusers.

Lastly, and perhaps most importantly, we ask whether derivative usage by commercial banks is associated with different sensitivities to stock market and interest rate fluctuations? Interestingly, our results imply that it is.

In the next section of this article we present some background on derivative usage and interest rate risk management by U.S. banking organizations. Next, we present an explanation of how the use of interest rate derivative instruments by banking organizations can complement lending strategies. We summarize some recent research on the relationship between lending and derivative usage of commercial banks. Then, we report some new results on the relationship between lending and derivative usage using a sample of bank holding companies that have both commercial banking and nonbanking subsidiaries. Finally, we examine the risk sensitivity of banking organizations' stock returns.

Measuring and managing interest rate risk

A typical U.S. bank has some floating rate liabilities (such as federal funds borrowings) and some fixed rate liabilities (such as certificates of deposit, or CDs). It will also have some floating rate assets (such as variable rate mortgages and loans and floating rate securities) and some long-term fixed rate assets (such as fixed rate mortgages and securities). Techniques for managing interest rate risk match the economic characteristics of a bank's inflows from assets with its outflows from liabilities. Early on, a bank matched the maturities of its assets and liabilities. More precise matching came later as banks began to look at the duration of assets and liabilities (we will discuss duration later in this section). U.S. commercial banks' need to match assets to liabilities arose from their strategic decisions regarding interest rate exposure. If the going forward changes in revenue from assets perfectly match the changes in expense from liabilities, then a rise or fall in interest rates will have an equal and offsetting effect on both sides of the balance sheet. In principle, perfect matching leaves a bank's earnings or market value unaffected by changes in interest rates. Alternatively, a bank can adjust its portfolio of assets and liabilities to make a profit when rates rise, but take a loss when rates fall. It could also position itself for the opposite. Realizing profits from changes in interest rates does represent a speculation and is risky, perhaps more risky than other profit opportunities.

In the past, banks typically had relatively fewer long-term fixed rate liabilities (such as CDs) than they had long-term fixed rate assets (such as loans). To make up for this shortfall, banks that wished to match assets and liabilities complemented their loan portfolios with fixed rate investments commonly called balancing assets, such as Treasury securities. By adjusting the characteristics of these balancing assets, a bank could better match the revenue inflows from its assets to the expense outflows from its liabilities.

Prior to the 1980s, most banks did not precisely measure their exposure to changes in interest rates. Instead, they generally avoided investing in longer maturity securities, feeling that these investments added undue risk to the liquidity of their investment portfolio. By the early 1980s, it had become clear to most bank management teams that measuring interest rate risk more precisely was a critical task. The second oil shock of the 1970s had increased the level and volatility of interest rates. For example, the prime rate soared to more than 20 percent in early 1980, twice the average for the 1970s and four times as large as the average in the 1960s. In 1980 alone, the prime rate rose to 19.8 percent in April, fell to 11.1 percent in August and rebounded to more than 20 percent in December. To determine their exposure to interest rate movements in this new, more volatile environment, many banks began measuring their *maturity gaps* soon after 1980.

Maturity gap analysis compared the difference in maturity between assets and liabilities, adjusted for their repricing interval. The repricing interval was the amount of time over which the interest rate on an individual contract remained fixed. For example, a three-year loan with a rate reset after year one would have a repricing interval of one year. Banks grouped their assets and liabilities into categories, or "buckets," on the basis of their repricing schedules (for example, typical categories or buckets might be intervals less than three months, three to six months, six to 12 months, and more than 12 months). The maturity gap for each category was the dollar value of assets less the dollar value of liabilities in that category. If the bank made short-term floating-rate loans funded by long-term fixed rate deposits, it would have a large positive maturity gap in the shorter categories and a large negative maturity gap in the longer periods. Banks used these maturity gaps to predict how their net interest margin, or accounting earnings, would be affected by changes in market interest rates. For example, if interest rates dropped sharply, a large positive maturity gap for the short maturity buckets would predict a drop in interest income and therefore earnings, because the bank would immediately receive lower rates on its loans while still paying higher fixed rates on its deposits.

While the dollar maturity gap tool is a useful starting point to measure a bank exposure to interest rate risk, it is crude. Simplicity is its virtue; its drawback is that it focuses only on the impact of interest rate changes on accounting measures of performance rather than on market value measures of performance. It does not consider economic values prior to maturity or repricing dates. Because the precise timing of interest receipts and payments is important to the market valuation of assets and liabilities, bank began to use a concept called *duration* to measure their interest rate risk exposure.

This concept, first introduced by Frederick R. Macaulay in the pricing of the interest rate sensitivity of bonds, considers the timing of all cash flows both before and at the asset's or liability's maturity. Duration is defined as the present-value weighted time to maturity. The formula for duration is

$$D = \frac{\sum_{t=1}^{N} tPV(F_t)}{\sum_{t=1}^{N} PV(F_t)},$$

where D is duration, t is the length of time (number of months or years to the date of payment, $PV(F_t)$ represents the present value of payment (F) made at t, or $F_t/(1+i)^t$, with i representing the appropriate yield to maturity, and $\sum_{t=1}^{N}$ is the summation from the first to the last payment (N).

Duration is an important measure of the average life of a security because it recognizes that not all of the cash flow from a typical security occurs at its maturity. Duration of a stream of positive payments is always less than the time until the last payment or maturity, unless the security is a zero-coupon issue, in which case duration is equal to maturity.[2] Duration also expresses the elasticity of a security's price relative to changes in the interest rate and measures a security's responsiveness to changes in market interest rates.

In the banking literature, a bank's exposure to interest rate risk is measured by the difference between the duration of assets, weighted by dollars of assets, and the duration of liabilities, weighted by dollar of liabilities. The larger this difference, or duration gap, the more sensitive is the bank's shareholder value to changes in interest rates.

If the duration gap is equal to zero, the shareholder value is protected against changes in interest rates. Thus, banks can hedge against uncertain fluctuations in the prices and yields of financial instruments by managing their loans and investments so that the asset duration, weighted by total assets, is equal to the liability duration, weighted by total liabilities. Because of the typical short duration of banks' liabilities and traditional emphasis on liquidity, banks often prefer short-duration to medium-duration assets.

If a bank accepts a liability, say, in the form of a deposit that is apt to be of short duration, it can offset that liability by lending for the same duration. In theory, the value of the asset and liability would be affected the same way by unanticipated changes in interest rates. The bank, presumably, is content to make its profit on the spread between the interest rate it pays on the liability and the rate earned on the asset.

To the extent, however, that banks try to match the durations of assets and liabilities, they can encounter conflicts between desired duration and opportunities for profits. This comes about when asset duration alters the duration of the existing portfolios, when the bank is unable to issue long duration liabilities, or when liquidity issues prevent needed adjustments. For greater flexibility and possibly greater profitability, most banks keep an approximate hedged position. Of course, once banks have obtained a more precise measure of their interest rate risk exposure, they can develop more precise strategies to manage it.

Interest rate risk management using derivatives

Most banks' evolving sophistication in managing interest rate exposure mirrored their sophistication in measuring it. In the early 1980s, most banks managed their exposure to interest rate risk by balancing the assets in their investment portfolio until they felt they had enough fixed rate investments to offset their fixed rate liabilities. By the mid-1980s, many banks shifted to derivative instruments (specifically, interest rate swaps) to help manage their exposure to interest rate risk.

Since the mid-1980s derivative instruments have become an increasingly important part of the product set used by depository institutions to manage their interest rate risk exposure. As interest rates have become more volatile, depository institutions have recognized the importance of derivatives, particularly interest rate futures and interest rate swaps, in reducing risk and achieving acceptable financial performance. Many researchers have documented the effect of interest rate risk on the volatility of earnings and the ensuing adverse impact on the common stock returns of depository institutions (see Flannery and James, 1984; Scott and Peterson, 1986; Kane and Unal, 1988, 1990; and Kwan, 1991). In coping with interest rate risk, depository institutions may alter their business mix and move away from traditional lending activity to nontraditional activities. Deshmukh, Greenbaum, and Kanatas (1983) argue that an increase in interest rate uncertainty encourages depository institutions to reduce lending activities that entail interest rate risk and to increase fee-based activities (for example, selling derivative instruments or providing investment advice and cash management services) that do not entail interest rate risk. Derivative instruments may be useful to depository institutions because such instruments give firms a chance to hedge their exposure to interest rate risk, complementing their lending activities. However, the financial press during 1994 (Jasen and Taylor, 1994, and Stern and Lipin, 1994) widely reported that trading derivatives for profit is risky and may expose firms to large losses.[3]

In theory, the existence of an active derivative market should increase the potential for banking firms to attain their desired levels of interest rate risk exposure. This potential has been widely recognized, and the question that has arisen in consequence is whether banking firms have used derivatives primarily to reduce the risks arising from their other banking activities (for hedging) or to increase their levels of interest rate risk exposure (for speculation). This research examines the role played by interest rate derivatives in determining the interest rate sensitivity of bank holding companies' (BHCs) common stock, controlling for the influence of on-balance-sheet activities and other BHC-specific characteristics.

Because the accessibility of credit depends heavily on banks' role as financial intermediaries, loan growth is a meaningful measure of intermediary activity.[4] We use commercial and industrial (C&I) loan growth as a measure of lending activity because of its importance as a channel for credit flows between the financial and productive sectors of the economy.

Derivative usage may complement lending

Lending is the cornerstone of explanations for the role of banks in the financial services industry (Kashyap, Stein, and Wilcox, 1991; Sharpe and Acharya, 1992; and Bernanke and Lown, 1991). Modern theories of the intermediary role of banks describe how derivative contracting and lending can be complementary activities (Diamond, 1984). Banks intermediate by offering debt contracts to their depositors and accepting debt contracts from borrowers. Their lending specialization enables them to economize the costs of monitoring the credit standings of their borrowers. Depositors facing the alternatives of incurring monitoring costs themselves or supplying funds to banks can benefit from the monitoring specialization by delegating monitoring activities to banks.

Delegation of monitoring duties does result in incentive problems referred to as "delegation costs." Banks can reduce delegation costs through diversification of their assets. However, even after diversifying, banks still face systematic risks. Diamond demonstrates that derivative contracts enable banks to reduce their exposure to systematic risk. The use of derivative contracts to resolve mismatches in the interest rate sensitivities of assets and liabilities reduces delegation costs and, in turn, enables banks to intermediate more effectively. Diamond's (1984) model predicts that interest rate derivative activity will be a complement to lending activity. Subsequently, we would expect a positive relationship between derivative usage and lending.

Derivatives might also be used to replace traditional lending activities. To improve financial performance, a bank might alter its business mix and move away from traditional business lines. Bank revenues from participating in interest rate derivative markets have two possible sources. One source of revenue comes from use of derivatives as speculative vehicles. Gains from speculating on interest rate changes enhance revenues from bank trading desks. A second source of income is generated when banks act as over-the-counter (OTC) dealers and charge fees to institutions placing derivative positions. When either of these activities is used as a replacement for the traditional lending activities of banks, we can expect a negative relationship between derivative usage and lending.

Lending and derivative usage of commercial banks—Early empirical evidence

Brewer, Minton, and Moser (2000) examine the relationship between lending and derivative usage for a sample of Federal Deposit Insurance Corporation insured commercial banks. Figure 1 presents year-end data for derivatives and bank lending activity for the sampled banks used in the Brewer, Minton, and Moser study. Figure 2 graphs data for banks with total assets greater than or equal to $10 billion. Both figures illustrate a decline in lending activity and a contemporaneous rise in derivative activity during the sample period.

For the full sample, the average ratio of C&I loans to total assets declined from about 19.0 percent at the end of 1985 to 14.2 percent at the end of 1992. Most of the decline occurred during the period from year-end 1989 to year-end 1992. As the figures suggest, the largest decline occurred in banks having total assets more than $10 billion.

During the period in which banks were becoming less important in the market for short- and medium-term business credit, they were becoming increasingly active in markets for interest rate derivative instruments as end-users, intermediaries, or both. There are two main categories of interest rate derivative instruments: swaps and positions in futures and forward contracts.

Interest rate futures and forwards markets experienced substantial growth during the sample period. The total face value of open contracts in interest rate futures reached $1.7 trillion for short-term interest rate futures contracts and $54 billion for long-term interest rate contracts by year-end 1991.

In addition to interest rate forwards and futures, banks also use interest rate swaps. Since the introduction of swaps in the early 1980s, activity has increased dramatically. At year-end 1992, the total notional principal amount of U.S. interest rate swaps outstanding was $1.76 trillion, about 225 percent higher than the amount in 1987 (International Swaps and Derivatives Association, ISDA). Of those swaps outstanding, 56 percent had maturities between one and three years. In contrast, only 10 percent had maturities beyond ten years.

Figure 1 presents the notional principal amount outstanding of interest rate derivatives stated as a fraction of total assets from year-end 1985 to year-end 1992. Figure 2 reports the same ratio for banks with total assets greater than or equal to $10 billion.

As evidenced by the growth of the derivative markets, banks increased their participation in the interest rate derivative market over the sample period. This increased use of interest rate derivatives and the concurrent downward trend in lending activity depicted in figures 1 and 2 suggest that derivative use might be substituting for lending activity.

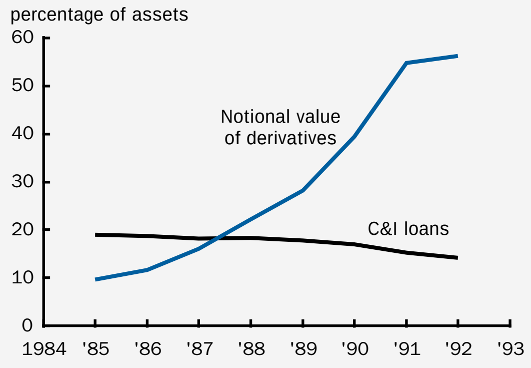
Empirical results

Brewer, Minton, and Moser estimate an equation relating the determinants of C&I lending and the impact of derivatives on C&I lending activity. The base model relates C&I lending to previous quarter capital to total assets ratio, C&I chargeoffs to total assets ratio, and the growth rate in state employment where the bank's headquarters is located. They add to the base model indicator variables for participation in any type of interest rate derivative contract.

In their base model results, C&I loan growth is significantly and positively related to beginning of period capital–asset ratios. This result is consistent with the hypothesis that banks with low capital–asset ratios adjust their loan portfolios in subsequent periods to meet some target capital–asset ratio. There is a significant and negative association between C&I

FIGURE 1

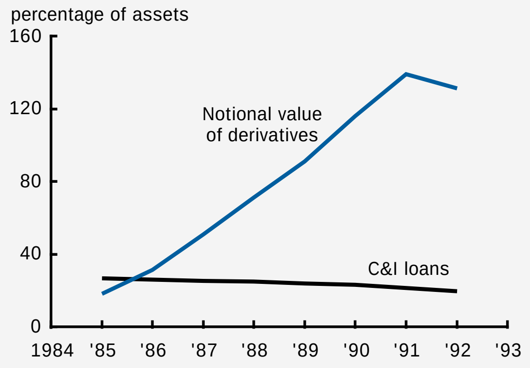
C&I lending and derivative activity
All banks: 1985–92*



*With total assets greater than $300 million as of June 30, 1985.
Source: Brewer, Minton, and Moser (2000).

FIGURE 2

C&I lending and derivative activity
Large banks: 1985–92*



*Large banks are firms with total assets greater than $10 billion.
Source: Brewer, Minton, and Moser (2000).

loan chargeoffs and C&I loan growth. This negative relation is consistent with the chargeoff variable capturing the impact of regulatory pressures, a strong economic environment or both. C&I loan growth is statistically and positively related to the previous period's state employment growth. Banks located in states with stronger economic conditions, on average, experience greater C&I loan growth. Thus, one may interpret the negative coefficient on the chargeoffs variable as capturing market-wide economic conditions (that is, national) not captured by the employment growth variable or the impact of regulatory pressures.

The derivative-augmented regressions indicate that banks using any type of interest rate derivative, on average, experience significantly higher growth in their C&I loan portfolios. This positive relation is consistent with models of financial intermediation in which interest rate derivatives allow commercial banks to lessen their systematic exposures to changes in interest rates and thereby increase their ability to provide more C&I loans. Further, given this positive coefficient estimate one may conclude that the net impact of derivative usage complements the C&I lending activities of banks. That is, the complementarity effect of derivative usage for bank lending dominates any substitution effect.

Some new results using a sample of bank holding companies

Financial characteristics of users and nonusers

We use a sample of BHCs that have publicly traded stock prices on June 30, 1986, the beginning of the first quarter in which BHC consolidated quarterly call reports of assets and liabilities (FR-Y9C) were filed with the Federal Reserve System. The sample begins with 154 BHCs in June 1986 and, because of failures and mergers, ends with 97 in December 1994. Balance-sheet data and information on banks' use of interest rate derivative instruments are obtained from the FR-Y9C reports. The sample of bank holding companies is sorted into three asset groups. There are 57 large BHCs, all of which have significant international banking operations and average total assets of more than $10 billion. The next group is labeled "mid-sized BHCs" and is made up of the 35 banking organizations with average total assets between $5 billion and $10 billion. The last group is referred to as "small BHCs" and consists of the 62 BHCs with average total assets less than $5 billion. At the end of 1986, the sample of BHCs had $1.9 trillion in total assets. Expressed as a percentage of the industry's total assets, sample BHCs constituted about 78 percent. By the end of 1994, the sample BHCs had $2.8 trillion in total assets (or 78 percent of total BHC assets).

For each quarter in the sample period, a BHC is labeled as a derivative user if it reported participation in any interest rate swap or futures-forward products on *Schedule HC-F* of the FR-Y9C report; otherwise it is labeled as a nonuser. Table 1 presents the notional principal amount outstanding and frequency of use of interest rate derivatives by BHCs during the period from year-end 1986 to year-end 1994. Data are reported for the three subsets of BHCs sorted by total asset size. Of BHCs with total assets greater than $10 billion, over 75 percent reported using both interest rate swaps and interest rate futures and forwards throughout the sample period. Swap dealers are included in this group of banking organizations. These dealers often use interest rate futures-forward contracts to manage the net or residual interest rate risk of their overall swap portfolios (Brewer, Minton, and Moser, 2000). Table 1 also shows that BHCs with total assets greater than $10 billion report the highest average ratio of the notional amount of interest rate swaps outstanding to total assets. However, the double counting referred to previously implies that these numbers overstate the actual positions held by these banking organizations. Since dealer institutions are more likely to have offsetting swap transactions, reported notional amounts generally overstate actual market exposures.

With the exception of 1987, over 50 percent of BHCs with total assets between $5 billion and $10 billion reported using both interest rate swaps and interest rate futures and forwards. On the other hand, less than 20 percent of BHCs with total assets less than $5 billion reported using both types of financial instruments. At the end of 1986, 30.6 percent of small BHCs reported using interest rate swaps and the same percentage reported using futures-forwards. By the end of 1994, these percentages were 48.5 percent and 24.2 percent, respectively.

Table 2 provides financial characteristics for derivative users and nonusers by asset categories. We use this information to highlight some of the differences between users and nonusers. Across all size categories derivative users tend to be on average larger than nonusers. For example, the average size of a representative nonuser in the small BHC category is $2.1 billion, while that of a user is $3.2 billion. The difference of $1.1 billion is statistically significant (at the 1 percent level). The average sizes of a representative nonuser and user in the mid-sized category are $6.1 billion and $7.3 billion, respectively. Nonusers in the large BHC category are less than one-third as large as users. Thus, relatively larger BHCs tend to make greater use of interest rate derivatives than smaller institutions.

TABLE 1

Interest rate derivative activities for BHCs, year-end 1986–94

	1986	1987	1988	1989	1990	1991	1992	1993	1994
Bank holding companies with total assets < $5 billion									
Users of swaps (%)	30.64	27.12	34.54	30.91	31.37	31.91	35.71	44.44	48.48
Avg. ratio to total assets[a]	0.0299	0.0313	0.0284	0.0505	0.0514	0.0351	0.0346	0.0520	0.0514
Users of futures/forwards (%)	30.64	28.81	27.27	30.91	29.41	25.53	26.19	27.78	24.24
Avg. ratio to total assets[b]	0.0307	0.0221	0.0148	0.0218	0.0215	0.0362	0.0216	0.0230	0.0133
Users of both swaps and futures/forwards (%)	16.13	13.56	16.36	16.36	13.72	14.89	14.29	16.67	18.18
No. of observations	62	59	55	55	51	47	42	36	33
Bank holding companies with total assets > $5 billion but < $10 billion									
Users of swaps (%)	71.43	73.53	78.79	74.19	79.31	81.48	80.00	79.17	91.67
Avg. ratio to total assets[a]	0.0187	0.0236	0.0234	0.0228	0.0248	0.0282	0.0426	0.0811	0.0773
Users of futures/forwards (%)	60.00	55.88	57.58	64.52	62.07	59.26	64.00	66.67	62.50
Avg. ratio to total assets[b]	0.0247	0.0177	0.0290	0.0324	0.0303	0.0877	0.0367	0.0624	0.0709
Users of both swaps and futures/forwards (%)	51.43	47.06	51.51	51.61	51.72	51.85	56.00	58.33	62.50
No. of observations	35	34	33	31	29	27	25	24	24
Bank holding companies with total assets > $10 billion									
Users of swaps (%)	85.96	88.89	92.00	98.00	95.92	95.65	95.45	100.00	100.00
Avg. ratio to total assets[a]	0.1223	0.2118	0.2820	0.3836	0.4379	0.4929	0.5459	0.6434	0.8005
Users of futures/forwards (%)	91.23	85.18	90.00	86.00	79.59	82.61	86.36	90.48	82.50
Avg. ratio to total assets[b]	0.0634	0.0770	0.1376	0.1746	0.3768	0.3868	0.4825	0.5709	0.6986
Users of both swaps and futures/forwards (%)	80.70	77.78	86.00	86.00	79.59	82.61	86.36	90.48	82.50
No. of observations	57	54	50	50	49	46	44	42	40

[a]Average ratio to total assets equals the ratio of the notional principal amount of outstanding swaps to total assets for bank holding companies reporting the use of swaps.
[b]Average ratio to total assets equals the ratio of the principal amount of outstanding futures to total assets for bank holding companies reporting the use of futures or forwards.
Source: Authors' calculations using Federal Reserve FRY-9C data.

An important reason why managing interest rate risk through derivatives may be preferable to balance-sheet adjustments using securities and loans is that the former lessens the need to hold expensive capital. Capital protects the liability holders and institutions that guarantee those liabilities. Federal deposit insurers are especially important guarantors of bank liabilities. In addition, capital imposes discipline by putting owners' funds at risk. Regulators set minimum capital requirements.[5] Most BHCs chose their actual capital levels to satisfy the capital guidelines plus a buffer of excess capital. Capital buffers reduce the chance that a banking firm will be forced to raise additional capital due to weak earnings performance. If a derivative position that allows banking firms to hedge against unanticipated changes in interest rates can negatively affect earnings, then users could hold less capital relative to assets than nonusers. This is because the gains or losses on the balance-sheet position as a result of unanticipated changes in interest rates are offset by losses or gains on the derivative position. For all size categories of BHCs, the average book capital ratios are higher for nonusers than for users. Nonusers' capital ratios are 39 basis points, 100 basis points, and 34 basis points higher than those of users for small-, mid-, and large-size BHCs, respectively. These differences are significant at conventional statistical levels. More importantly for banking institutions, they imply substantial reductions in cost.

When users are sorted into capital categories using the leverage ratio of 5.5 percent of total assets as the regulatory minimum, an interesting pattern emerges.[6] About 51 percent of the observations for small BHC users are less than 200 basis points above the 5.5 percent guideline. For small nonusers, about 45 percent of the observations are less than 200 basis points above the guidelines. On the other hand, approximately 31 percent and 40 percent of the users' and nonusers' observations, respectively, show capital ratios more than 200 basis points above the 5.5 percent guideline. A similar pattern is observed for mid-sized banks. The percentages of the observations with capital ratios no more than 200 basis points above the guidelines are 68 percent and 20 percent for mid-sized BHC users and nonusers, respectively. The percentages of the observations with capital ratios greater than 200 basis points above the guidelines are 23 percent and 71 percent for users and nonusers, respectively. Because over 95 percent of large BHC observations are for derivative users, we were not able to meaningfully sort them into different capital categories. Nevertheless, the results for the two smaller banking categories suggest that derivative usage affords banking organizations the opportunity to operate with less excess capital than they otherwise would need.

Because derivative usage allows BHCs to cope with interest rate risk, BHCs may decide to hold more loans to earn more income from their lending activity. This activity involves services in which the banking subsidiaries of BHCs have a comparative information advantage. For example, banking subsidiaries are often perceived as having a comparative advantage over other intermediaries in the loan market because they have special access to timely information about their loan customers since they clear customers' transactions. Deposit accounts provide early warning of deterioration in borrowers' cash flows. By monitoring the total amount of checks clearing through the bank, the banker can gauge a client's sales relatively accurately without waiting for quarterly reports from accountants. If derivative usage allows banks to reduce interest rate exposure and expand their lending activity, which entails default risk, then users should have higher loan to asset ratios. Table 2 shows that nonusers have higher loan to asset ratios than users. For instance, the average small nonuser had 61 cents of each dollar of assets invested in loans, while the average small user had 59 cents of each dollar of assets in loans. A similar pattern is evident at the other two groups of BHCs. The difference is significant at all BHCs. One factor acting to raise the loan to asset ratios of nonusers relative to users is the higher capital ratio at the former institutions.

If, as is often perceived, loans are illiquid and subject to the greatest default risk of all bank assets, then nonusers are more exposed to loan losses than users. Because the ratio of loans to total assets measures the corrosive effect of potential loan losses on assets and equity, a high ratio could have a negative effect on the level of earnings and the volatility of earnings. The ability to use derivative instruments to reduce the volatility of earnings is another justification for their use by BHCs. A BHC that has a high volatility of earnings tends to have low debt capacity and high probability of failure. High earnings volatility increases the chances that earnings will fall below the level needed to service the BHC's debt, raising the probability of bankruptcy. Derivative usage can lower earnings variability. A reduction in earnings variability should improve debt capacity and reduce the probability of bankruptcy. The volatility of equity returns is frequently used to proxy for earnings volatility. Higher volatility of equity implies greater risk, and lower volatility of equity implies less risk. With the exception of the large BHC category, table 2 shows that volatility of equity is higher for nonusers than for users. However, this difference is statistically significant only for small BHCs. Consistent with the higher loan to asset ratio, the higher volatility of equity suggests, at least for small BHCs, that nonusers tend to be on average riskier than users. But the higher capital ratios at nonusers tend to mitigate the effects of these factors.

To capture the probability of bankruptcy more directly and the possibility that losses (negative earnings) will exceed equity, we employ an insolvency index used in the banking literature (see Brewer, 1989). See box 1 for a discussion of this measure of risk. Table 2 indicates that only small BHCs realize a significant difference in the insolvency index between nonusers and users. Nonusers have an insolvency index, the Z-score, of 51.3, compared with 57.9 for users. It seems, then, that small users tend, ex ante, to pose less risk than small nonusers to investors and insurers. The insolvency index is roughly the same for both nonusers and users in the mid-sized BHC category. While large nonusers have a lower probability of insolvency than large users, the difference is not significant.

A banking organization's risk profile is also reflected in its interest rate risk exposure as measured

TABLE 2

Univariate tests of financial characteristics and derivative usage, 1986–94

	Small BHCs			Mid-sized BHCs			Large BHCs		
	Nonusers	Users	T-ratio	Nonusers	Users	T-ratio	Nonusers	Users	T-ratio
Size									
Total assets ($ billions)	2.09	3.23	–17.04	6.14	7.27	–6.02	12.98	39.92	–15.03
			(0.0001)			(0.0001)			(0.0001)
Capitalization									
Book capital/total assets	0.0721	0.0682	3.76	0.0779	0.0679	3.72	0.0664	0.0630	2.10
			(0.0002)			(0.003)			(0.0400)
Capital category (percent)									
Less than or equal to 5.5%	15	17	—	9	9	—	—	—	—
Between 5.5 and 7.5%	45	51	—	20	68	—	—	—	—
Greater than 7.5%	40	31	—	71	23	—	—	—	—
Market capital/total assets	0.0908	0.0939	–1.40	0.1257	0.0881	6.89	0.0708	0.0767	–1.99
			(0.1624)			(0.0001)			(0.0511)
Risk									
Loans/ total assets	0.6062	0.5878	3.55	0.6545	0.6330	3.62	0.6400	0.6200	2.87
			(0.0004)			(0.0004)			(0.0052)
Loan loss allowance/ gross loans	0.0193	0.0199	–1.03	0.0176	0.0191	–1.27	0.0157	0.0265	-6.88
			(0.3020)			(0.2056)			(0.0001)
Dollar maturity gap/ total assets	0.0638	0.0876	–2.28	0.0942	0.0601	2.34	–0.0207	0.0542	–5.64
			(0.0226)			(0.0210)			(0.0001)
Standard deviation of daily stock returns	0.0253	0.0229	2.62	0.0188	0.0167	1.23	0.0166	0.0181	–0.90
			(0.0088)			(0.2216)			(0.3711)
Z-score	51.3814	57.9317	–5.52	71.6853	70.7329	0.42	73.2001	66.5701	1.96
			(0.0001)			(0.6762)			(0.0547)
Profitability									
Return on assets	0.0042	0.0039	0.64	0.0045	0.0048	–0.31	0.0045	0.0044	0.09
			(0.5217)			(0.7572)			(0.9293)
Return on equity	0.0442	0.0645	–0.88	0.0603	0.0639	–0.09	0.1329	0.0614	1.25
			(0.3793)			(0.9291)			(0.2161)
(Gross interest income – gross interest expense)/total assets	0.0245	0.0234	2.20	0.0237	0.0230	0.74	0.0240	0.0214	1.81
			(0.0279)			(0.4628)			(0.0750)
(Noninterest income – noninterest expense)/total assets	–0.0157	–0.0142	–3.85	–0.0125	–0.0128	0.51	–0.0149	–0.0109	–4.30
			(0.0001)			(0.6110)			(0.0001)
Efficiency ratio	0.3964	0.4067	–2.19	0.3741	0.3668	0.87	0.3723	0.3680	0.75
			(0.0289)			(0.3859)			(0.4562)

Notes: Sample period is June 30, 1986–December 31, 1994. Subsample classification is by average assets during the full sample period. Small institutions are those with assets averaging less than $5 billion. Mid-sized are those with average assets between $5 billion and $10 billion. Large are those with assets averaging over $10 billion. The t-ratio tests the difference in the values of derivative users and nonusers. The number in parentheses under the t-ratio is the level of statistical significance. For example, for small BHCs, the value of difference in the total assets row is –17.04 and the number in parentheses indicates that this is significantly different from zero at a level of better than 1 percent.

Source: Authors' calculations using Federal Reserve FRY-9C data.

by the duration gap. The presumption is that the higher the duration gap, the more the banking organization is exposed to unanticipated interest rate changes. Data limitations require most researchers to measure a bank's interest rate risk exposure with the so-called dollar maturity gap measure—the difference between the dollar value of short-term on-balance-sheet assets and liabilities (where short-term is typically defined as maturities less than a year). The dollar maturity gap position is taken as a percentage of total assets to express the degree of interest rate sensitivity relative to the banking organization's total size. This dollar gap position as reported does not include the impact of derivative activity on a banking organization's interest rate risk exposure. Thus, banking firms that are derivative users should have a larger dollar maturity gap than nonusers. The results in table 2 support this prediction. Notice that the dollar maturity gap as percent of total assets presented in table 2 for small BHCs is higher for users (0.0876) than for nonusers (0.0638).

The dollar maturity gap results in table 2 suggest that a 100 basis points decrease in interest rates will cause net interest margin to fall by 0.0638 percentage points for small BHC nonusers. The same interest rate change would cause net interest margin to fall by 0.0876 percentage points for small BHC users, but this may be partly or completely offset by their derivative position. Thus, when derivatives are present, their use tends to increase the amount of on-balance-sheet interest rate risk exposure an average small bank holding company is willing to accept. A similar pattern is observed for large BHCs. The gap position is larger, in absolute value, for large users than for large nonusers. For mid-size users, the dollar gap position is smaller than for mid-size nonusers.

Does derivative usage allow banking organizations to earn higher accounting profits?

We use two profitability measures to answer this question: return on book value of assets and return on book value of capital. Return on book value of assets (ROA) is an indicator of managerial efficiency. It is calculated in this study as the ratio of net income divided by total assets. ROA indicates the extent of success realized by bank management in converting the assets of the bank into net earnings. Return on book value of equity (ROE) is a measure of the rate of return flowing to the institution's shareholders. We calculate ROE as net income divided by the total book value of bank equity. ROE approximates the rate of return the stockholders have received for investing their capital (that is, placing their funds at risk in the hope of earning suitable profits). Table 2 shows that for the smallest and largest asset size categories derivative users have lower ROA than nonusers, while for the mid-size group of BHCs derivative users have a higher ROA than nonusers. However, these differences are not statistically significant. Similarly, the difference in ROE between derivative users and nonusers is not significant. Thus, derivative users, on average, do not appear to earn higher (or lower) accounting profits than nonusers.

On the other hand, net interest margin as measured by the difference between gross interest income and gross interest expense divided by total assets is smaller for users. Net interest margin is a comprehensive measure of management's ability to control the spread between interest revenues and interest costs.[7] With the exception of mid-sized BHCs, nonusers appear to be able to control the spread better than users.

BOX 1

Insolvency index

The insolvency index is a comprehensive measure of risk that includes three pieces of information (capital ratio, returns, and variability of returns) into a single number and captures the probability of failure (see Brewer, 1989). That is,

Probability of failure = *Probability* (*Earnings* < –*Equity*).

Dividing both terms of the inequality in the parentheses by equity, the probability of failure can be expressed as being equal to the probability that the rate of return on equity, $r_E = (Earnings/Equity)$, is less than negative one:

1) *Probability* $(r_E < -1)$.

Assuming that the return on equity is distributed as a normal random variable, and standardizing the terms in equation 1, the probability of failure is equal to

Probability $[(r_E - \bar{r}_E)/\sigma_E < z]$,

where $\bar{r}_E$ is the expected rate of return on equity, equals $[(-1 - \bar{r}_E)/\sigma_E]$, and σ_E is the standard deviation (volatility) of equity returns. The variable z is the standard normal variate, representing how far, in standard deviations, the rate of return would have to fall below its expected value for the bank to fail. To be consistent with the banking literature, we will use the negative of z and denote it as an insolvency index. Thus, a higher value of this index indicates a lower probability of failure.

In the small BHC category, for every dollar of assets, derivative nonusers are able to generate a return of about 2.45 percent, compared with 2.34 percent for derivative users. The difference is greater between large users and large nonusers. For nonusers, every dollar of assets is able to generate a return of about 2.4 percent, while for users it is able to generate a return of about 2.14 percent. In the mid-sized BHC category, every dollar of assets generates about a 2.30 percent return for users and a 2.37 percent return for nonusers.

Banking organizations also earn noninterest income from deposit service charges, other service fees, and off-balance-sheet activities; and incur noninterest costs in the form of salaries and wages expense and repair and maintenance costs on bank equipment and facilities. Net noninterest rate margin as measured by the difference between noninterest revenue and noninterest expense divided by total assets captures the banking organization's ability to generate noninterest revenue to cover noninterest expenses. For most banking organizations net noninterest margin is negative, with noninterest costs generally outstripping fee income. The less negative this profitability measure is, the better the banking organization is at generating noninterest income to cover noninterest expenses. Table 2 shows that, with the exception of mid-sized BHCs, derivative users have a less negative net noninterest margin than nonusers. In the small BHC category, for every dollar of assets, derivative users incurred a net cost of about 1.42 percent, compared with 1.57 percent for derivative nonusers. In the large BHC category, derivative users incurred a net cost of 1.1 percent for every dollar of assets, compared with 1.49 percent for nonusers. However, in the mid-size BHC category, the difference was not significant at conventional levels. These results suggest that, with the exception of mid-size BHCs, derivative users have better control over noninterest expenses relative to noninterest income than nonusers. This could reflect lower noninterest expense and/or higher noninterest income.

Are derivative users more efficient than nonusers?

One way to measure efficiency is to compare noninterest expenses to total operating income (the sum of interest and noninterest income). The lower is this ratio, the greater the efficiency. The results in table 2 suggest that in the smallest category derivative users are less efficient than nonusers. For example, in the small BHC category derivative users spend about 41 cents per dollar of operating income on personnel, occupancy, and equipment expenses, while nonusers spend 40 cents. Thus, the 15 basis points difference in net noninterest income between small users and small nonusers is primarily caused by higher noninterest income at users. Mid-size users spend about the same amount of their operating income on noninterest expenses (37 cents) as nonusers. The same 37 cents per dollar of operating income was spent on noninterest expense by both users and nonusers at large BHCs. Thus, users in the small BHC category tend to be less efficient than nonusers, while those in the mid- and large-size BHC categories appear to be as efficient as nonusers.

Lending and derivative usage of BHCs

The study by Brewer, Minton, and Moser (2000) shows that banks using interest rate derivatives experienced greater growth in their C&I loan portfolio than banks that did not use these financial instruments. Here, we reexamine the notion that firms' use of interest rate derivatives allows them to continue to provide credit by applying the Brewer, Minton, and Moser (2000) methodology to a sample of BHCs over the period from the fourth quarter of 1986 to the fourth quarter of 1994.

As in Brewer, Minton, and Moser (2000), the association between BHCs' lending and their use of derivatives can be measured by examining the relationship between the growth in BHC business loans and their involvement in interest rate derivative markets. The base model relates C&I lending to previous quarter capital to total assets ratio and C&I chargeoffs to total assets ratio.[8] We next add to the base model indicator variables for participation in any type of interest rate derivative contract. Table 3 reports the results of these pooled cross-sectional time series regressions. The results show that the previous quarter ratio of capital to total assets is positively related to growth in BHC business lending. The chargeoff rate is negatively related to lending, and the relationship is statistically significant at the standard levels. When the indicator variable for interest rate derivative usage is added to the base model, the results show a significant positive relationship between lending and derivative activity. The base model was also estimated using two alternative indicator variables of derivative usage: interest rate swap and futures contracts. Both of these indicator variables are positively correlated with lending. Overall, these results are consistent with those in Brewer, Minton, and Moser (2000), suggesting that derivative usage complements business lending. These empirical results show that banking organizations that employ interest rate derivative instruments tend to increase their business loan portfolio at a faster rate than other banking organizations. These results are consistent with the derivative users employing interest rate derivative instruments to hedge their exposure to interest rate risk as a result of their financial intermediation activity. The additional lending resulting from this activity expands banking organizations' level of financial intermediation in that area where some researchers claim banks can generate returns above the competitive rate. But this lending could raise a bank's exposure to another type of risk—credit risk. Thus, while a bank may decrease its exposure to interest rate risk through the use of interest rate derivatives, the rise in lending as a result of derivative usage may increase its exposure to credit risk. The net effect of these changes on banks' overall risk and on the return a bank must earn to compensate stockholders for bearing this risk can only be determined empirically by examining stock market returns.

Risk sensitivity of BHC stock returns

Finance theory suggests that bank risk sensitivity can be measured by analyzing stock market returns. Financial economists typically consider the total variance of historical stock returns (or its standard deviation) as an appropriate measure of the overall volatility associated with the asset risk of a firm. This measure of risk can be separated into 1) the risk associated with movements in the overall stock market and interest rates, and 2) risk associated with the specific operations of the firm. Bank equity values are sensitive to all the factors that affect the overall stock market as well as to factors specific to the banking industry. For example, banks are sensitive to "earning risk" through possible defaults on their loans and investments, changes in loan demand, and potential variability in growth and profitability of their nonloan portfolio operations. Bank equity values are also sensitive to movement in interest rates because, as we have noted above, banks typically fail to match the interest rate sensitivity of their assets and liabilities. As a result, changes in interest rates affect the market value of both sides of the bank's balance sheet and its net worth (or capital) and stock values.

We use a widely accepted two-index market model to characterize the return generating process for bank common stocks.[9] This model is an extension of the common single-index market model in which capital market risk sensitivity can be represented by the equity "beta," or the measured sensitivity of the firm's equity return with respect to the return on the market-wide

TABLE 3

Univariate multiple regression coefficient estimates for the determinants of quarterly changes in C&I loans

Independent variables	Basic model, including bank-specific determinants of lending and a local economic condition factor	Basic model, adding the derivative indicator variable	Basic model, adding separate derivative indicator variables
Previous quarter ratio of capital to total assets	0.2088 (0.0000)	0.2073 (0.0000)	0.2116 (0.0000)
Previous quarter ratio of commercial and industrial chargeoffs to total assets	–1.9264 (0.0000)	–1.9853 (0.0000)	–2.0104 (0.0000)
Indicator variable for derivative usage		0.0035 (0.0000)	
Indicator variable for interest rate swap usage			0.0023 (0.0001)
Indicator variable for interest rate futures usage			0.0019 (0.0001)
Adj. R^2	0.0913	0.0936	0.0951
Observations	4,130	4,130	4,130

Notes: The dependent variable is the quarterly change in C&I loans relative to last period's total assets. The estimates are measured relative to last period's total assets. All regression equations contain time period indicator variables. Sample period is 1986:Q4 to 1994:Q4. The numbers in parentheses below the regression coefficients are the significance levels. For example, a value of 0.001 would indicate a statistical significance at the 1 percent level.
Source: Authors' calculations using Federal Reserve FRY-9C data.

portfolio of risky assets. We examine one other determinant of bank stock returns: unanticipated changes in interest rates.

Our two-index market model takes the following form

1) $RET_{j,t} = \beta_0 + \beta_1 RMKT_t + \beta_2 RTBOND_t + \varepsilon_{j,t}$,

where $RET_{j,t}$ is the rate of return on equity; $RMKT_t$ is the rate of return on a stock market index; $RTBOND_t$ is a measure of the unanticipated change in interest rates; and $\varepsilon_{j,t}$ is a stochastic error term.

The value of β_1 measures the riskiness of a BHC stock relative to the market as a whole; and β_2 measures the effect of changes in interest rates on the stock returns of the *j*th firm given its relation to the market index.

Equation 1 was estimated over the period January 1986 through December 1994 using daily stock returns data (adjusted for dividends and stock splits) for our sample of 154 BHCs. There are 2,250 daily stock return observations over this period. Based on the asset sizes used in the previous section, we formed three groups: large, mid-size, and small banking organizations. As mentioned earlier, there are 57 large BHCs (average total assets of more than $10 billion), 35 mid-size BHCs (average total assets between $5 and $10 billion), and 62 small BHCs (average total assets less than $5 billion). Within each group, we formed portfolios based on derivative usage. Because there are only a few derivative nonusers in the large BHC group, we formed one portfolio for this asset group. Thus, we formed five equally weighted portfolios. The sample period was divided into two subperiods: January 1986 to December 1990 and January 1991 to December 1994. There are 1,249 daily stock return observations in the first subperiod and 1,001 in the second subperiod. We select these two subperiods in recognition that over a representative business cycle there may be a shift in the relationship between BHC stock returns and our two-index market model.

The relationship between stock returns and the return on the market portfolio and return on a short-term Treasury security is estimated for each of the five portfolios over the two subperiods. The return on the market portfolio is measured by the return on a value-weighted portfolio of the firms on the New York Stock Exchange and American Stock Exchange obtained from the Center for Research in Security Prices (CRSP) database. The return on the short-term Treasury security is computed by taking the percentage change in the yield on a one-year security instrument.

The results of estimating the relationship between stock returns and the return on the market portfolio and the return on the one-year Treasury security are shown in table 4 for the entire sample period and in table 5 for each of the two subperiods. Tables 4 and 5 also show the total risk (standard deviation of stock returns) and the portfolio-specific risk for each of the five portfolios.

Entire period: January 1986 – December 1994

For small BHCs, the results indicate that the market risk of both the average derivative user and nonuser was about 0.44. This suggests that, over the nine years of the sample interval, changes in the stock market as a whole were associated with less than one-for-one changes in the average small BHC stocks. The interest rate risk coefficient is negative for both derivative users and nonusers, suggesting that a rise in holding period return on one-year Treasury securities will lead to lower stock returns. For example, a 100 basis point rise in the holding period return on one-year Treasuries will lead to an 83 basis point (0.8353 × 100) decline in the stock return of the average small derivative nonuser. The number in the difference row (0.2201) suggests this change in holding period return will have roughly the same impact on both derivative users and nonusers.

The two groups of mid-size BHCs all exhibited generally higher values for market risk than small-size BHCs. A 100 basis point increase in stock market returns leads to an approximately 57 basis point increase in the stock return on the average mid-size BHC, while the same change in market returns leads to a 44 basis point increase in the stock return of the average small BHC. Thus, the stocks of the mid-sized BHCs are more sensitive to stock-market-related risk than those of smaller banking organizations. Like the results for small BHCs, the interest rate risk coefficient is negative for both derivative users and nonusers. However, the coefficient is only statistically significant for derivative users.

For large BHCs, the market risk coefficient is higher than that for smaller BHCs, and it is close to one. A value of this coefficient that is close to one for large BHCs is reasonable because they are expected to hold diversified portfolios of loans and other assets whose returns should mimic the behavior of the broader market. As in the other cases, the interest rate risk coefficient is negative, but it is not statistically significant.

While the estimates in table 4 contain important information about BHC equity risks during the nine–year period ending in 1994, they also conceal substantial time-series variation in BHC stocks' responses to stock market and interest rate risks. There may be several reasons for time-variations in BHC risk sensitivity. For example, an important source of BHC stock return variability over time is related to earnings variability due to the business risk of a banking organization represented by the demand and supply shifts for its services and inputs, specifically loans, deposits, and transactions services. BHC stock returns are related to future cash flows from changing levels of bank activities, such as lending. The present value of the loan business may change, in part, with expected changes in economic activity. Business expansions increase the quantities of bank loans, securities, and deposits. These factors are thought to have a positive impact on the expected earnings stream and, as a result, BHC stock returns. Conversely, business recessions may affect the performance of the existing loan portfolio and decrease the quantities of bank loans, securities, and deposits. This would tend to have a negative implication for BHC stock returns.

Alternatively, monetary policy is likely to shift over the business cycle. As the Federal Reserve System shifts, for example, from tight to easy monetary policy during the business cycle, this may lead to a shift in the relationship between BHC stock returns and the market index. To capture the time-variation in market and interest rate risk sensitivities, we estimate the two-factor market model over two subperiods: January 1986 to December 1990 and January 1991 to December 1994. Over the first subperiod, the average volatility of one-year Treasury security return was more than 25 percent of the average volatility over the second subperiod. This difference is statistically significant at the 5 percent level. The lower volatility in the second subperiod may have shifted the relationship between BHCs stock returns and interest rates.

Subperiod: January 1986 – December 1990

For small BHCs, the standard deviation of stock returns is greater for users (0.0085) than for nonusers (0.0075). The equity values of derivative users are equally exposed to market risk as those of nonusers. For derivative users, the regression results indicate that for every 1 percent change in the return on the market portfolio, bank returns will change 0.40 percent. Although derivative users are equally sensitive to market risk, their equity values are significantly less exposed to interest rate risk. The coefficient for the interest rate factor is significantly negative for both derivative users and nonusers.

A negative coefficient on the interest rate variable indicates that higher than anticipated interest rates will cause bank holding company equity values to decline. This implies that over the estimation period, the BHCs in our sample held on average more interest rate

TABLE 4

Risk sensitivity of bank holding company stock returns, January 1986–December 1994

Derivative participation	Total risk (standard deviation of stock returns)	Market risk	Interest rate risk	Unsystematic risk
		Small BHCs (62)		
Users (33)	0.0078	0.4253	–0.5008	0.0068
Nonusers (29)	0.0078	0.4379	–0.8353	0.0068
Difference		0.4931	0.2201	
		Mid-size BHCs (35)		
Users (30)	0.0082	0.5899	–0.9425	0.0062
Nonusers (5)	0.0120	0.5661	–0.6041	0.0108
Difference		0.3346	0.3507	
		Large BHCs (57)		
All	0.0109	0.9278	–0.0144	0.0070

Notes: Subsample classification is by average assets during the full sample period. Small institutions are those with assets averaging less than $5 billion. Mid-size are those with average assets between $5 billion and $10 billion. Large are those with assets averaging over $10 billion. Difference in the table is the level of statistical significance of the difference in the values of derivative users and nonusers. For example, for small BHCs, the value of difference in the interest rate risk column is 0.02201, indicating that the market risk sensitivity of derivative users is significantly different from that of nonusers at the 22.01 percent level.
Source: Authors' calculations using daily data from the Center for Research in Security Prices database.

TABLE 5

Risk sensitivity of BHC stock returns, two subperiods

Derivative participation	Total risk (standard deviation of stock returns)	Market risk	Interest rate risk	Unsystematic risk
Sample Period: January 1986–December 1990				
		Small BHCs (62)		
Users (33)	0.0085	0.4036	–0.9274	0.0073
Nonusers (29)	0.0075	0.3841	–1.5013	0.0063
Difference		0.3675	0.0946	
		Mid-size BHCs (35)		
Users (30)	0.0084	0.5477	–1.5872	0.0060
Nonusers (5)	0.0136	0.5443	–1.3502	0.0123
Difference		0.6325	0.9147	
		Large BHCs (57)		
All	0.0111	0.8553	–0.4666	0.0062
Sample Period: January 1991–December 1994				
		Small BHCs (62)		
Users (33)	0.0069	0.5044	0.3277	0.0061
Nonusers (29)	0.0081	0.6375	0.3577	0.0072
Difference		0.0005	0.9477	
		Mid-size BHCs (35)		
Users (30)	0.0078	0.7459	0.2504	0.0062
Nonusers (5)	0.0094	0.6446	0.8978	0.0084
Difference		0.0206	0.2164	
		Large BHCs (57)		
All	0.0106	1.1987	0.6424	0.0075

Notes: Subsample classification is by average assets during the full sample period. Small institutions are those with assets averaging less than $5 billion. Mid-size are those with average assets between $5 billion and $10 billion. Large are those with assets averaging over $10 billion. Difference in the table is the level of statistical significance of the difference in the values of derivative users and nonusers. For example, for small BHCs covering the January 1986 to December 1990 subperiod, the value of difference in the interest rate risk column is 0.0946, indicating that the interest rate risk sensitivity of derivative users is significantly different from that of nonusers at the 9.46 percent level.

Source: Authors' calculations using daily data from the Center for Research in Security Prices database.

sensitive assets than interest rate sensitive liabilities. This follows from four facts. First, declining interest rates raise holding period returns on bonds. Second, the returns on interest rate sensitive assets and the cost of interest rate sensitive liabilities decrease when market interest rates decrease. Third, a BHC's net interest income decreases when gross revenues from its assets decline by a larger amount than interest expenses on its liabilities. And, fourth, this change in net interest income is priced in BHC equity values. However, small derivative nonusers have a larger negative coefficient than users, suggesting that nonusers have significantly more exposure to interest rate risk.

For mid-size BHCs, the standard deviation of stock returns is less for users (0.0084) than for nonusers (0.0136). However, there is little, if any difference in the market and interest rate sensitivities of users' and nonusers' stock returns. Thus, there is little difference in the sensitivity of both types of BHCs to economy-wide movements in both market returns and interest rates.

Subperiod: January 1991 – December 1994

For small BHCs, the standard deviation of stock returns is less for users (0.0069) than for nonusers (0.0081). However, the equity values of derivative users are relatively less exposed to market risk than those of nonusers. For derivative users, the regression results indicate that for every 1 percent change in the return on the market portfolio, derivative-users' stock returns will change 0.50 percent, while nonusers returns' will change 0.64 percent. Thus, nonusers are more exposed to economy-wide movements than users. There is little statistical difference in the interest rate sensitivity of derivative users and nonusers.

For mid-size BHCs, similar to the results covering the January 1986 to December 1990 subperiod, the standard deviation of stock returns is less for derivative users (0.0078) than for nonusers (0.0094). Unlike the earlier subperiod, the market risk sensitivity of derivative users is more significant than that for nonusers.

Conclusion

In this article, we examine the major differences in the financial characteristics of banks that use derivatives relative to those that do not. We find that banking organizations that use derivatives also increase their business lending faster than banks that do not use derivatives. So, derivative usage appears to foster relatively more loan making, or financial intermediation.

We also find that banking organizations that use derivatives to manage interest rate risk hold lower levels of (expensive) capital than other institutions. This implies that derivative usage (and interest rate risk management in general) allows banks to substitute (inexpensive) risk management for (expensive) capital.

Our results strongly suggest that large banks are much more likely than small banks to use derivatives. This is in agreement with the idea that there is a fixed cost associated with initially learning how to use derivatives. Large banks are more willing to incur this fixed cost because they will more likely use a larger amount of derivatives. Thus, this fixed cost can be spread across more opportunities to actually use derivatives, thereby lowering the average usage cost.

Our stock return results suggest that for the group of banking organizations for which there is a substantial variation in usage of interest rate derivative instruments, users tend to have less exposure to interest rate risk than nonusers and they also tend to have the same sensitivity to stock market risk. This suggests that derivative users overall tend to have less systematic risk than nonusers. This is an important observation because the derivative losses in the mid-1990s caused regulators and others to express grave concerns about the risk exposure of commercial banks operating in the derivative markets.

Regulators seem mainly concerned that losses on derivative trading could force the failure of some of the institutions serving as dealers, which would send shock waves not only through the derivative markets, but also through money and exchange rate markets to which derivative trading is closely linked through complex arbitrage strategies (Phillips, 1992). Our results suggest that derivative users are less risky than nonusers, and the introduction of stiffer regulations of the use of derivative instruments by federally insured depository institutions could have unintended consequences for the risk exposure of the deposit insurance agency. Moreover, any regulatory or accounting (for example, Financial Accounting Standard No. 133, “Accounting for derivative instruments and hedging activities”) initiatives affecting hedging behavior and risk exposures may have negative implications for lending and banking organizations’ stock market valuation.

NOTES

[1]In this article, we use banks and banking organizations interchangeably to refer to institutions for which banking is an important line of business.

[2]This concept is similar to standard payback ratios in corporate finance with the cash flows being adjusted to their present values.

[3]See Loomis (1994) for an insightful discussion about the risk exposure of firms using derivative instruments.

[4]See Kashyap, Stein, and Wilcox (1991), Sharpe and Acharya (1992), and Bernanke and Lown (1991).

[5]In the early 1980s, bank regulators announced minimum “primary capital ratios” for banks and bank holding companies. Primary capital included common and preferred equity, mandatory convertible debt instruments, perpetual debt instruments, and loan-loss reserves. After a phase-in period, the minimum primary capital ratio was set at 5.5 percent of total assets. In the second half of the 1980s, regulators introduced a plan for risk-based capital requirements. The risk-based capital ratio measures a bank’s capital with respect to the default risk of its on- and off-balance-sheet credit exposures. In addition, regulators tightened the old primary capital standard and added it to the risk-based requirements. The result is the leverage ratio. Published regulations indicated that most banking organizations will be required to maintain an equity (the sum of common equity, certain preferred stock, and minority interests in consolidated subsidiaries less goodwill) to total assets ratio of at least 4 percent to 5 percent (Baer and McElravey, 1993). We use an equity to total assets ratio of 5.5 percent as the minimum required by regulators. This is probably more stringent than the actual standard during the first part of our sample period (because we do not include certain items) and weaker than the actual standard during the last part of our sample period (because we do not exclude goodwill), but it should represent a middle ground that will allow us to investigate the capital management behavior of derivative nonusers and users.

[6]See Baer and McElravey (1993) for an excellent discussion of this type of analysis.

[7]Unfortunately, these booked gains/losses would not capture the unbooked gains/losses from the derivative position.

[8]We do not include the growth rate in state employment because the holding company is likely to operate in several different states.

[9]See, for example, Stone (1974), Lloyd and Shick (1977), Lynge and Zumwalt (1980), Chance and Lane (1980), Flannery and James (1984), Kane and Unal (1988), and Kwan (1991).

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