MARCH/APRIL 1997

ECONOMIC PERSPECTIVES

Announcement

1997 Conference on Bank Structure & Competition

A review from the Federal Reserve Bank of Chicago

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FEDERAL RESERVE BANK OF CHICAGO

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ECONOMIC PERSPECTIVES March/April 1997, Volume XXI, Issue 2

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ECONOMIC PERSPECTIVES is also available on the World Wide Web at http://www.frbchi.org.

ISSN 0164-0682

Value at risk for a mixture of normal distributions: The use of quasi-Bayesian estimation techniques

Subu Venkataraman

Rapid globalization, innovations in the design of derivative securities, and examples of spectacular losses associated with derivatives over the past decade have made firms recognize the growing importance of risk management. This increased focus on risk management has led to the development of various methods and tools to measure the risks firms face.

One popular risk-measurement tool is value at risk (VaR), which is defined as the minimum loss expected on a portfolio of assets over a certain holding period at a given confidence level (probability). For example, consider a trader who is concerned about the risk, over the next ten days, associated with holding a specific portfolio of assets. A statement that, at the 95 percent confidence level, the VaR of this portfolio is $100,000 implies that 95 percent of the time, losses over the 10-day holding period should not exceed $100,000 (or losses should exceed $100,000 only 5 percent of the time).

The use of value at risk techniques in risk management has exploded over the last few years. Financial institutions now routinely use VaR techniques in managing their trading risk and nonfinancial firms have started adopting the technology for their risk-management purposes as well. In addition, regulators are beginning to design new regulations around it. Examples of these regulations include the determination of bank capital standards for market risk and the reporting requirements for the risks associated with derivatives used by corporations.

Proponents of VaR argue that the ability to quantify risk exposure into a single number represents the single most powerful advantage of the technique.[1] Despite its simplicity, however, the technique is only as good as the inputs into the VaR model.[2] Many implementations of VaR assume that asset returns are normally distributed. This assumption simplifies the computation of VaR considerably. However, it is inconsistent with the empirical evidence of asset returns, which finds that asset returns are *fat tailed*. This implies that extreme events are much more likely to occur in practice than would be predicted based on the assumption of normality. Take, for example, the stock market crash of October 1987. The assumption of normality would imply that such an extreme market movement should occur only once in approximately 5,900 years. As we know, however, there have been worse stock crashes than that of October 1987 even in this century. This suggests that the normality assumption can produce VaR numbers that are inappropriate measures of the true risk faced by the firm.

While alternative return distributions have been proposed that better reflect the empirical evidence, any replacement for the normality assumption must confront the issue of the simplicity of computations, which is one of the

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primary benefits of VaR. In this article, I examine one such alternative assumption that simultaneously allows for asset returns that are fat tailed and for tractable estimations of VaR. This distribution, based on a mixture of normal densities, has also been proposed by Zangari (1996). First, I relate the *mixture of distributions* approach to alternatives that have been presented in the academic literature on the stochastic processes governing asset returns. Second, I use an estimation technique for the parameters of the mixture of distributions that is computationally simpler than the techniques suggested by Zangari—the quasi-Bayesian maximum likelihood estimation (QB-MLE) approach (first suggested by Hamilton, 1991).[3] Third, using simulated data, I show that the QB-MLE combined with the mixture of normals assumption provides better measures of value at risk for fat-tailed distributions (like the Student's *t*) than the traditional normality assumption. I then establish that the technique does not suffer from the problems associated with the traditional maximum likelihood approach and that it is effective in recovering the parameters from simulated data.

Finally, this methodology is applied to foreign exchange data for eight currencies from 1978 to 1996. It is well known that returns in the foreign exchange market show dramatic violations of the assumption of normality by exhibiting fat tails (Jorion, 1995). I compute VaR estimates under both the assumption of normality and the mixture of normals approach for each of the eight currencies. I show that the mixture of normals assumption combined with QB-MLE outperforms the traditional normality assumption. First, the traditional normality assumption leads to a significantly larger number of violations of VaR than the mixture of normals. Moreover, the number of violations of VaR observed over the sample period under the QB-MLE is consistent with the stated goals of VaR.

To evaluate the performance of portfolio VaRs (as in Hendricks, 1996), I examine how information on the parameters governing individual currencies can be aggregated in the context of portfolios of these currencies. In contrast to the normality assumption, however, the use of the mixture of normals complicates this aggregation considerably. I propose a specific algorithm for computing portfolio statistics from the individual components that keeps the analysis computationally simple. The effectiveness of the approximations underlying this algorithm is judged by examining the magnitude of violations from simulated portfolios of currencies. Again, I compare the results under the QB-MLE approach with the normality-based results and the expected outcomes. I find that, despite the simplifying aggregation assumptions, the QB-MLE technique again outperforms the normality-based approach and provides VaR estimates consistent with what one would expect. These results suggest that combining the mixture of normals approach and the QB-MLE estimation technique allows us to capture fat-tailed distributions, while maintaining a computationally tractable approach to VaR computations.

VaR estimation under normality

Below, I review the concept of VaR under the assumption of normality and how this assumption simplifies the computation of VaR considerably. Suppose that the return for any asset, i, (i=1 to N) at a given point in time, t, is normally distributed, that is, $R_{it} \sim N(\mu_i, \sigma_i^2)$. Moreover, assume that asset returns are uncorrelated over time, that is, $cov\,(R_{i,t}, R_{i,t-j}) = 0, j = 1, 2...$, but could be contemporaneously correlated across assets, that is, $cov\,(R_{i,t}, R_{i,t}) = \sigma_{ij}\ \forall i \text{©} i, t$, with the covariance matrix being denoted by . For any portfolio of these assets, with portfolio weights given by $\omega = [\omega_1\ \omega_2 \ldots \omega_N]$, with $_i\,\omega_i = 1$, the returns can be written as the weighted average of the returns on the individual assets, that is, $R_p = \ _i\,\omega_i R_i$. The returns on this portfolio are also normally distributed, with mean $\mu_p = \ _i\,\omega_i \mu_i$ and variance $\sigma_p^2 = \omega\ \ \omega^T$. This represents the first major advantage of assuming normality. If individual asset returns are normally distributed, then the returns on any portfolio of these assets has a normal distribution as well. At a critical probability of α, the VaR is the solution to

$$1)\quad \int_{-\infty}^{VaR_\alpha} \text{©}(R_p \mid \mu_p, \sigma_p)\, dR_p = \alpha,$$

where ©.) is the normal density for portfolio returns. Typical values of α range from 1 percent to 10 percent. The second advantage of the normality assumption is that the computation of VaRs at different critical values

(that is, solving equation 1) is relatively straightforward.

However, these simplifying assumptions have two drawbacks. First, many derivative securities have payoffs that are nonlinear functions of the underlying assets. The fact that the asset satisfies the normality assumption does not imply that the derivative has a normal distribution. This raises questions about whether this version of VaR analysis can be applied universally. This has been the focus of much concern (Beder, 1995) and several variants have been proposed to alleviate the problem (Fallon, 1996).[4] Second, there is considerable evidence in the academic literature to suggest that security returns are non-normal, typically exhibiting fat tails and volatility clustering (Kim and Kon, 1994, and the references cited therein).

Several alternatives to normality have been proposed in the literature. For example, in their comprehensive survey of alternative definitions for the stochastic process for stock returns, Kim and Kon classify the return processes as time-dependent and time-independent models of conditional heteroscedasticity (that is, of changes in the volatility of asset returns).[5] While the time-dependent models are more successful as models of asset returns, they are also considerably more complicated. Moreover, when firms are attempting to forecast the risk of losses over short holding periods (ranging from one day to two weeks), simpler models might be adequate. This seems to have been the justification behind the RiskMetrics™ framework developed by JP Morgan, as well as the variant proposed by Zangari (1996), which uses a simple version of the mixture of normals approach.[6] Clearly, the trade-off between having a procedure that accurately reflects the risk of the portfolio and one that is not too computationally intensive for the end user needs to be considered. Below, I discuss this mixture of distributions approach, relate it to the existing academic findings, and discuss problems with conventional estimation techniques. I then describe the alternative approach that overcomes these problems—the QB-MLE technique (Hamilton, 1991).

VaR estimation for a discrete mixture of normals

Empirical evidence suggests that the assumption that asset returns are normally distributed is inappropriate and that returns are actually fat tailed. One way to model such a distribution is to assume that returns are generated from a mixture of normal distributions. Specifically, suppose the stochastic process for the returns for security i is defined by

$$2)\quad R_{it} = \lambda_{it} R^{n}_{it} + (1 - \lambda_{it}) R^{\beta}_{it},$$

where $R^{n}_{it} \sim N(\mu_n, \sigma^2_n)$, $R^{\beta}_{it} \sim N(0, \sigma^2_{\beta})$, and λ_{it} takes on a value of 1 with probability p, being equal to zero otherwise. The three random variables $\{R^{n}_{it}, R^{\beta}_{it}, \lambda_{it}\}$ are assumed to be uncorrelated with each other and over time.[7]

Intuitively, the return on an asset at any given time can be drawn from one of two normal distributions, with the outcome, λ, determining which distribution is chosen. For example, most of the time (with probability p) the returns might be from the first distribution, that is, $\lambda = 1$. Occasionally (with probability $1 - p$), something unusual might happen (like the stock market crash of October 1987) that significantly increases volatility. This would be reflected in equation 2 by returns generated from the second (potentially higher variance) distribution, that is, $\lambda = 0$. The benefit of such a specification is that it allows for the possibility that occasionally the return is generated from a distribution with a higher variance, while simultaneously maintaining the structure of normal densities, conditional on the realization of λ (a *jump* from one distribution to another).[8]

The first issue of concern, then, is the estimation of the parameters $\{p, \mu_n, \sigma_n, \sigma_{\beta}\}$ for individual assets (since the realization of λ is not typically observed by the researcher). I discuss three alternative methodologies for estimating $\{p, \mu_n, \sigma_n, \sigma_{\beta}\}$. First, I consider traditional maximum likelihood. It turns out that there are problems associated with this approach in the context of mixtures. These problems motivate the next approach, which is the QB-MLE technique. I discuss alternative interpretations of the approach, and assess its effectiveness estimating parameters in simulated data. For completeness, I briefly compare the QB-MLE approach to the Bayesian (Gibbs-sampling based) approach proposed by Zangari (1996).

Traditional maximum likelihood approach

This approach would require the researcher to select the parameters that maximize the following log-likelihood function (dropping subscript i for convenience) for the mixture of normal densities

$$3)\quad \ell\Big((p, \mu_n, \sigma_n, \sigma_\beta)|\{R_t\}\Big) = \sum_t \log\left[\frac{p}{\sigma_n}\exp\left(-\frac{1}{2}\frac{(R_t-\mu_n)^2}{\sigma_n^2}\right) + \frac{1-p}{\sigma_\beta}\exp\left(-\frac{1}{2}\frac{R_t^2}{\sigma_\beta^2}\right)\right].$$

Unfortunately, as pointed out by Hamilton (1991), a global maximum does not exist for this function.[9] Consequently, attempting to use this approach to parameter estimation leads to instability, local solutions, and nonconvergence problems.

Quasi-Bayesian maximum likelihood estimation

Hamilton (1991) points out that the estimation problem would have been simplified considerably if the researcher had observations on the realization of λ available directly. Moreover, even if one had some observations, or some priors, this estimate could be improved. Second, while technical restrictions get around the problem of the failure of the existence of a global maximum, this still leaves the question how to deal with these problems in the small sample case. The method suggested by Hamilton is to maximize the following variant to the likelihood function:

$$4)\quad \ell\Big((p, \mu_n, \sigma_n, \sigma_\beta)|\{R_t\}\Big) - \frac{a_n}{2}\log(\sigma_n^2) - \frac{a_\beta}{2}\log(\sigma_\beta^2) - \frac{b_n}{\sigma_n^2} - \frac{b_\beta}{\sigma_\beta^2} - \frac{c_n(m_n-\mu_n)^2}{2\sigma_n^2},$$

where $\ell(.)$ is the likelihood function defined in equation 3 and $\{a_n, b_n, c_n, m_n, a_\beta, b_\beta,\}$ are (nonnegative) constants that reflect one's prior beliefs about the parameters that are being estimated.[10] Hamilton presents four alternative interpretations for the functional form that he has suggested and the manner in which the constants reflect the researcher's prior beliefs about the parameters.[11] Under three of these four approaches, the estimator can be interpreted as being based on Bayesian updating of the researcher's prior beliefs.

Zangari's methodology is based on the Bayesian updating of the densities for the relevant parameters using the observed return series. Since the computation of this posterior distribution is difficult in practice, Zangari suggests the use of the Gibbs sampler instead.[12] This procedure is time consuming; consequently, Zangari proposes that the mixture-related parameters be reestimated only once a month. Moreover, as pointed out earlier, the QB-MLE technique also has several Bayesian interpretations and the method is relatively straightforward to implement.

A direct comparison of the QB-MLE with the Bayesian estimation technique is beyond the scope of this article. Instead, the analysis focuses on how well the mixture of normals assumption combined with QB-MLE does relative to the traditional normality assumption.

Results based on simulated data

To examine both the effectiveness of the estimation technique and the ability of the mixture of normals to capture fat tails, I provide two sets of results. First, I examine how well the QB-MLE performs in estimating the parameters in simulated data generated from a mixture of normals data-generating process. Then, I compare the implications of assuming normality with those of the mixture of normals when the underlying density has a fat-tailed distribution.

Returns generated from a mixture of normals

To examine the robustness of the QB-MLE technique, I generate a variety of samples and examine the ability of the algorithm to estimate the parameters. Specifically, I consider mixtures drawn from two normals with zero means, variances $\sigma_n = 2$, $\sigma_\beta = 10$, and p ranging from 0.10 to 0.90. For each set of parameter inputs, I generate 100 samples of size 1,000 and estimate the parameters for each subsample. The results of this process, the mean and the standard deviation of the parameter estimates, are presented in table 1. The estimation routines are stable and do a good job in estimating the underlying parameters. The next step is to evaluate the effectiveness of this technique when the return-generating process exhibits fat tails (without necessarily being drawn from a mixture of normal distributions).

TABLE 1

Estimates from simulated data

Probability (p)	Estimates		
	$\hat{p}$	$\hat{\sigma}_n$	$\hat{\sigma}_\beta$
0.10	0.10741 (0.03919))	1.95615 (0.62693)	10.02450 (0.32751)
0.20	0.20857 (0.03249)	1.99397 (0.30232)	10.01270 (0.32215)
0.30	0.29628 (0.02919)	1.98501 (0.21278)	10.02834 (0.31111)
0.40	0.39521 (0.02837)	1.98489 (0.15897)	9.93684 (0.40044)
0.50	0.50197 (0.02800)	1.99356 (0.10294)	10.02182 (0.39484)
0.60	0.60376 (0.02981)	2.00225 (0.11112)	9.98221 (0.39651)
0.70	0.70108 (0.02322)	1.99523 (0.08838)	9.95835 (0.48623)
0.80	0.80018 (0.021877)	1.99578 (0.07755)	10.05155 (0.64645)
0.90	0.89690 (0.01380)	1.99648 (0.05238)	9.87647 (0.90500)

Notes: The maximum likelihood estimates are based on equation 4, with $a_i = b_i = 0.20$, $c_i = 0.10$, $m_i = 0$, for $i = n,\beta$ (as in Hamilton, 1991). Averages for 100 samples (of size 1,000) drawn from a mixture of normals distribution with σ_n=2, σ_β=10, and p varying from 0.10 to 0.90 across the runs. Standard deviations of the estimates are in parentheses.

Returns generated from a Student's t distribution

A distribution that exhibits the typical property of fat tails seen in asset returns is the Student's t distribution, which is characterized by its *degrees of freedom*. Fat-tailed behavior is more pronounced at lower degrees of freedom, with the distribution resembling a normal density at higher degrees of freedom. I generate simulated data from Student's t distributions with 2, 4, 10, and 100 degrees of freedom. For each of these, I generate a sample of size 10,000. The VaR for each simulation is computed in two ways. The theoretical VaR is computed based on the parameters used in the simulation. The sample VaR is based on the appropriate percentile from the sample itself.

Then, I estimate parameters under the assumption of normality as well as the assumption that the data have been generated from a mixture of normals. Based on these parameters, I compute the VaRs at different probability levels for the normal and mixture of normals approach and compare them to the theoretical and sample VaRs.

Table 2 illustrates that the mixture of normals has smaller errors than the normal approach at higher percentile levels. Moreover, when it has higher absolute errors than the normal approach, it errs toward conservative (high) VaR estimates. This is in contrast to the normal approach, which tends to generate low VaR estimates. Looking first at the columns labeled *error relative to theoretical*, we see that both the normal and the mixture of normals approach do a better job of measuring VaR at higher degrees of freedom. This is not a surprise, since the distribution begins to more closely resemble a normal density. Moreover, the normal approach understates (in absolute terms) the VaR relative to the true value at very high levels of confidence and overstates it at lower levels. In contrast, the mixture of normals approach reflects the opposite behavior, understating VaRs only under very low levels of confidence. While the percentage error under the mixture can be quite high (as much as 36.10 percent), it is generally biased toward being higher than the normals when a high level VaR is required. This represents a desirable characteristic of such a risk measure. Contrary to conventional wisdom, assuming normality when the distribution is fat tailed need not result in VaRs that are consistently understated. Similar patterns are also observed if one compares the computed VaRs to the sample VaR, which is defined as the critical return, in the simulated sample, such that μ percent of the returns lie below this threshold.

Estimation results for foreign exchange data

To assess the ability of the mixture of normals and the QB-MLE technique to estimate parameters and measure VaR more accurately than the normal distribution, I examine how well it does with a sample of daily foreign exchange returns for eight currencies—the Canadian dollar, French franc, German mark, Italian lira, Japanese yen, Swiss franc, British pound, and Dutch guilder. Returns are measured from January 1, 1978, to August 26, 1996.[13]

TABLE 2

Simulation results comparing VaR estimates for Student's *t* distributions

Percentile	*t* dist (theoretical)	*t* dist (actual)	Normal	Mixture of normals	Error relative to theoretical (normal)	Error relative to theoretical (mixture)	Error relative to sample (normal)	Error relative to sample (mixture)
				Student's *t* with 2 degrees of freedom				
0.5	–9.9248	–9.6126	–6.7562	–11.8241	–31.93%	19.14%	–29.72%	23.01%
1.0	–6.9646	–6.7726	–6.1018	–9.4787	–12.39%	36.10%	–9.90%	39.96%
2.5	–4.3027	–4.3153	–5.1408	–5.6513	19.48%	31.34%	19.13%	30.96%
5.0	–2.9200	–2.9249	–4.3143	–2.7758	47.74%	–4.94%	47.50%	–5.10%
				Student's *t* with 4 degrees of freedom				
0.5	–4.6041	–4.4062	–3.5883	–4.9642	–22.06%	7.82%	–18.56%	12.66%
1.0	–3.7469	–3.5614	–3.2407	–4.0344	–13.51%	7.67%	–9.00%	13.28%
2.5	–2.7764	–2.6265	–2.7303	–2.7487	–1.66%	–1.00%	3.95%	4.65%
5.0	–2.1318	–2.0445	–2.2914	–2.0543	7.49%	–3.64%	12.08%	0.48%
				Student's *t* with 10 degrees of freedom				
0.5	–3.1693	–3.1248	–2.8916	–3.2123	–8.76%	1.36%	–7.46%	2.80%
1.0	–2.7638	–2.7663	–2.6115	–2.7647	–5.51%	0.03%	–5.60%	–0.06%
2.5	–2.2281	–2.2517	–2.2002	–2.2112	–1.25%	–0.76%	–2.29%	–1.80%
5.0	–1.8125	–1.8064	–1.8465	–1.8038	1.88%	–0.48%	2.22%	–0.14%
				Student's *t* with 100 degrees of freedom				
0.5	–2.6259	–2.6388	–2.6105	–2.6368	–0.59%	0.42%	–1.07%	–0.08%
1.0	–2.3642	–2.3869	–2.3576	–2.3777	–0.28%	0.57%	–1.23%	–0.39%
2.5	–1.984	–2.0292	–1.9863	–1.9970	0.12%	0.66%	–2.11%	–1.59%
5.0	–1.6602	–1.6896	–1.6670	–1.6700	0.41%	0.59%	–1.34%	–1.16%

Notes: Errors are computed based on the (percent) difference between the VaR based on either the normal or the mixture of normals assumption and a benchmark VaR. This benchmark is computed using the known degrees of freedom for the *t* distribution (*theoretical VaR)* as well as the appropriate percentile in the sample (*sample VaR).*

Summary statistics for the currency returns are provided in table 3. The hypothesis that these returns are drawn from a normal distribution is strongly rejected.[14]

First, I evaluate the difference between VaR measures based on the normal versus the mixture of normals for each currency. I compute VaRs for each currency on a daily basis

TABLE 3

Sample statistics
Daily foreign exchange returns

Mean	Canadian dollar	French franc	German mark	Italian lira	Japanese yen	Swiss franc	British pound	Dutch guilder
(X 10^5)	3.37	–7.63	.807	10.2	–16.0	–7.03	–11.0	–3.99
Median	0	0	0	0	0	0	0	0.000123
Maximum	0.01728	0.058678	0.058746	0.066893	0.035571	0.063879	0.103479	0.045885
Minimum	–0.01864	–0.04141	–0.03876	–0.03672	–0.05155	–0.03985	–0.09723	–0.03843
Std. deviation	0.002621	0.006929	0.006784	0.006542	0.006621	0.006884	0.008205	0.006643
Skewness	0.11387	0.035704	0.173338	0.531506	–0.39195	0.0313	0.097693	–0.08654
Kurtosis	6.62272	6.29632	7.666992	10.25995	6.501476	6.82522	15.23094	6.239683
Jarque-Bera statistic	2,471.592	2,039.186	4,108.262	10,098.9	2,415.103	2,745.512	28,068.85	1,974.41
Probability	0	0	0	0	0	0	0	0
Number of observations	4,502	4,502	4,502	4,502	4,502	4,502	4,502	4,502

Notes: The sample consists of daily returns from January 1, 1978, to August 26, 1996. A normal distribution should have a skewness (S) of 0 and kurtosis (K) of 3. The Jarque-Bera statistic is

$\frac{T}{6}\left[S_2 + \frac{1}{4}(K-3)^2\right]$, where T is the number of observations. The test statistic has a χ^2 distribution with 2 degrees of freedom.

and examine the frequency and the magnitude of the violations that occur. These are compared to what one would have expected if the VaRs had been correctly computed.

I use a 250-day estimation window and compute VaRs based on a one-day holding period, at the 97.5 percent confidence level, based on a recent survey of typical assumptions underlying VaR models used by firms.[15] The survey found that the confidence interval used by firms ranges from 95 percent to 99 percent, the one-day holding period VaR is typically computed, an observation period of one year (250 trading days) is used, and the historical data are equally weighted. The original sample consists of 4,502 daily (log) return observations. The initial estimation window and the need to compare VaRs with the next day's outcome reduce the VaR comparison to 4,251 observations. On any given day, t, I use the return series $\{R_{t-i}\}_{i=1}^{i=250}$ to compute the parameters and, therefore, VaR_t. This is compared with R_t and a violation is said to occur whenever $|R_t| > |VAR_t|$.[16] If the VaR is computed correctly, the expected number of violations is 0.05 times the number of observations, implying 212.5 violations. I examine the implications of both the assumption of normality and the mixture of normals approach. Figure 1 shows the time variation in the parameter estimates over the sample period for the German mark.[17] There is considerable time variation in the volatility measures (panels A, C, and D) under both approaches. Interestingly, there is also considerable variation over time in the estimate of p, the probability that returns are drawn from one distribution in the mixture.

The results from comparing VaR estimates for the eight currencies with the actual number of violations are summarized in table 4. In a sample size of 4,251, one would expect 212.5 violations. The number of violations that occur under the assumption of normality is significantly higher than one would expect and a likelihood ratio test rejects the hypothesis that the true underlying probability of a violation is 5 percent. In contrast, the number of violations of the VaR estimated under the mixture of normals is much lower than under the normal. In addition, one cannot reject the hypothesis that the model has a probability of violations equal to 5 percent.

TABLE 4

Violations of VaR under alternative methodologies

	Number of violations		Average size of violations (percent)		Expected size of violations (percent)	
Currency	**Normal**	**Mixture**	**Normal**	**Mixture**	**Normal**	**Mixture**
Canadian dollar	256 (8.801)**	233 (2.011)	0.7113	0.7421	0.0428	0.0407
French franc	245 (4.981)*	227 (1.012)	1.7722	1.7975	0.1021	0.0960
German mark	263 (11.757)**	224 (0.639)	1.7481	1.7463	0.1082	0.0920
Italian lira	251 (6.938)**	223 (0.533)	1.6692	1.7694	0.0986	0.0928
Japanese yen	251 (6.938)**	215 (0.030)	1.4333	1.4052	0.0846	0.0711
Swiss franc	248 (5.921)*	222 (0.436)	1.8809	1.8906	0.1097	0.0987
British pound	279 (19.995)**	226 (0.879)	1.4411	1.4932	0.0946	0.0794
Dutch guilder	261 (10.873)**	237 (2.859)	1.7545	1.7319	0.1077	0.0966

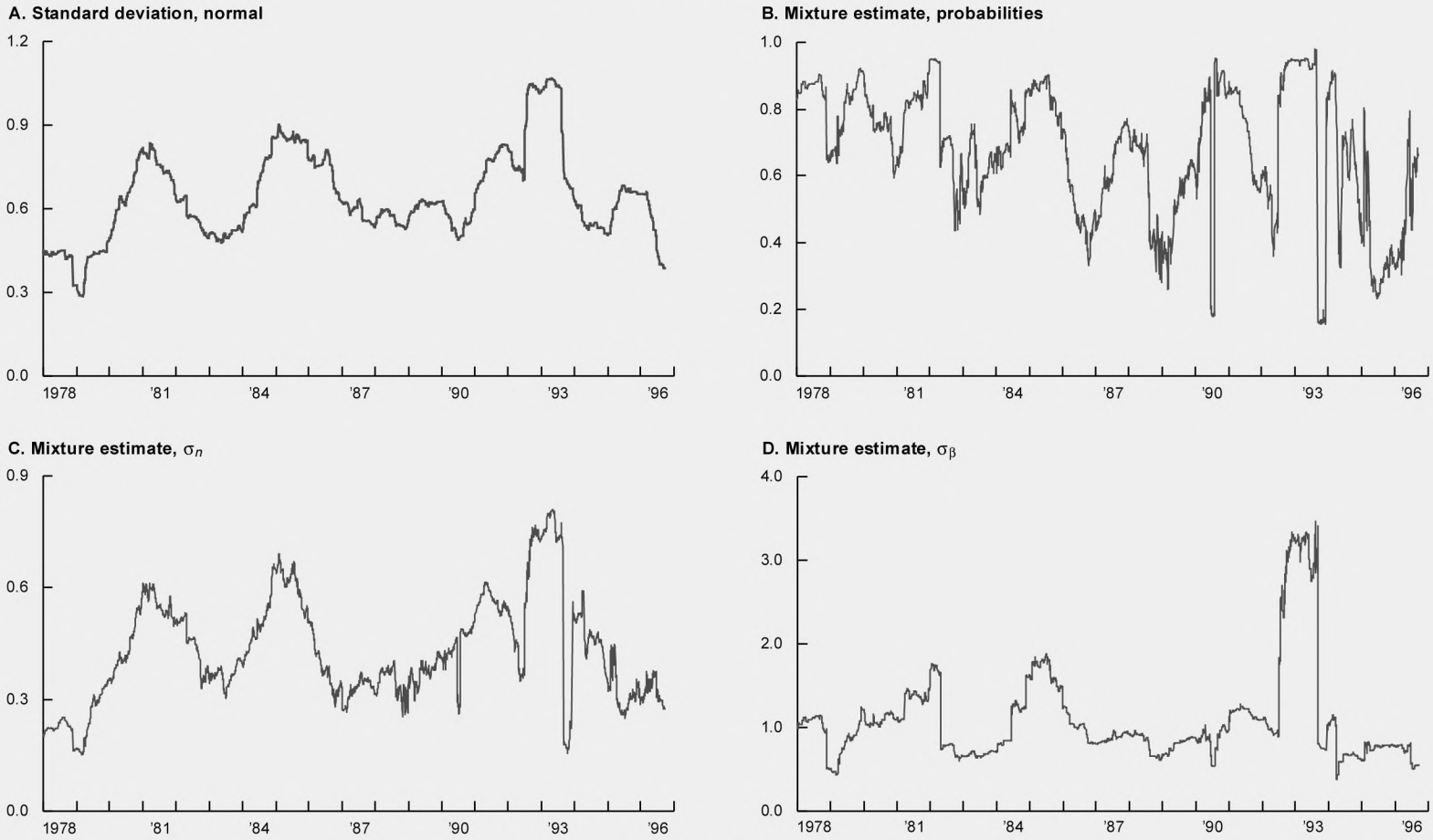
*Significant at the 5 percent level.

**Significant at the 1 percent level.

Notes: The log-likelihood test statistic (reported in parentheses) is $LR = 2[1n[(\alpha^*)^x(1-\alpha^*)^{T-x}] - 1n[\alpha^x(1-\alpha)^{T-x}]]$, T = sample size (4,251), x = number of violations, $\alpha = 0.05$, and $\alpha^* = x/T$ is the sample fraction of violations. The test statistic has an asymptotic χ^2 distribution with 1 degree of freedom. The critical values are 6.6349 and 3.841 at the 99 percent and 95 percent confidence levels, which translates into violations of 250 and 241, respectively.

FIGURE 1

Parameter estimates of the German mark



Notes: The estimates are computed using rolling 250-day windows [t–250,t–1]. The maximum likelihood estimates for panels B–D are based on equation 4, with $a_i = b_i = 0.20$, $c_i = 0.10$, $m_i = 0$, for $i = n, \beta$ (as in Hamilton, 1991).

Table 4 also shows the average size of a violation and the expected size of a violation (defined as the average size times the frequency of a violation). The average size of the violation is larger under the mixture than under the pure normal assumption. While this might seem surprising, recall (from the results of table 2) that the rank ordering of the VaRs under the normal versus mixture of normals depends critically on the level of confidence as well as the shape of the distribution, and this could explain the results in table 4.

The expected size of the violations is uniformly smaller under the mixture (the last two columns of table 4). This suggests that for individual assets, the mixture of normals provides superior VaR estimates than the conventional normality assumption because both the number and expected size of violations are lower under the mixture of normals approach. Next, I examine how well this process works in the context of portfolios.

Portfolio results

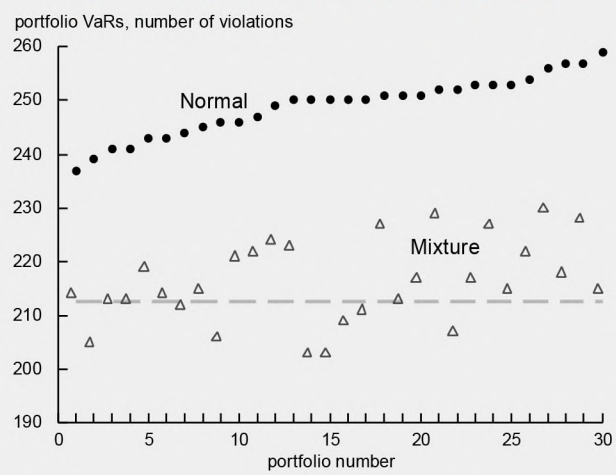
As mentioned earlier, the two benefits of the normality assumption are that it is relatively simple to calculate the VaRs associated with different confidence levels and to aggregate individual parameters to develop the parameters of a portfolio. The mixture of normals shares the first property. But how would one aggregate these parameters in the context of a portfolio? I assume that the covariance across assets is independent of λ_i. This implies that there are only two covariance matrices that could be generating the returns. The off-diagonal terms of these matrices are independent of λ realizations, while the diagonals are either $\sigma^2_{i,n}$ or $\sigma^2_{i,\beta}$ depending on the realization of λ_i. The second issue is whether these realizations are independent across assets. The assumption of independence would be consistent with the large literature on jump diffusion models, which typically assumes that the jump risk is fully diversifiable (Merton, 1976). However, it is not immediately clear that this assumption is reasonable in the context of the risk-management activities of a bank, since the prospect of bankruptcy could make the bank worry about risk that might seem diversifiable in an asset pricing context. Moreover, this assumption complicates the mapping between confidence levels and VaRs considerably. For example, with eight assets, one would have to consider $2^8 = 256$ possibilities for the realizations of λ_i, with the process quickly becoming intractable.

The assumption of perfect correlation is not valid either, since one would then expect identical values of p for all eight currencies. Here, I adopt a computationally simpler alternative and test to see whether the approximation works. For a portfolio ω, I use as inputs $p_p = \sum_i \omega_i p_i$ and the two covariance matrices, $\sum_n$ and $\sum_\beta$, which are identical along the off-diagonals and contain the relevant variances on the diagonals. These assumptions approximate the distribution of portfolio returns by a mixture of normals distribution. To assess how good an approximation this represents, I form 30 random portfolios of the eight currencies and evaluate how well the portfolio VaR estimates do relative to the profits and losses on the portfolio.

In figure 2, I plot the number of violations (the simulation is for 4,251 daily returns for 30 different portfolios) under the mixture of normals approach relative to the conventional normality assumption. The portfolios have been sorted based on their VaR estimates under the assumption of normality. Again, the fraction of violations under the mix is much lower than under

FIGURE 2

Violations for foreign currencies portfolios



Source: Author's calculations from data provided by the Federal Reserve Bank of New York.

TABLE 5

VaR violations for portfolios of currencies

	Normal	Mixture of normals
Number of violations	249	217.4
	(5.5460)	(7.7442)
Proportions of violations	0.0586	0.0511
	(0.013)	(0.0018)
Magnitude of violations	1.0970	1.1293
	(0.1766)	(0.1845)
Average violations	0.0643	0.0580
	(0.0109)	(0.0109)

Notes: The statistics are based on 30 random portfolios of currencies constructed over the entire sample period. Standard deviations are in parentheses.

the normality assumption. Moreover, the critical number of violations to reject the hypothesis that the VaR is consistent with a 2.5 percent confidence level is 250 (at the 1 percent level) or 241 (at the 5 percent level). For the normal density, the hypothesis can be rejected in 26 of the 30 portfolios at the 5 percent level and in 13 of the portfolios at the 1 percent level. One cannot reject the mixture-based VaRs in any of the portfolios.

Table 5 indicates that, similar to the findings for individual currencies, the magnitude of the violations under the mixture tends to be larger than the magnitude under pure normality. However, the expected size of the violations is smaller under the mixture of normals approach.[18] Thus, in the context of portfolios as well as individual assets, the mixture of normals provides superior VaR estimates relative to the conventional normality assumptions, because the number of violations is lower and consistent with expectations and the *ex ante* expected size of violations is smaller.

Conclusion

The analysis in this article highlights the critical nature of the existing assumptions underlying VaR computations and the complications that result when the methodology is used for assets that exhibit fat-tailed return distributions. The mixture of normals approach combined with QB-MLE is shown to perform significantly better, in the context of both individual assets and portfolios. Further research is needed on the number of components to include in the mixture, more complicated intertemporal dependencies, and the development of computationally feasible aggregation algorithms.

NOTES

[1]In fact, the concept of VaR was motivated by this ability to capture risk by one number. Dennis Weatherstone, the chief executive officer of JP Morgan at the time (and also the chairman of the influential Group of Thirty study on derivatives), insisted that such a single measure of the firm's exposure be made available to him every morning, resulting in the development of the underlying quantitative techniques (Financial Engineering, Ltd., *Risk*, special supplement, 1996).

[2]The inputs into the model include 1) assumptions (and estimation techniques) for the stochastic processes that determine the returns on individual assets; 2) a methodology for mapping the return distributions for individual assets into the aggregate return distribution for the portfolio (and hence to profits and losses [P&L]); and 3) a computationally simple process for evaluating VaR at different probability levels for this aggregate P&L distribution. All these steps obviously also depend on the relevant holding period over which the analysis is conducted. In this article, my primary focus is not on the second aspect (refer to JP Morgan's RiskMetrics™ document on position mappings for greater detail). I focus instead on the estimation of the underlying stochastic processes and the difficult trade-off between the need for an approach that is accurate and the need for one that is easy to implement. I discuss some aggregation issues later in this article.

[3]I also briefly review the problems associated with standard estimation techniques (such as maximum likelihood), and the Bayesian approach using Gibbs sampling proposed by JP Morgan.

[4]Most techniques try to approximate these nonlinearities based on Taylor series expansion, leading to methods based on the delta and gamma of security-type approaches, for example.

[5]Under the former, they consider ARMA, GARCH, and EGARCH models (Bollerslev, Engle, and Nelson [1994]) and the Glosten, Jagannathan, and Runkle (1993) specifications for asset returns. Under the latter, they consider Student's *t* models, generalized mixtures of normals, Poisson jump models, and stationary normal models.

[6]See Kon (1984) for a comparison of a general version of the mixture of normals with the Student's *t* density, for example.

[7]The mixture of normals also allows for more complex structures where λ_t could follow a Markov process. See Engel and Hamilton (1990) for an application.

[8]In fact, the traditional jump diffusion model can be interpreted as allowing for the possibility of a jump between an infinite number of normal distributions (Kon [1984]).

[9]Specifically, a singularity arises whenever one of the observations is attributed entirely to a single distribution, since the mean is then imputed to be the value of the observation and the variance approaches zero. However, focusing attention on just the largest local maximum with positive variances leads to consistent estimates. The problem at that stage is one of ensuring that the numerical algorithms are bounded away from zero, which is difficult to do in practice. Moreover, as pointed out by Lehmann (1983) and Robert (1994), in any finite sample, the probability that none of the observations was generated from one of the mixture components is strictly positive. They argue that this also contributes to the instability of the maximum likelihood estimation process. Consequently, estimation under this approach is not recommended.

[10]Notice that in the special case where these constants are all set to zero, the functional form suggested by Hamilton (1991) collapses to the traditional maximum likelihood function. The constants are identical in our estimation to those used by Hamilton. Moreover, perturbing the parameters had no effect on the estimates. Refer to table 1 for additional details.

[11]Specifically, he suggests that one could interpret the estimator as 1) representing prior information which is equivalent to observed data, 2) the mode of a Bayesian posterior distribution, 3) an analogy with a Bayes estimator, or 4) a penalized maximum likelihood function.

[12] For full details of this methodology, see Zangari (1996).

[13]The currencies selected here are identical to those in Hendricks (1996). The start of the time period is also identical, while the ending point reflects when this research project was started.

[14]All the currencies reflect significant skewness and kurtosis relative to what one would expect if the samples had been drawn from normal distributions. In addition, the Jarque-Bera statistic rejects normality for all currencies.

[15]"Amendment to the Capital Market Accord to incorporate market risks: The use of internal models for supervisory purposes," a study conducted by a joint ISDA/LIBA task force which surveys its members to assess the assumptions underlying their use of VaR.

[16]I focus attention on both excessive losses and gains throughout this analysis. Disaggregating these two does not change the nature of the results.

[17]The patterns for the other currencies are substantially similar and are therefore not included.

[18]These simulation runs are computationally intensive, but increasing the number of portfolios to 50 did not change the nature of the results.

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Conference on Bank Structure and Competition
April 30–May 2, 1997
Federal Reserve Bank of Chicago

The major theme of the 33rd annual Conference on Bank Structure and Competition will be the changing role of technology in the financial services industry. The discussions will evaluate the opportunities and potential concerns raised by the incorporation of recent technological innovations. Special attention will be given to public policy implications.

In recent years, technology has had a major impact on the activities and processes of financial institutions. The traditional Norman Rockwell image of a banker providing basic services at the teller window has long since passed. Technology has altered the means by which banks deliver and market services, evaluate and manage portfolio risk, and respond to supervisors and regulators. It has significantly altered back-office operations and has brought into question the appropriateness of regulations concerning service offerings, geographic and ownership restrictions, traditional antitrust enforcement, and the very framework of the existing regulatory structure.

There is also significant disagreement on just how quickly new technology will be incorporated and, as a result, how quickly the industry will evolve. Has the bank branch become obsolete just as banks have obtained the legal right to branch on an interstate basis? Will consumers embrace new methods of utilizing financial services? Will banks continue to be "special," or will technology further homogenize all financial institutions? Will banks maintain their dominant position in the financial sector by developing alliances with the providers of technology, or will providers of the evolving technology make significant inroads into current bank markets? What are the consumer security issues associated with new electronic delivery systems, and how can they be addressed?

The 1997 conference will focus on these and related policy issues. Featured speakers include Alan Greenspan, Chairman of the Board of Governors of the Federal Reserve System, Jerry McElhatton, President, MasterCard International, Scott Cook, Chairman, Intuit Inc., and John Grundhofer, President and Chief Executive Officer, First Bank System, Inc.

To discuss issues directly related to the conference theme, we have arranged a special panel of industry experts including Dominick Cavuoto, Principal, KPMG Peat Marwick, Bill Randle, Senior Vice President, Huntington Bancshares, Inc., Cathy Minehan, President, Federal Reserve Bank of Boston, Christine Varney, Commissioner, Federal Trade Commission, and Charles Goodhart, London School of Economics. Each will bring a unique perspective to issues concerning technology and the future of the financial services industry.

An additional session to discuss the impact of technology on issues related to risk management, payments, and antitrust enforcement will include Susan Phillips, Board of Governors of the Federal Reserve System, James Culberson, Jr., President, American Bankers Association, and Brian Smith, Partner, Mayer, Brown, and Platt.

There will also be sessions addressing the following:

- Incentive-compatible regulation,
- The opaqueness of bank assets,
- Modeling bank risk,
- Corporate control in banking,
- Bank activity in over-the-counter markets,
- Credit scoring models,
- Bank–firm and bank–regulator relationships, and
- Bank performance.

The first day of the conference has traditionally been intended primarily for an academic audience and has emphasized more technical research papers. This year we are also scheduling a bankers round table the first day. The Thursday and Friday sessions are for a more general audience.

Invitations to the conference will be mailed in March. If you are not currently on the conference mailing list or have changed your address and would like to receive an invitation, please contact Regina Langston at the Federal Reserve Bank of Chicago at 312-322-5641, or send your request to the Federal Reserve Bank of Chicago, Public Affairs Department, 3rd Floor, P.O. Box 834, Chicago, Illinois, 60690-0834.

Banking reform in a transition economy: The case of Poland

Thomas S. Mondschean and Timothy P. Opiela

The demise of several Communist-led governments in Central and Eastern Europe has given way to an economic transformation of these nations that may be as important to the people who live there as the political transformation has been. These countries are trying to reduce the use of central planning and rely more on the behavior of firms and households operating in open markets to improve economic decisionmaking and resource allocation. However, the transformation has not progressed as quickly or as smoothly as originally hoped. Moreover, basic policy disagreements continue over the pace of privatization, the conditions under which foreign firms should be allowed to enter a nation's market or buy its existing firms, and other issues central to the process of economic reform.

To understand better the difficulties policymakers face in reforming these economies, we focus on one aspect of the economic transition, banking reform, in one transition economy, Poland. A country's banking system exists to collect funds from savers and lend them to borrowers, as well as to provide an efficient payments mechanism. A system's ability to allocate funds as efficiently as possible to finance productive investment and consumption expenditures is crucial in producing a high and sustainable rate of economic growth. Under central planning, however, the state directed the distribution of funds throughout the economy with no regard for their most productive use. The institutional infrastructure and incentive structure necessary for decentralized credit allocation decisions based on rational economic criteria never developed.

The issues Poland has faced in reforming its banking system are similar to those confronting other transition economies. The banking system emerged from the Communist era with little capital, a large portfolio of nonperforming loans, no meaningful system of accounting, little recourse for lenders in the event of default, technologically backward operations, and inadequately trained staff. Prudential regulatory and supervisory capabilities to address moral hazard incentives and corruption were almost nonexistent. In addition, by the end of the 1980s, the country was on the brink of hyperinflation,

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which was eroding public confidence in the Polish currency, the złoty.

Poland's banking problems also bear similarities to those of developed economies. Even though Poland has been making the transition toward a market economy for several years, the majority of its banking system assets are still controlled by the state. Thus, deciding how and when to privatize commercial banks is an important issue. However, some of Poland's largest banks are undercapitalized and have inadequate resources to address their nonperforming loan problems. Privatizing poorly capitalized banks can create a moral hazard incentive that would raise the cost of resolving bank failures in the future, a situation we have seen develop in many countries in recent years. For example, the problems in the U.S. banking and savings and loan industries in the 1980s—inadequately capitalized institutions, insufficient regulatory oversight, and an unwillingness to address the moral hazard incentives caused by generous deposit insurance guarantees—led to a large taxpayer-financed bailout and congressional reform. The knowledge gained in the U.S. can help policymakers in Poland to avoid similar mistakes.

Another topic of current interest in Poland is whether the banking industry should consolidate to improve efficiency and better serve larger firms. Some believe that existing Polish banks are too small and too regional in nature to compete effectively; hence, they favor merging regional banks to form larger banking groups. Given that the U.S. has also been undergoing a period of banking consolidation and expansion across state lines, an understanding of the pros and cons of consolidation in Poland broadens our understanding of the issue.

A third issue concerns policy on foreign financial institutions wishing to operate in Poland. Some foreign banks have entered the Polish market by acquiring an equity stake in an existing bank, while others have built their operations from scratch. On the one hand, Poles recognize that foreign banks bring in modern technology, management techniques, and additional capital, which can enhance the quality and sophistication of the financial services offered to the public. On the other hand, they fear that domestic institutions will be unable to compete effectively and that foreign banks will dominate the Polish banking system. Given Poland's history of being dominated by foreign countries, there is a strong feeling that allowing foreign banks to gain the upper hand would not be in the country's best interests in the long run. Many countries, including the U.S., have confronted this issue.

While Poland has come a long way in reforming its banking system, in our view more progress needs to be made before Polish banks can operate efficiently. We believe the key problem facing Polish banks today is not that they are too small but that they have too little capital. Without adequate capital, these banks are constrained to hold large amounts of government securities instead of making commercial loans. As a result, less credit is available to businesses and households than would otherwise be the case. Consolidating banks without infusing capital would not improve the situation; indeed, the cost of consolidation would reduce capital adequacy even further. Improving capital adequacy, in our opinion, should be a higher priority than encouraging consolidation.

Below, we present an overview of the banking reform program and the impact of economic conditions on the banking industry in the first few years of the transition. We analyze the performance of Polish banks during the 1990s. Then we discuss the most pressing issues facing both the government and the industry in the years to come.

Banking reform at the beginning of the transition

Under Communist control from the end of World War II to the end of the 1980s, Poland's banking system became highly centralized and primarily served as a conduit for transferring funds between the central government and the various state enterprises that controlled the country's economic life. The most important financial institution, the National Bank of Poland (NBP), served as both central bank and supplier of credit to key industries. Decisions on monetary policy, the allocation of credit to borrowers, and the scope of the NBP's operations were made by the central government. The NBP was directly responsible to the Ministry of Finance, with the president of the NBP serving as Undersecretary of State at the ministry.

During the 1980s, the Polish government began reforming the banking system. The Banking Act of 1982 separated the NBP from the Ministry of Finance and required parliamentary approval for the appointment of the president of the NBP. This act also legalized the formation of private banks as joint stock companies with or without foreign equity participation. However, the NBP continued to perform the functions of both a central and a commercial bank until 1989, when the Parliament passed a new Banking Act and the National Bank of Poland Act. Approximately 400 regional branch offices of the NBP were converted into nine regional, state-owned commercial banks, as listed in table 1. These banks, centered in major cities, inherited a substantial part of the NBP's commercial loan portfolio, consisting primarily of loans to existing state-owned enterprises (SOEs). As the first step in the ultimate privatization of these banks, in September and October 1991 the nine banks were converted into joint stock companies wholly owned by the Ministry of Finance. To date, four of the nine have been privatized, with their stocks trading on the Warsaw Stock Exchange.

The remainder of the NBP became a traditional central bank in the western sense, holding reserves, issuing currency, advancing credit to the banking system, overseeing the payments system, and holding part of the debt of the Polish government. The independence of the central bank was reinforced by law, with the president of the NBP now nominated by the President of Poland and confirmed by Parliament. In addition to its monetary policy functions, the reorganized NBP is responsible for supervision and regulation of the banking system.[1]

By 1990, the government owned six other specialized banks (also listed in table 1). PKO BP was separated from the NBP in 1988. Its primary functions were to accept household deposits and advance loans to finance public housing construction. The bank has a nationwide network of branches and other outlets and the largest share of total deposits (26.8 percent

TABLE 1

Structure of the Polish banking industry

	City	Total assets	Percent of total banking assets
		(million złoty)	
The nine commercial banks			
Bank Depozytowo-Kredytowy	Lublin	3,658.8	2.1
Bank Gdański	Gdańsk	4,636.6	2.7
Bank Przemysłowo-Handlowy (BPH)	Kraków	7,448.3	4.3
Bank Zachodni	Wrocław	5,048.7	2.9
Pomorski Bank Kredytowy (PBKS)	Szczecin	3,661.6	2.1
Powszechny Bank Gospodarczy (PBG)	Łódź	9,181.0	5.4
Powszechny Bank Kredytowy	Warsaw	8,373.5	4.9
Wielkopolski Bank Kredytowy (WBK)	Poznań	5,035.9	2.9
Bank Śląski	Katowice	8,683.7	5.1
Total for the nine banks		**55,728.1**	**32.5**
The specialist banks			
Powszechna Kasa Oszczędności - Bank Państwowy (PKO BP)	Nationwide	35,839.1	20.9
Polska Kasa Opieki SA (Pekao SA)	Nationwide	21,679.3	12.6
Bank Handlowy	Warsaw	12,731.4	7.4
Bank Gospodarki Żywnościowej (BGŻ)	Warsaw	13,153.1	7.7
Polski Bank Rozwoju (PBR)	Warsaw	1,263.0	0.7
Bank Rozwoju Eksportu (BRE)	Warsaw	3,621.5	2.1
Total for the specialist banks		**88,287.4**	**51.5**
Other banks		27,475.7	16.0

Note: Total assets data are for September 30, 1996.
Source: *Gazeta Bankowa,* December 8, 1996.

as of the end of June 1996) of any bank in Poland. Pekao SA offers deposit accounts denominated in foreign currencies through its nationwide branch network, and serves as a vehicle for overseas Poles to remit funds to their relatives in Poland. As of June 30, 1996, it held 16.8 percent of Poland's total deposits. Bank Handlowy, which was started in 1870, is a major corporate bank providing a wide range of financial services, including foreign trade financing. BGŻ, the Bank for Food Economy, is the primary supplier of credit to the agricultural sector. The bank is owned partly by the national government and partly by over 1,200 local cooperative banks, which offer deposit accounts and loans to private farmers and self-employed craftsmen. BRE, the Export Development Bank, was established in 1987 to provide trade financing and competition for Bank Handlowy and Pekao SA. This bank was privatized in 1992. Finally, PBR, the Polish Development Bank, was established in 1990. It operates primarily as a banker's bank, channeling funds to other banks from foreign credit lines or its own resources. It has also been involved in the organization and development of the Polish interbank money market.

During the early part of the transition, the growth of privately owned banks was encouraged. In an effort to increase competition among banks, the government liberalized entry requirements for the establishment of new banks. For example, the minimum amount of capital needed to secure a banking license at the end of 1989 was 400,000 złoty, approximately $61,500 at the prevailing exchange rate.[2] Moreover, the rules concerning the background and experience of bank owners and managers were not rigorously enforced. As a result of the liberal entry policy, the number of banks in Poland expanded from six in 1988 to 75 by the end of 1990.

The economic environment in the early years of the transition

As Poland's first non-Communist government since the end of World War II assumed power in September 1989, the economy was in serious difficulty. To curry favor with the electorate prior to the 1989 parliamentary elections, the previous government had increased government spending and paid for it by increasing the money stock. As a result, the budget deficit soared to 7.4 percent of gross domestic product (GDP) in 1989, and the inflation rate rose from an already high 60.2 percent in 1988 to 251.1 percent in 1989. (Selected economic statistics are presented in table 2.) After some discussion of what kind of economic reform program to put in place, the Polish government implemented what came to be known as the Balcerowicz Plan, a bold program of "shock therapy" designed to speed the process of economic liberalization and make it extremely difficult for a future government to go back to the previous system.[3] Almost all prices in the economy were decontrolled in 1990, while at the same time consumer and producer subsidies were cut from 12.9 percent of GDP in 1989 to 7.3 percent in 1990, 5.1 percent in 1991, and 3.3 percent in 1992. As a result of the lifting of price controls and the lagged effects of the expansionary monetary policy, inflation worsened in 1990 to 585.8 percent.

Another aspect of the Balcerowicz Plan was to promote greater competition among Polish industries. As a result of central planning, most Polish industries were highly concentrated, and the fear was that decontrolling prices would lead to monopolistic pricing policies that would reduce overall social welfare. The government addressed this issue by eliminating all nontariff restrictions on imports and reducing the average tariff rate from 13.3 percent to 8 percent. Foreign competition, it was hoped, would hold in check the desire of large industrial enterprises to raise prices and also give these firms an incentive to improve quality and service to their customers. At the same time, the Polish złoty was devalued by 31.6 percent from 0.65 to 0.95 złoty per dollar to give Polish firms an initial competitive advantage over their foreign competitors.

The initial effects of the Balcerowicz Plan were positive. The government budget actually showed a surplus of 2.8 percent of GDP in 1990. The quantity and variety of goods available for sale expanded, and lines to purchase scarce consumer goods, a fact of life under Communism, disappeared. The currency devaluation initially helped Polish exporters. A spirit of optimism pervaded the country and was bolstered by the fall of Communism in neighboring countries. The initial euphoria over political and economic reform, however, gave way to a severe recession, with declines in real GDP of 11.6 percent in 1990 and 7.6 percent in 1991. There were several causes. First, the

rapid change in relative prices brought about by deregulation forced businesses to restructure quickly or close their doors. Unemployment grew rapidly and industrial production fell. Second, the shift in the government budget from deficit in 1989 to surplus in 1990 was, in effect, a substantial tightening of fiscal policy, which in time would have a dampening effect on the growth of aggregate demand. Third, in an effort to contain inflation, the NBP adopted a more restrictive monetary policy and interest rates soared. Thus, even if firms could gain access to credit, the price of credit was very high. Fourth, with the collapse of the Soviet Union, Poland lost its largest export market. Finally, Western Europe was undergoing a recession of its own during this period, which further reduced demand for Polish exports. Not surprisingly, the rate of unemployment rose dramatically from almost zero in 1988 to 11.8 percent by the end of 1991.

Effect of economic reform on the banking system

The volatile conditions that persisted in the economy also affected the banking sector. In terms of reported income, bank profits were positive at the beginning of the transition. In particular, 1990 was an excellent year, with the industry earning 1.66 billion złoty, which represented a return on assets of 7.2 percent. The high rate of net income was primarily due to the banks' ability to hold deposit interest rates below the rate of inflation while earning a positive real return on loans; hence, the industry recorded a net interest margin of 17 percent of total assets during 1990. Net income fell in nominal terms by 13.5 percent in 1991 to 1.44 billion złoty, and rose in 1992 by 4.3 percent to 1.5 billion złoty. Adjusted for inflation, however, net income fell by 49 percent in 1991 and by 27.1 percent in 1992. The deterioration in the industry's net profit position was based in part on greater competition in both the loan

TABLE 2

Selected economic indicators, 1989–96

	Units	1989	1990	1991	1992	1993	1994	1995	1996
GDP (current prices)	bil. złoty	11.8	59.2	80.9	114.9	155.8	210.4	286.0	351.7[a]
Inflation (CPI)	%	251.1	585.8	70.3	43.0	35.3	32.2	27.8	19.9
Real GDP growth	%	0.2	–11.6	–7.6	1.5	3.8	5.3	7.0	6.0[a]
Government budget surplus	% of GDP	–7.4	2.8	–2.0	–4.9	–2.3	–2.2	–1.8	–2.4
Unemployment rate	% (yearend)	6.1	11.5	11.8	13.6	15.7	16.0	14.9	14.0[a]
Current account balance	bil. $	–1.8	0.7	–2.2	–0.3	–2.3	0.9	–2.3	–1.0[b]
External debt	bil. $	49.0	48.0	47.6	48.4	47.3	42.2	43.9	42.9[c]
Exchange rate	złoty/$ (yearend)	0.7	1.0	1.2	1.6	2.1	2.4	2.5	2.9
Total currency in circulation	bil. złoty (yearend)	1.0	3.9	5.6	7.8	10.0	12.3	19.5	23.6
Annual growth rate	%	91.5	298.1	42.8	38.8	28.0	23.0	59.1	20.6
Currency plus domestic deposits	bil. złoty (yearend)	NA	13.1	19.7	30.9	39.8	55.2	83.0	111.1
Annual growth rate	%	NA	NA	50.3	57.3	12.9	38.7	50.2	34.0
Currency plus domestic and foreign deposits	bil. złoty (yearend)	NA	19.1	26.1	41.1	55.9	77.3	104.3	134.5
Annual growth rate	%	NA	NA	36.9	57.5	36.0	38.2	34.2	29.0

[a]1996 figures are estimates.
[b]For 11 months of 1996.
[c]Through September 1996.
Note: NA is not available.
Sources: GDP figures are from the Central Statistics Office in Warsaw. All other figures are from the National Bank of Poland, *Information Bulletins*, various years.

and deposit markets, which reduced the net interest rate spread to 3.7 percent of total assets by 1992.

However, these profit data do not reflect the true economic deterioration of Polish banks during the 1990–92 period for several reasons. First, in 1990 and 1991 banks were required to record interest accrued on loans but not actually paid by borrowers as income. This had the effect of overstating the actual income that banks were receiving, as well as depleting the industry's capital since banks had to pay income tax on profits they did not actually receive. The Ministry of Finance finally rectified this situation in 1992, leading to lower reported interest income in 1992 and subsequent years.

A second reason bank profit figures overstated the sector's performance was the deteriorating condition of the economy and the banks' response. Real GDP fell 18.3 percent from 1989 to 1991. Much of the decline was concentrated among the large SOEs, but these firms were unable or unwilling to restructure their operations in response to falling demand for their output. As a result, these firms were unable to service their loans and needed additional credit to cover their losses. Because they had always been bailed out by the government in the past and their size meant they could not be closed without a huge increase in local unemployment, they had little incentive to change. For the most part, the banks chose to extend the loan repayment period and convert the unpaid interest into principal rather than declare the loan to be in default or initiate other workout procedures. This increased these banks' overall risk exposure. Moreover, because they were among the largest firms in Poland and at the time there were no restrictions on the amount a bank could lend to one customer, their solvency could be jeopardized by the default of a small number of borrowers.

A third reason the accounting data masked the deterioration of bank capital was that banks did not add enough to their loan loss reserves as the amount of nonperforming loans was increasing. One reason for this was that only provisions made for loans classified as lost were tax deductible; provisions for loans classified as doubtful or substandard are not tax deductible. In addition, the degree of regulatory oversight was low because the NBP did not have legal authority to enforce provisioning standards until March 1992. Thus, banks had little incentive to provision against potential loan losses, so the amount of reported capital on their balance sheets overstated their true net worth.

An examination of problem loans reported by Polish banks sheds some light on the extent of the bad loan problem in the 1990–92 period. During that time, the number of enterprises estimated by banks as incapable of repaying interest and principal on time grew more than sevenfold from 548 to 4,448. As shown in table 3, the proportion of nonperforming loans increased from 1991 to 1992. According to NBP bank supervision policy, the loan provision requirements against nonperforming loans (as a fraction of these loans) were 20 percent for substandard, 50 percent for doubtful, and 100 percent for loss. The data in table 3 show that actual provisioning as of the end of 1992 was considerably below what was needed to meet government standards. Clearly, some banks did not have enough capital to reserve fully against their nonperforming loans. Although these firms were insolvent in economic terms, they were allowed to continue operations. In the case of privately owned and operated banks, such a decision would have created a moral hazard incentive to increase risk taking in the hope of regaining solvency. Because the vast

TABLE 3

Nonperforming loans

As a percent of total loans

Category	1991	1992	1993	1994	1995
Substandard	8.4	9.2	7.1	5.7	5.0
Doubtful	4.8	9.2	6.0	5.3	3.4
Loss	2.6	11.6	17.9	17.7	12.8
Total	15.8	30.0	31.0	28.7	21.2

Provision coverage as a percent of required

Category	1991	1992	1993	1994	1995
Substandard	31.6	11.8	16.3	25.8	26.1
Doubtful	16.9	6.6	25.0	55.4	59.5
Loss	26.7	36.8	87.1	100.1	100.2
Total	62.1	33.1	82.6	103.1	103.8

Note: Total loan provision coverage is calculated based on required coverage of 20 percent, 50 percent, and 100 percent for loans classified as substandard, doubtful, and loss, respectively.

Sources: Data for 1991 and 1992 are from the National Bank of Poland. Data for 1993 through 1995 are from OECD (1996).

majority of banking assets was still owned and controlled by the government, the moral hazard incentive could be contained.

The problems confronting Poland's banking industry required action on several fronts. First, the government passed a revised banking law in March 1992, giving the NBP the authority to enforce capital adequacy and loss provisioning standards. The law also set limits on the amount a bank could lend to one borrower; no loan could be for more than 10 percent of capital and total loans to a single borrower could not exceed 15 percent of capital. Second, to address knowledge deficiencies among bank employees and management about modern bank practices, the International Monetary Fund and the World Bank funded a program in which a commercial bank from the West would be "twinned" with one of the nine ex-NBP banks. The western bank would send staff to the Polish bank to introduce western banking practices and technology and to train staff. Seven of the nine banks chose to participate and contracts were signed in mid-1992. A similar program was set up to help train bank examiners and provide technical assistance to the NBP to modernize its operations.

Now that it had the legal authority to deal with the banking crisis, the NBP, in cooperation with the Ministry of Finance, began to act. First, international accounting firms were hired in 1992 to conduct an audit of loan portfolios as of the end of 1991. For the nine ex-NBP banks, 9 percent of the best bank's loan portfolio was considered doubtful or lost, while in the worst bank the figure was as high as 60 percent. All nine banks were instructed to establish workout departments, assign to these departments loans classified as doubtful or loss, and take action to recover the loans. In November 1992, the NBP issued an order requiring banks to provision fully against all lending to these customers by the end of 1993 (later extended to March 31, 1994). Finally, an Enterprise and Bank Restructuring Program (EBRP) to address the undercapitalization of the banks and the causes of the bad loan problem went into effect on March 19, 1993.

The EBRP initially applied to seven of the nine ex-NBP banks. (Wielkopolski Bank Kredytowy and Bank Śląski were shown by the 1992 audit not to require restructuring and were privatized in 1993 and 1994, respectively.) The key feature of the EBRP was a one-time recapitalization of the banks, with the size of the capital infusion based on the value of each bank's nonperforming loan portfolio at the end of 1991. The recapitalization, totaling approximately $520 million, would raise each bank's risk-based capital–asset ratio to 12 percent, well above the Basel norm of 8 percent, to ensure adequate capitalization should loan quality deteriorate and to make credible the promise that this would be the last opportunity to recapitalize. To qualify, the banks were required to undergo another credit evaluation by outside auditors, set up workout departments, and take action to resolve all loans classified as nonperforming at the end of 1991. By the end of March 1994, each bank had to show that either 1) a court or bank conciliation agreement had been signed (similar to chapter 11 in the U.S.); 2) the debtor had been fully servicing its debt for at least the previous three months; 3) the debtor had been declared bankrupt; 4) liquidation had been initiated under the Privatization Law (privatization is pending) or under the law on SOEs (the enterprise is being shut down); or 5) the debt had been sold on a secondary market. The law also required that no new loans be made to nonperforming borrowers, which reinforced a guideline put in place by the NBP in 1992.

Gray and Holle (1996) analyzed the effect of the EBRP on creditors and borrowers. They conclude that the program had many benefits. It gave the banks a needed recapitalization and forced them to develop the institutional capability to deal with problem debtors. It required them to resolve these loans through workouts, loan sales, or forced liquidation. Gray and Holle report that larger and/or stronger firms tended to repay their debt or enter bank conciliation, while smaller and/or weaker firms tended to go into bankruptcy or liquidation. However, they also conclude that the program has not achieved the level of borrower restructuring its architects had hoped for. The restructuring agreements that banks signed with borrowers dealt primarily with financial conditions and did not address fundamental management or operational changes. Gray and Holle contend that the system of bankruptcy and, especially, SOE liquidation does not give enough control to creditors of distressed firms. They argue the existing system leads to lenient treatment of borrowers that may delay needed restructuring of SOEs.

Behavior and performance of Polish banks since 1992

As shown in table 2, the economy recovered strongly from the recession of the early 1990s, with real GDP growth increasing from 3.8 percent in 1993 to 7 percent in 1995 and an estimated 6 percent in 1996. Inflation has continued to fall every year since 1990, reaching 19.9 percent in 1996.

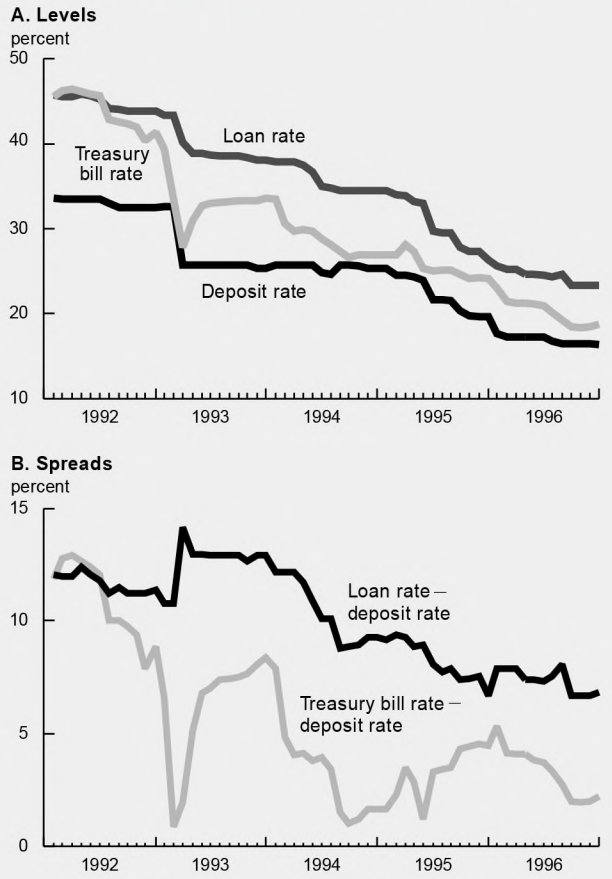
The improving inflation picture has led to a rapid decline in interest rates. Figure 1 illustrates the decline in short-term interest rates since the beginning of 1992. In January 1992, the three-month Treasury bill yield was 45.6 percent. It declined steadily over the next four years to 18.79 percent by December 1996. Deposit and loan rates have also declined, but the spread between Treasury bills and deposit rates of similar maturity has remained positive. The spread between loans and deposits has also remained large, though it has decreased somewhat over the past two years. The large spreads between interest-earning assets and the banks' costs of funds have enabled banks to maintain high net interest margins.

Table 4 presents aggregate balance sheets for selected years from 1992 to 1996, and table 5 shows selected ratios. As shown in table 5, the ratio of capital to total assets declined from 4.8 percent in 1992 to 4.3 percent in September 1996. However, the 1992 figure overstated the true net worth position of the banking system because provisions for loan losses were made for only 33.1 percent of what was legally required. By the end of 1994, according to OECD (1996) data, the coverage ratio had risen to over 100 percent, indicating that reserve levels now appear to be adequate. The capital–asset ratio declined to 3.1 percent in 1995, but due to improved profitability and a 700 million złoty capital infusion into BGŻ, it rose in 1996.

Table 5 also shows the rapid growth of holdings in government securities. The share of securities in bank portfolios rose from 15.6 percent at the end of 1992 to 30.1 percent at the end of September 1996. There are three reasons for the growth in government securities relative to other asset categories. First, Treasury spreads over deposit rates have been positive, so they have represented a low-risk method to increase net interest income. Second, since Treasury bills and bonds are counted as only 10 percent and 20 percent, respectively, in the calculation of risk-weighted assets, the return per złoty of capital is extremely high, especially adjusted for risk. Moreover, the low level of capital in the Polish banking system implies that banks must hold a significant quantity of government securities to meet the risk-based capital standard of 8 percent of risk-weighted assets. Finally, given the risky commercial lending environment in Poland, it made sense

FIGURE 1

Selected three-month interest rates



Source: National Bank of Poland, *Information Bulletins*, various issues.

TABLE 4

Aggregate balance sheet of commercial banks

	1992		1994		1996[a]	
	bil. złoty	% of total assets	bil. złoty	% of total assets	bil. złoty	% of total assets
Assets						
Cash and reserves at NBP	5.85	8.96	8.39	6.94	10.61	5.56
Due from other financial institutions	2.60	3.98	6.06	5.01	11.65	6.11
Due from abroad	10.49	16.07	18.87	15.60	16.97	8.85
Due from general government	2.66	4.08	0.89	0.74	1.68	0.88
Total loans	24.33	37.28	41.54	34.34	70.59	37.01
Corporate	23.14	35.45	38.21	31.59	61.22	32.11
Personal	1.19	1.82	3.32	2.74	9.37	4.91
Securities	10.17	15.58	28.87	23.87	57.46	30.13
Other assets	9.01	13.80	16.35	13.52	21.73	11.39
Total assets	**65.27**	**100.00**	**120.95**	**100.00**	**190.70**	**100.00**
Liabilities						
Foreign liabilities	3.02	4.63	3.76	3.11	6.54	3.43
Due to financial institutions	7.97	12.21	13.86	11.46	21.95	11.51
Due to general government	3.91	5.99	3.69	3.05	8.00	4.19
Złoty deposits of nonfinancial sector	23.06	35.33	42.97	35.53	77.89	40.84
Demand deposits	7.10	10.88	15.18	12.55	1.35	11.20
Savings deposits	0.95	1.46	1.45	1.20	2.37	1.24
Time deposits	15.01	23.00	26.35	21.79	54.16	28.40
Foreign currency deposits of nonfinancial sector	9.08	13.91	22.05	18.23	22.39	11.74
Demand deposits	2.59	3.97	7.52	6.22	8.26	4.33
Time deposits	6.49	9.94	14.53	12.01	14.13	7.41
Other liabilities	14.90	22.83	28.47	23.54	45.71	23.97
Tier 1 capital	3.13	4.80	5.40	4.46	8.22	4.31
Total liabilities and capital	**65.27**	**100.00**	**120.95**	**100.00**	**190.70**	**100.00**

[a]Through September 1996.
Note: Numbers may not total exactly due to rounding.
Source: National Bank of Poland, *Information Bulletins*, various issues.

TABLE 5

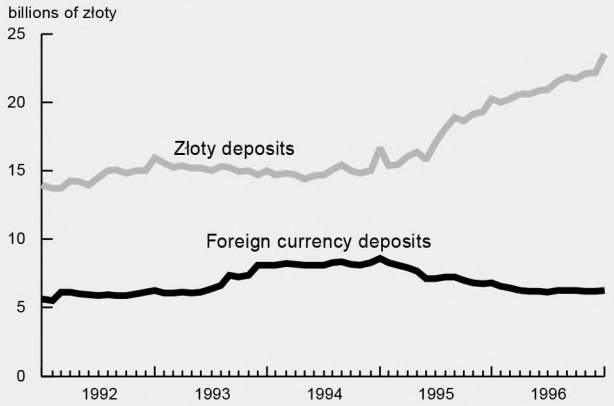
Polish banks: Selected ratios
(percent)

Category	1992	1993	1994	1995	1996[a]
Tier 1 capital/asset ratio	4.8	5.5	4.5	3.1	4.3
Nonperforming loans/total loans	30.0	31.2	28.3	21.5	15.1
Loans/total assets	37.3	36.2	34.3	35.1	37.0
Securities/total assets	15.6	19.9	23.9	27.0	30.1
Demand deposits/total deposits	30.2	31.2	34.9	30.3	29.5
Foreign deposits/ total deposits	28.3	35.0	33.9	25.1	22.3
ROA	2.7	-0.2	-0.0	2.0	2.8
ROE	54.0	-4.6	-0.2	44.9	65.7
Loans/GDP	20.3	19.1	17.7	17.9	22.4

[a]Balance sheet estimates as of September 30, 1996. ROA and ROE through first nine months of 1996.
Source: National Bank of Poland.

FIGURE 2

Złoty deposits versus foreign currency deposits, adjusted for inflation



Note: The deposit levels were deflated by the Consumer Price Index (December 1991 = 1.0).
Source: National Bank of Poland, *Information Bulletins*, various issues.

for banks to invest in safe government securities until they had adequate capital to bear the risks of commercial lending. This behavior is similar to that observed among U.S. commercial banks during the so-called credit crunch from 1989 to 1992. Indicating an improvement in the Polish banking environment, the share of loans to total assets has been increasing since the end of 1994.

The most striking feature on the liability side of the balance sheet is the huge growth in domestic deposits in 1995, up 47.6 percent from the 1994 level. Most of the increase is concentrated in personal time deposits, which rose by 80.6 percent. However, personal demand and savings deposits rose by 95.3 and 41.2 percent, respectively, indicating a growing level of personal savings is finding its way into the banking system. Figure 2 illustrates the growth of inflation-adjusted złoty deposits and foreign currency deposits since the end of 1991. Adjusted for inflation, złoty deposits showed little change from the end of 1991 to early 1995, but have grown significantly since then. The growth has been exclusively in domestic currency deposits. The re-denomination of the złoty in January 1995 presumably increased public confidence in holding domestic currency deposits, while the decline in the value of the dollar in the first half of 1995 made foreign currency deposits less attractive to Polish savers. The introduction of formal deposit insurance in Poland, effective February 1995, may also have contributed to the growth in domestic deposits.[4] Despite this rapid deposit growth, banking services are underutilized relative to other countries. For example, OECD (1996) reports that only 10 percent of the population have a bank account and cash is by far the most common means of payment in Poland.

As these data illustrate, the period from 1992 to the present has been an opportunity for the banking system to recapitalize and increase its reserves against nonperforming loans. Polish banks have held a high proportion of government securities, a policy that continues to be very profitable on a return-on-equity basis. As shown in table 6, Polish banks are still undercapitalized relative to the U.S. and the UK. Although their capitalization appears comparable to that of German banks, German banks have equity holdings on their balance sheet that are booked below their market value. Until very recently, the need to maintain large holdings of government securities to boost profits, improve capital

TABLE 6

Country comparisons of selected banking ratios for 1995
(percent)

Country	Capital/ assets	Securities/ assets	Loans/ assets	ROA
United States	8.1	18.8	60.4	1.13
United Kingdom	4.8	16.1	50.0	0.84
Germany	3.0	16.4	56.6	0.24
Czech Republic	3.5	16.2	35.0	0.19
Poland	3.1	27.0	35.1	2.00

Notes: Data for the U.S., the Czech Republic, and Poland are for the entire banking system. Data for Germany are based on a summation of data for Bayerische Vereinsbank, Commerzbank, Deutsche Bank, Dresdner Bank, BHF Bank, and Hypobank. Data for the UK are based on a summation of data for Barclays, HSBC, Lloyds, Midland, Nat West, and Standard Chartered Banks.

Sources: U.S. data are from the FDIC, *Statistics on Banking*. German, UK, and Czech banking data are from *BankWatch*. Polish data are from the National Bank of Poland.

adequacy, and remain above risk-based capital levels has constrained Polish banks from increasing their commercial lending activity.

The undercapitalization of the banking system and its effect on the balance sheet can be seen in the performance of the largest state-owned banks (see table 7 for selected ratios by bank group). The top four banks, PKO BP, Pekao SA, BGŻ, and Bank Handlowy, hold over 40 percent of banking system assets. This group has the lowest leverage ratio, the highest concentration of securities to assets, and the lowest ratio of loans to assets of any group of Polish banks in the last two years. The data in table 7 also indicate that these four banks have the lowest risk-based ratios of any Polish bank group from 1993 to 1996. Their combined capital ratio rose in 1996 due to higher bank profits and the partial recapitalization of BGŻ. The remaining groups' capital ratios dropped in 1996 due to a surge in loans made by banks. (See appendix on PKO BP and BGŻ and section on consolidation below for more details on the undercapitalization of these banks. Bank Handlowy is well-capitalized and profitable.)

TABLE 7

Selected ratios by bank group

	1993	1994	1995	1996 (Oct)
Top four banks				
% of system assets	45.4	45.0	43.8	42.7
Leverage ratio[a]	5.1	4.4	1.6	3.0
Risk-based capital ratio	3.5	6.7	5.3	9.0[b]
Securities/assets	20.5	27.0	33.2	38.0
Loans/assets	34.5	31.6	30.0	29.8
Remaining state-owned banks				
% of system assets	22.9	23.3	17.2	15.6
Leverage ratio	6.2	5.0	5.0	5.1
Risk-based capital ratio	22.5	21.4	20.1	16.9[b]
Securities/assets	22.1	22.2	23.4	22.4
Loans/assets	39.5	37.0	40.3	47.2
Domestic private banks[c]				
% of system assets	29.3	28.6	35.0	36.6
Leverage ratio	3.7	2.4	2.7	3.2
Risk-based capital ratio	9.8	13.5	14.9	14.5[b]
Securities/assets	18.0	21.3	22.1	21.2
Loans/assets	36.7	36.2	38.3	33.1
Foreign banks				
% of system assets	2.4	3.1	4.0	5.1
Leverage ratio	10.0	10.7	13.4	15.4
Risk-based capital ratio	10.0	12.3	21.7	18.9[b]
Securities/assets	8.9	14.3	19.3	15.1
Loans/assets	31.3	37.4	41.0	42.5

[a]Leverage ratios are computed with Tier 1 plus Tier 2 capital.

[b]September 1996.

[c]These include banks owned by local governments and state-owned enterprises as well as banks held in receivership by the NBP.

Source: Computed from data obtained from the National Bank of Poland.

Challenges: The role of foreign banks, privatization, and consolidation

The role of foreign banks, the timetable and extent of Polish bank privatization, and the issue of consolidation are intricately intertwined. These issues are also closely linked to the capital adequacy, profitability, and efficiency of Polish banks.

Foreign banks

In the initial stages of Poland's economic transition, the government had encouraged the entry of foreign banks to the market. In the liberal licensing environment of the early 1990s, the government tried to promote private banks that would compete with the large state-owned banks that were planned for quick privatization. The Ministry of Finance sought strategic investors and encouraged foreign participation through the twinning program (which was implemented with the idea that foreign participating banks would be allowed to hold a stake in their Polish twin).

The privatization of most state-owned banks has been delayed, however, due to systemic problems related to the lack of prudential regulation and supervision, bad loan problems, and undercapitalization. Consequently, the entry of foreign banks into Poland has also been delayed. Currently, foreign banks are limited to purchasing shares in existing Polish banks or to outright purchase and recapitalization of failing banks. As of the end of September 1996, they held 5.1 percent of total bank assets in Poland and 5.6 percent of total loans. The NBP has maintained a policy of quickly resolving troubled banks through

liquidation or merger, regardless of the origin of the potential buyer. Thus, foreign banks have been allowed to enter the market if they could aid in restructuring Polish banks.

Only recently has the Ministry of Finance agreed to allow foreign banks to control the majority of equity in a large bank. For example, the ministry agreed last summer to sell the remainder of its stake in Bank Śląski to ING (Netherlands), raising its stake to 51 percent. This change in policy toward foreign ownership of banks may have been influenced by Poland's entry to the OECD in the summer of 1996 and the continuing negotiations over its proposed entry to the European Union. Nevertheless, the government has postponed opening the banking sector to full foreign entry from 1997 to 1999. At that time, foreign banks will be able to establish a branch merely through registration.

Since foreign banks are well capitalized, well managed, and highly profitable, they are seen as a threat to the inadequately capitalized and relatively less skilled Polish banks. To date, foreign banks in Poland have concentrated in commercial loans, trade finance, cash management, and other fee-based activities, but their territory is expanding. For example, Citicorp started accepting deposits from households in January 1997, while Hypobank (Germany) is interested in developing consumer and mortgage lending operations. Several foreign banks have applied for licenses to operate in Poland. On the positive side, foreign banks bring in capital that can help the banking system expand to meet the needs of Poland's growing economy. Furthermore, competition from foreign banks will induce Polish banks to become more efficient and offer their customers better service.

Privatization

Of the original nine banks spun off from the NBP, four have been successfully privatized, WBK of Poznań (1993), Bank Śląski (1994), BPH of Kraków (1995), and Bank Gdański (1995), although Bank Śląski and BPH subsequently received capital infusions through foreign participation. Powszechny Bank Kredytowy of Warsaw is tentatively scheduled for privatization in 1997 and Bank Zachodni of Wrocław in 1998. The remaining three banks have been consolidated with Pekao SA into a holding company that is due to be privatized in 1998. In addition, Bank Handlowy will be privatized later this year.

Originally, the nine regional banks were scheduled to be privatized by the end of 1996, but the government decided to delay their privatization. Thus, seven years into Poland's economic transition, 54 percent of total capital in the banking industry was still held by the state (OECD, 1996). There are arguments for and against quick privatization. Proponents of quick privatization argue that the discipline of the market will foster more efficient financial institutions. Private shareholders have a greater incentive to implement cost reductions and expansion of profitable financial services than state-owned institutions. On the other hand, the presence of de facto government guarantees on bank liabilities exacerbates the moral hazard incentive to increase risk taking. Given that many of the state-owned banks are still inadequately capitalized, the government can contain the potential moral hazard problem associated with undercapitalized banks. In view of the danger of allowing poorly capitalized banks to operate with little regulatory oversight, the Polish government could have justification for not following the original privatization schedule for all banks.

The 1994 EBRP recapitalization and the improved profitability of the industry as a whole have allowed banks to increase reserves against potential losses and to build their capital positions. As a result, the case for privatization grows stronger every day. Well-capitalized state-owned banks should be privatized as soon as possible, because the discipline of private ownership and management will induce them to operate more efficiently than they would under public control. Nevertheless, after seven years of government protection, many banks, including some of the largest banks (see appendix), remain undercapitalized and unable to compete effectively with foreign banks. These banks may need to remain in government hands for a longer time to contain the moral hazard problem. However, the policy goal of eventually privatizing these banks as well keeps pressure on them to continue modernizing operations, rebuilding capital, and improving customer service. In the absence of genuine private ownership, such pressure is needed to improve their ability to compete.

Consolidation

The privatization of the remaining state-owned banks has been put into limbo by the government's bank consolidation plans. In late 1994, the Ministry of Finance announced plans to consolidate two groups of banks, one around Pekao SA and the other around Bank Handlowy. The Bank Handlowy consolidation was opposed by BPH (Kraków), one of the banks to be included in the merger, and by the Fund for the Privatization of Polish Banks, which controls foreign donations that have been used to recapitalize the banking system. As a result, the Bank Handlowy consolidation was abandoned and BH will be privatized by itself later this year. However, in September 1996, an agreement was signed officially joining Pekao SA with three of the original nine NBP banks: BDK (Lublin), PBG (Łódź), and PBKS (Szczecin). A full merger of their operations will be worked out over the next year.

The case for consolidation is based partly on the belief that Polish banks lack the size and capital to compete with foreign banks in the loan market and that foreign banks will be able to offer more favorable lending terms to creditworthy Polish firms. Thus, the quality of the loan portfolios at Polish banks will gradually deteriorate, potentially increasing the risk of failure. There are two main arguments in favor of consolidation: 1) the ability of a large bank to make larger loans, given the constraint on lending no more than 15 percent of a bank's capital to any one borrower; and 2) the cost savings of consolidation before privatization. Some argue that loans made by a consolidated bank would have substantially lower transactions costs than loans made through a lending consortium (Wyczański and Gołajewska, 1996). Moreover, some research suggests that the cost per złoty of assets of privatizing a consolidated bank would be lower than the cost of privatizing a group of banks and then allowing them to merge (Bonin and Leven, 1996).

Proponents of privatizing banks before consolidating them argue that banks' management can choose how best to consolidate. Private banks deciding to consolidate would have an incentive to improve efficiency to increase their value at the time of the merger. Proponents also contend that with private firms, the decision to consolidate is more likely to be made on strict economic grounds, allowing for antitrust considerations, than if these firms were consolidated first by the government.

In the banking literature, the main arguments for mergers are efficiency gains (through economies of scale and scope) and risk reduction (through a diversified asset portfolio). However, research evidence shows that most mergers do not, on average, decrease cost ratios (total expenses to assets and noninterest expenses to assets). Studies that take into account the cost effects of changes in output mix generally come to the same conclusion. (Laderman, 1995). We only have indirect evidence on whether, in general, bank mergers reduce risk. Boyd and Graham (1991) found that between 1971 and 1988, U.S. banks with $1 billion or more in assets failed at roughly twice the rate of banks with less than $1 billion. This failure rate, however, could have been due to lower capital ratios rather than operating risk.

It is not clear that the banks which are consolidated to form Group Pekao will enjoy economies of scale or scope. Although the decision to merge Pekao SA and three other banks has been finalized, the details of any projected cost savings have not been worked out. It could be argued that this merger will produce a more extensive branch network and a more geographically and industrially diversified loan portfolio. Currently, there are big disparities in regional growth and some banks are heavily concentrated in certain types of loans, so there may be some advantages to such diversification.

On the other hand, since this consolidation is being arranged by the Ministry of Finance and not by direct negotiation among the banks, the merger of the Pekao SA group has produced tensions among the banks involved. These tensions, which may reflect different organizational structures, goals, and corporate cultures, may produce problems that could raise the cost of consolidation. For example, the smaller banks have expressed concern about losing autonomy. Before the merger, Pekao SA planned to centralize operations like distribution, credit and debit card management, the ATM network, brokerage offices, and international payments. This would relegate the other banks in the group to gathering deposits and making limited loans. The mayor of Łódź has argued that the merger would inhibit regional development by limiting PBG's ability to make local loan and deposit decisions. The smaller banks have proposed a more decentralized organizational structure, akin to a multibank holding company in the

U.S., which would reduce the potential economies of scale from the merger. Even if this issue can be resolved in a manner that leads to a more efficient bank, the four banks together do not have enough capital to build a strong banking organization. To be viable in the long run, the consolidated bank will need an infusion of new capital. At the present time, it is difficult to see where such capital will be found.

The issue of whether to privatize first or consolidate first is not clear. What is clear is that if there is insufficient capital, consolidation only yields a larger institution with insufficient capital. This may exacerbate the moral hazard incentive because the government would be more likely to fully guarantee the liabilities of a large bank than a small bank in the event of a failure. A large bank therefore has a greater incentive to take risks. In our view, until a solution is found that increases the overall capital of the combined group of banks, the proposed consolidation of Pekao SA should not go forward.

Conclusion

Since 1989, Poland has been engaged in a process of economic transformation on several fronts. With respect to bank reform, the overall performance has been mixed. On the positive side, Polish banks have used the latest technology to modernize their operations and have enhanced the knowledge base of their staff through training. They have improved their ability to evaluate creditworthiness and, out of necessity, have developed departments to resolve problem loans to financially distressed borrowers. In general, Polish banks appear to be profitable, and capital adequacy is gradually improving. On the negative side, they have not yet proven successful in effecting changes in corporate governance that would successfully restructure firms with nonperforming loans. In addition, the large state-owned banks, PKO BP and BGŻ, continue to pose problems for the government and the banking system. Their size, undercapitalization, state protection, and slow institutional change have impeded the overall development of the industry.

As Poland looks toward the year 2000, it aims to become more integrated into the West by joining both NATO and the European Union. Reform of the banking system is necessary for this integration to occur. However, reform is inhibited both by a deep distrust of foreigners, partly because several foreign powers have at one time or another controlled its territory, and by a reluctance of entrenched management at state-owned banks to make necessary changes or concede power. What is happening in the banking industry reflects these conflicting attitudes. The government knows that the country would benefit from western experience and capital, but it also wants its banking system to be dominated by Polish-owned and -operated banks. Consolidation of banks has been proposed as a way of building institutions large enough to compete with multinational banking organizations such as Citicorp or Deutsche Bank. In the final analysis, however, capital adequacy is more important than size. With adequate capital, a bank can pursue profit opportunities, take intelligent risks, or expand operations. Without adequate capital, a bank's growth is constrained, it is limited to holding less risky securities instead of potentially more profitable loans, and it has a hard time making needed investments that can enhance its efficiency. The main problem facing Polish banks today is not that they are too small but that they do not have enough capital. Solving the capital problem will enable Poland to build a strong banking industry with or without foreign participation. In order to recapitalize the banks using domestic funds only, the government would have to divert resources from other areas of need. Given current budgetary difficulties, this does not seem feasible. Thus, utilizing foreign sources of capital seems to be a necessary ingredient in achieving the goal of an efficient and sound banking system.

APPENDIX: Big banks, big problems: PKO BP and BGŻ

As of September 1996, PKO BP (State Savings Bank) and BGŻ (Bank for Food Economy) together held 28.6 percent of the total assets of the Polish banking system. Their combined capital was less than 2 percent of assets. Clearly, PKO BP and BGŻ are not the only problem banks in Poland. However, due to their slow restructuring, large capital needs, and sizable nonperforming loan portfolios relative to capitalization, these banks are likely to remain a drain on the government budget and an impediment to the development of a sound banking system for years to come.

PKO BP

PKO BP was established in 1919 as the Post Office Savings Bank, taking its present name in 1950. It was consolidated with the NBP in the mid-1970s and was separated from the NBP in 1988. PKO BP is the largest bank in Poland, with over 1,000 branches and outlets controlling approximately 21 percent of total banking system assets and 26 percent of total deposits as of September 1996. Before 1990, PKO BP's assets consisted mainly of state residential construction loans. Currently, the bank has a high concentration of securities (39 percent of total assets) and a low concentration of loans (28.6 percent of total assets) with new lending primarily going to finance private residential construction. Net earnings for 1996 were 985 million złoty, compared with 345 million złoty in 1995.

The bank is burdened with a large proportion of nonperforming housing loans inherited from the Communist era. At the end of 1993, 84 percent of its loans were housing related and 93 percent of these were made before 1990. By the end of 1994, 16 percent of PKO BP's loans were classified as nonperforming and provisions against these losses were only 37.2 percent of what was required. These loans were mainly given to the 500 largest building cooperatives that constructed and managed low-cost housing. Over the last six years, these cooperatives have been repaying only 20 percent to 30 percent of the interest due to PKO BP. The remaining interest has been capitalized and added to the loan amounts.

Due to the forced capitalization of interest, the Ministry of Finance purchased 2.9 billion złoty of capitalized interest from 1990 to 1992 to maintain PKO BP's liquidity (OECD, 1996). In 1993, the bank received 573.4 million złoty ($272 million) in restructuring bonds as a result of the EBRP. The bad loan problem persists. Although the housing cooperatives are still legally liable for their debts, the bank has not pursued collection. In addition, PKO BP operates inefficiently. For example, the bank's employee–asset ratio of 5.1 per million złoty of assets as of the end of 1994 is more than twice as high as that of any other state-owned bank in Poland.

Although PKO BP's recent earnings performance has been very good, its future remains uncertain. The government will conduct a diagnostic study later this year and it already has plans to convert PKO BP into a joint stock company owned by the Ministry of Finance in 1998. The joint stock company could then be restructured for privatization, but the process is likely to take several years. The government has decided that PKO BP should be controlled by Polish capital, but the source of this capital is unknown. Several options are being discussed, including issuing shares to deposit holders, selling some shares to state pension funds that have yet to be created, and/or selling shares to local governments. Delaying privatization should not affect Poland's entry into the EU, since PKO BP (and BGŻ) will be exempt from EU regulations.

BGŻ

BGŻ was started in 1919 as the State Agricultural Bank and took its current form in 1975 when the Agricultural Bank merged with the Central Association of Credit and Savings Cooperatives. The bank performed financial and coordinating services for nearly 1,600 farm cooperative banks. At the end of 1994, these cooperatives held only 8 percent of the loans in the banking system but served about one-third of the rural population. The bank's internal decisionmaking structure is influenced by the Peasant Party (PSL), which is heavily supported by Polish farmers and agricultural interests.

The cooperative banks were originally required to affiliate with BGŻ, which, in turn, provided the coops with refinancing credit, clearing facilities, and a depository for surplus liquidity. BGŻ functioned as a conduit for direct and subsidized funds from the state to farmers, either directly or through the cooperatives. In an effort to reduce BGŻ's central control and give more authority to the cooperative banks, the government passed the Cooperative Law of 1990. BGŻ was legally separated from the cooperatives. Although BGŻ then formed agreements with 1,270 of the cooperatives to continue their previous relationship, approximately 400 cooperatives became independent of BGŻ. Neither BGŻ nor any other supervisory authority was given responsibility for overseeing these cooperatives. Not surprisingly, many of these unsupervised cooperatives increased their risk exposure by making irresponsible loans and guaranteeing loans. The number of troubled or insolvent cooperatives grew rapidly in 1993 and 1994. By 1994, the activities of 43 cooperative banks were suspended. More than 200 cooperatives were insolvent at the end of 1995.

The cooperatives were not the only source of BGŻ's problems. Although it inherited many of its problem loans from the 1980s, difficult conditions for European agriculture in general and the drought of 1992 in particular have also contributed to its bad loan problem. BGŻ's loan portfolio, comprising about one-half of its assets, is mainly concentrated in food processing, agriculture, and food cooperatives. In 1992, about 24 percent of problem loans were from the food processing sector, which accounts for 40 percent of the bank's loan portfolio. By the end of 1995, BGŻ's share of nonperforming loans stood at 59 percent of total loans. The separation of BGŻ from some of its cooperatives, the lack of supervision, and the absence of a restructuring plan led to irresponsible practices. To correct these problems, the government required BGŻ to convert into a state-owned corporation by the end of 1992 as a precondition for recapitalization in 1993. BGŻ did not comply, in part because compliance would have limited the PSL's control over the bank's board of directors. With the PSL representing the swing vote in Parliament, BGŻ was able to secure a capital infusion via recapitalization bonds of 4.3 billion złoty. As a condition for BGŻ receiving

1.6 billion złoty in recapitalization bonds in 1994, the Restructuring Act of June 24, 1994 was passed.

The law creates 11 regional banks to improve supervision of the cooperatives. The majority of BGŻ's branches will be transferred to the regional banks and all state shares will eventually be sold to these banks. BGŻ will function as a holding company, controlling and coordinating the activities of the regional banks and performing all parent company functions for the cooperative units, including international business. State influence will continue under the new structure.

To date, the restructuring has gone slowly. Only three of the 11 regional banks have been created and BGŻ continues to have problems. In 1996, the bank was given an additional capital infusion of 700 million złoty ($260 million). A true assessment of BGŻ's problems is hampered by politics and a lack of financial transparency. BGŻ continues to receive direct subsidies from the government and to offer below market rate loans. Likewise, BGŻ controls the loan and deposit interest rates of the cooperatives. In addition, BGŻ's deposits are fully covered by the Bank Guarantee Fund and the Ministry of Finance.

The restructuring of BGŻ will continue through the year 2000 and there are no plans to privatize the bank or remove its state guarantees before 2002. Without additional capital or huge earnings, it is difficult to see how BGŻ will reach its target 6 percent solvency ratio by 1999 (or the 8 percent needed for privatization). Recently, Crédit Agricole (France's largest cooperative bank) entered into a twinning agreement with BGŻ. BGŻ is also trying to form joint ventures with RUS (the pension fund for farmers) and Allianz AG of Germany (the largest insurance company in Europe). The European Bank for Reconstruction and Development is considering taking a 10 percent to 20 percent stake in BGŻ and making the bank a large loan. Foreign participation in BGŻ may be its only hope for restructuring, recapitalization, and privatization.

NOTES

[1]See Ugolini (1996) for an excellent discussion of the reorganization of the National Bank of Poland.

[2]The złoty was re-denominated at the beginning of 1995 with one new złoty equal to 10,000 old złoty. To avoid confusion, all figures in the article have been recalculated using new złoty.

[3]The Balcerowicz Plan was named for Leszek Balcerowicz, Deputy Prime Minister and Minister of Finance in the first non-Communist Polish government. For a detailed discussion of the plan and its economic effects, see Slay (1994).

[4]Prior to the introduction of formal deposit insurance, the Polish government did offer deposit guarantees. Deposits at banks in existence at the beginning of 1989 were always guaranteed. Later, the NBP declared that household deposits up to 2,000 ECU would be fully guaranteed and deposits between 2,000 ECU and 3,000 ECU would be partially guaranteed.

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