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Review
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In This Issue . . .

The sluggish response of the U.S. trade and current account balances to the decline of the dollar's foreign exchange value against the currencies of the major industrialized countries since early 1985 has led many analysts to question the traditional construction of exchange rate indexes. Criticism that the coverage of traditional indexes are too narrow to reflect accurately the current pattern of U.S. trade, has led to new, more inclusive aggregate exchange rate measures in recent years. In the first article of this *Review*, "Do The New Exchange Rate Indexes Offer Better Answers to Old Questions?", Dallas S. Batten and Michael T. Belongia examine several of these recently introduced exchange rate indexes.

They find that the newer indexes performed no better than the older measures in explaining U.S. trade flows during the floating rate period. In fact, the traditional, narrower indexes outperformed the newer indexes in explaining the flow of U.S. non-petroleum imports. Hence, the authors conclude that the new exchange rate indexes do not solve the current puzzle surrounding the persistence of the U.S. external deficit.

* * *

Numerous commentators have claimed that the recent application of computer techniques to monitor price differences and trigger trades between the spot, futures and options markets for stocks (called programmed trading) has increased the volatility of stock prices. The alleged increase in volatility is important because it has led to closer scrutiny of the stock market by the Securities and Exchange Commission and periodical calls for legislative action.

G. J. Santoni examines this issue in the second article in this *Review*, "Has Programmed Trading Made Stock Prices More Volatile?" Santoni discusses the theory that underlies programmed trading and examines various measures of stock price variation. These results suggest that programmed trading has *not* increased price volatility in the spot market for stocks.

* * *

Financial stress in agriculture is evident among farmers and their creditors as well. One example of the impact of financial stress among agricultural creditors is the 168 agricultural banks that failed between 1984 and 1986. Nonetheless, not all farm lenders have experienced significant financial difficulty in the course of the post-1980 downturn in the farm sector. Thus, an examination of the puzzle of why some banks failed while others survived is the focus of the third article in this *Review*, "Agricultural Banks: Causes of Failures and the Condition of Survivors."

In this article, Michael T. Belongia and R. Alton Gilbert analyze a sample of farm banks to isolate the likely causes of failures. By looking at 1981 data, they rule out weaker balance sheets or lower earnings prior to the farm sector downturn as potential causes of farm bank troubles: banks that failed and those that survived were similarly capitalized and profitable in 1981. However, the banks that failed held somewhat riskier portfolios than those who did not. For example, the failed banks invested more of their assets in loans generally, and farm loans particularly, than did the surviving banks. The failed banks also held fewer federal government securities, which are free of default risk. Of the surviving banks in 1986, Belongia and Gilbert find that about 70 percent are in sound financial condition. Finally, they find that most counties in the sample still are served by at least one healthy agricultural bank.

Do the New Exchange Rate Indexes Offer Better Answers to Old Questions?

Dallas S. Batten and Michael T. Belongia

THE persistent U.S. trade and current account deficits appear somewhat paradoxical in light of the dramatic decline of the dollar's foreign exchange value against the currencies of industrialized countries since early 1985. Some analysts have argued that the dollar's decline has been overstated. The traditional dollar exchange rate indexes, which include primarily industrial countries' currencies, have been criticized as too narrow to reflect the movement of the dollar accurately. In response to this argument, new, more inclusive aggregate exchange rate measures have been developed.[1] The new broader indexes are alleged to be better measures of the dollar's foreign exchange value and hence, they should better explain U.S. trade flows.

Although the notion that indexes with a broader range of currencies will contain more information has intuitive appeal, neither economic nor index number theory can be used to determine whether a particular exchange rate index is superior to another.[2] In this article we assess the performance of the new indexes empirically. Specifically, we investigate whether one or more of the new indexes is related more closely to U.S. merchandise exports and U.S. non-petroleum imports than three more established and more traditional exchange rate measures. The performance of the alternative exchange rate indexes is evaluated in terms of their in-sample and out-of-sample statistics.

THE CONSTRUCTION OF EXCHANGE RATE INDEXES

Constructing a multilateral exchange rate index requires addressing a number of theoretical and statistical issues.[3] The primary issue in this paper is whether the number of currencies in the index matters — a question for which theory offers no guidance. An index also requires a base year for the trade (or other) weights that will be applied to the constituent currencies. It generally is not possible, however, to find a year that satisfies the necessary criteria.[4] Other practical problems associated with constructing an exchange rate index include the choice of weighting schemes (multilateral or bilateral) and alternative mathematical formulas (geometric or arithmetic).[5]

Characteristics of the Traditional Indexes

Among the best-known exchange rate indexes are those produced by the Federal Reserve Board (FRB), Morgan Guaranty (MG-15) and the International Mon-

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[1]See Cox (1986), Rosensweig (1986), Hervey and Strauss (1987) and Morgan Guaranty (1986). Rosensweig's index is nominal, not real, as this analysis requires. Hence, it is not included in the empirical investigation.

[2]In fact, contrary to the intuitive argument, Belongia (1986) found that certain indexes especially designed for specific purposes performed poorly in their designed role relative to other, more general indexes.

[3]See Dutton and Grennes (1985) for a detailed discussion of theoretical and statistical issues concerning the construction of exchange rate indexes.

[4]In theory, absolute purchasing power parity should hold in the base year and the constituent countries should consume identical commodity bundles. Absolute purchasing power requires an exchange rate that equates the price levels between nations.

[5]See Dutton and Grennes (1985), pp. 20–27. Also, see Belongia (1986), p. 7, for a numerical example and further discussion of the distinction between arithmetic and geometric weights.

Table 1

Characteristics of Alternative Exchange Rate Indexes

Index	Averaging Procedure	Weights	Coverage	Deflator (to convert nominal to real)
SDR	Arithmetic	Multilateral exports plus imports fixed at 1980–84 level	5 major industrial countries (U.S., Germany, Japan, France, United Kingdom)	CPI
FRB	Geometric	Multilateral exports plus imports fixed at 1972–76 level	10 major industrial U.S. trading partners (G-10 plus Switzerland)	CPI
MG-15	Geometric	Bilateral exports plus imports of only manufactures fixed at 1980 level	15 major industrial U.S. trading partners (the 10 countries in FRB plus Australia, Austria, Denmark, Norway, Spain)	WPI
7-Gr	Geometric	Bilateral exports plus imports; 12-quarter moving average changing quarterly	16 major U.S. trading partners (the 10 countries in FRB plus Australia, Hong Kong, Singapore, Spain, South Korea, Taiwan)	CPI
MG-40	Geometric	Bilateral exports plus imports of only manufactures fixed at 1980 level	40 major U.S. trading partners including 22 LDCs (including the 15 countries in MG-15)	WPI
X-101	Geometric	Bilateral exports plus imports; 3-year moving average changing annually	101 U.S. trading partners (essentially all)	CPI

etary Fund for the Special Drawing Right (SDR). Their basic characteristics, along with those for the newer indexes — the Federal Reserve Bank of Chicago's 7-Gr, Morgan Guaranty's 40-currency index (MG-40), and the Federal Reserve Bank of Dallas' X-101 — which will be discussed later, are presented in table 1. Table 2 reports the weights that each of these indexes assigns to different foreign currencies. The narrowest index is the SDR index, which assigns weights based on the four other currencies (besides the U.S. dollar) that make up the SDR.[6]

The FRB and MG-15 indexes base their weights primarily on trade with the G-10 countries and Switzerland.[7] These indexes reflect trade among developed, industrialized economies but do not include the currencies of less-developed countries (LDCs).[8] The MG-15 index is somewhat more broadly based than the FRB index in that it includes Australia, Spain and several other countries.

The difficulty of choosing among the traditional exchange rate measures to represent the dollar's value is perhaps best illustrated by the relationships in chart

[6]The SDR is the International Monetary Fund's official unit of account and serves as an international reserve asset often used in place of gold for making international payments. Since the SDR is denominated in terms of only the U.S. and four other nations' currencies, however, a dollar exchange rate based on SDR weights reflects changes in the dollar against only four other currencies.

[7]The Group of Ten, or G-10, countries are Belgium, Canada, France, West Germany, Italy, Japan, the Netherlands, Sweden, the United Kingdom and the United States.

[8]A less-developed country typically is defined as one in which per capita income is less than one-fifth of U.S. per capita income.

Table 2

Percentage Weights Assigned to Major Currencies in Six U.S. Dollar Exchange Rate Indexes

Country	Exchange Rate Index					
	SDR[1]	FRB	MG-15	7-Gr[2]	MG-40	X-101[2]
United States	42.0	—	—	—	—	—
Germany	19.0	20.8	10.9	7.2	9.9	5.4
Japan	15.0	13.6	23.2	21.5	18.5	17.1
France	12.0	13.1	5.9	4.0	5.1	2.9
United Kingdom	12.0	11.9	9.2	7.5	8.2	4.8
Canada	—	9.1	30.3	29.8	20.7	21.0
Italy	—	9.0	4.1	3.3	3.7	2.7
Netherlands	—	8.3	3.0	3.4	2.0	2.1
Belgium	—	6.4	3.5	2.4	2.2	1.5
Sweden	—	4.2	1.7	1.3	1.5	1.1
Switzerland	—	3.6	2.8	1.6	1.8	1.1
Australia	—	—	2.4	2.1	1.7	0.2
Mexico	—	—	—	—	4.6	5.9
Spain	—	—	1.4	1.4	1.3	1.0
South Korea	—	—	—	4.2	2.1	3.0
Taiwan	—	—	—	5.2	3.1	4.0
Singapore	—	—	—	2.1	0.9	1.4
Hong Kong	—	—	—	3.0	2.0	2.1
All other	0.0	0.0	1.6	0.0	10.7	22.7
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0

[1]Weights are for \$/SDR. The reciprocal of this, SDR/\$, was used in the empirical analysis.
[2]1985 weights are shown. Actual weights are three-year moving averages, and hence, vary over time.

1 and table 3. Using measures of the real exchange rate, which are the nominal exchange rate indexes adjusted for differences in price levels between the United States and foreign countries, the chart shows that, between 1973 and 1980, the real value of the dollar fell by as little as 3 percent based on the MG-15 measure, or by as much as 14 percent based on the FRB measure.[9] Similarly, the chart indicates that the real value of the dollar rose by as much as 57 percent (FRB) or as little as 32 percent (MG-15) between 1980 and 1984. Finally, the range of values for the dollar's decline since the September 1985 Plaza Accord is between −15 percent (SDR) and −22 percent (FRB).

The divergent behavior of these indexes also is evident in table 3. As the top portion of the table indicates, the SDR index has the smallest average quarterly change, the smallest standard deviation, and narrowest range for quarterly changes; these statistics indicate its relative stability over time. The FRB and MG-15 indexes have slightly wider ranges for quarterly changes over time. The bottom portion of the table, which reports simple correlation coefficients between different pairs of real exchange rates, shows that percentage changes in each index are quite highly correlated.[10] Overall, the data in chart 1 and table 3 indicate that, although movements in the indexes are

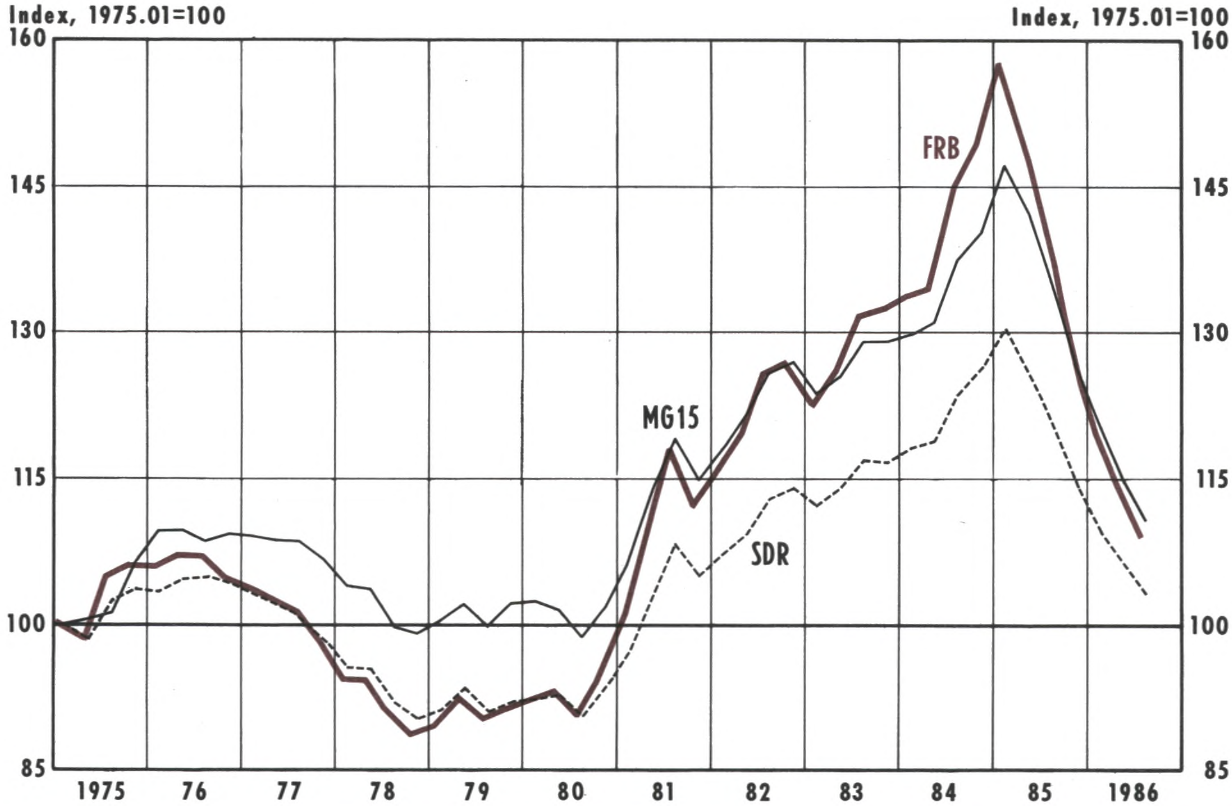
[9]A geometric, real trade-weighted exchange rate index can be constructed by the formula:

$$100 \prod_{i=1}^{n} \left(\frac{P_{US,t}}{P_{i,t}} \cdot \frac{E_{i,t}}{E_{i,0}} \right)^{w_i}$$

where P_{US} and P_i are the price levels in the U.S. and the foreign country, respectively, E_i is the nominal exchange rate in foreign currency units per dollar, t denotes time period with base period at zero, n denotes number of currencies in the index and w_i is the weight associated with trade between the United States and foreign country i.

[10]Each correlation coefficient is significant at the 0.001 level or higher. Percentage changes in variables are used to eliminate the effects of any common trend in the data.

Chart 1
Selected Real Effective Exchange Rates Expressed as Value of Dollar



positively correlated, there are substantial quantitative differences in their movements over time.

The New Indexes

Some economists have viewed these three traditional indexes as deficient not only because they have failed to produce a consensus about the dollar's "true" value, but because they have significant problems of error by omission. The primary criticism is that these indexes ignore the importance of LDCs and Newly-Industrialized Countries (NICs), especially Pacific-rim countries, to U.S. trade. Thus, although the degree of broader coverage differs, the new indexes expand considerably the number of countries represented relative to the more traditional measures.

The countries and weights used to construct the new exchange rate indexes are shown in the last three columns of table 2. Again, refer to table 1 for the characteristics of these indexes. Two of the indexes (MG-40 and 7-Gr) expand the number of countries primarily to emphasize trade with Pacific-rim countries. The X-101 index covers U.S. trade with *all* countries for which data are available. (There actually is a broader nominal index, based on 131 countries, but gaps in the data on foreign price levels narrow the coverage for the real index.) These newer indexes, because they recognize the increasing importance of U.S. trade with LDCs and NICs over time, are intuitively appealing; it would seem that they *should* provide a more accurate assessment of the dollar's value.

As a first comparison, chart 2 and table 3 can be examined to investigate relationships between the new and the old indexes. In the table's upper half, percentage changes in each of the new indexes appear to be less variable than the traditional indexes. In the table's lower portion, however, percentage changes in the new indexes are shown to be significantly correlated with each other and the traditional indexes. Thus, the new indexes appear to reflect much of the information contained in the narrower, traditional

Table 3

Summary Statistics for Alternative Real Exchange Rate Measures, I/1975–III/1986

Index	Mean	Standard Deviation	Minimum	Maximum
SDR	−0.0002	0.027	−0.051	0.058
FRB	0.0005	0.041	−0.082	0.084
MG−15	0.0008	0.032	−0.064	0.064
7−Gr	0.0004	0.026	−0.052	0.051
MG−40	0.0019	0.027	−0.054	0.059
X−101	0.0024	0.022	−0.036	0.049

	Correlation Coefficients				
Index	FRB	MG-15	7-Gr	MG-40	X-101
SDR	0.988	0.922	0.947	0.923	0.910
FRB		0.921	0.963	0.914	0.915
MG-15			0.908	0.990	0.844
7-Gr				0.902	0.950
MG-40					0.862

NOTE: All calculations are based on first differences of logarithms.

indexes and vice versa. Chart 2, however, which shows the SDR index plotted against the three new indexes, however, indicates that judgments about how much the dollar's value has changed still depend crucially on the measure chosen.

THE SENSITIVITY OF TRADE FLOWS TO CHANGES IN EXCHANGE RATES AND INCOME

The dollar has been depreciating since February 1985. One major puzzle that has accompanied this decline is why the trade and current account balances have not responded more. When analyzed in nominal terms, the standard J-curve phenomenon typically is used to explain the slow adjustment of the current account balance to a change in the foreign currency value of the dollar. For example, because of prior commitments and contracts, import prices will rise and export prices will fall before the volume of exports and imports responds to a decline in the foreign exchange value of the dollar. When analyzed in real terms, however, only the volume adjustment is relevant. Thus, one would expect that lagged adjustment exists and that differentials in real income growth play important roles.

To investigate the sensitivity of real trade flows to changes in real incomes and the real exchange rate, simple reduced-form models were constructed for U.S real exports and U.S. real non-petroleum imports.[11] Before presenting the models, three caveats must be recognized. First, these are highly simplified, aggregated models and are not meant to capture all the specifics and nuances of trade flows. Their sole purpose is to provide a general, quantitative indication of the income and exchange rate elasticities of trade flows to enable a comparison of the various exchange rate indexes. Second, because these models are highly aggregated, they ignore the special problems of LDCs and their efforts to generate increased trade surpluses to better service their external debt. Third, all of the statistical results presented are specific to the models estimated and may vary if alternative models or sample periods are applied to the problem. As the references in footnote 11 suggest, however, the models estimated certainly follow an established tradition in the empirical literature.

The Export Model

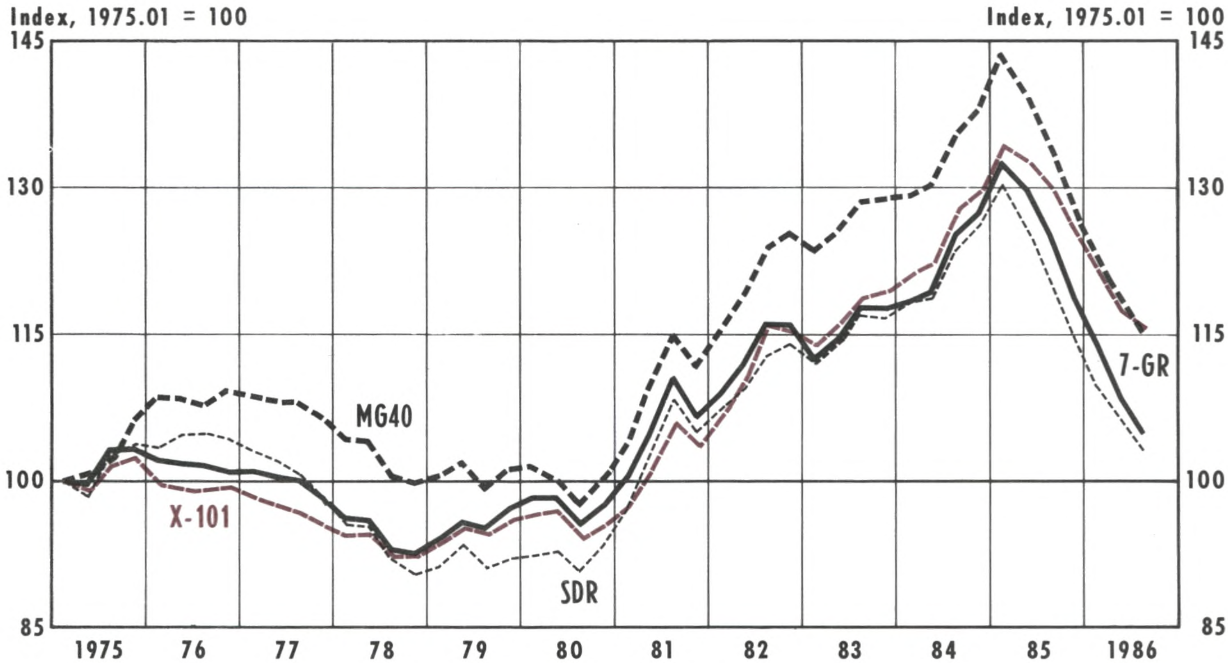
The model of U.S. real exports emphasizes the forces that affect the world demand for and the U.S. supply of U.S. exports. The world demand for U.S. exports is assumed to depend on two factors: the level of foreign real economic activity (income) and the price of U.S. goods relative to those of other countries. The higher the level of foreign real income, *ceteris paribus,* the larger the foreign demand for U.S. exports. The higher the price of U.S. goods relative to those abroad, *ceteris paribus,* the lower the demand for U.S. exports.

The supply of U.S. exports is expressed as a function of the price of U.S. exports relative to the prices of other goods and services produced in the United States and the utilization of productive capacity in the United States. The higher the price of U.S. exports relative to the prices of other goods or the higher the level of capacity utilization, *ceteris paribus,* the larger the production of U.S. goods for export.

To generate an estimating equation, a dynamic representation is assumed. Because the demand for or

[11]These models are fashioned after those of Batten and Belongia (1986), Clark (1974), Goldstein and Khan (1978), and Spitäller (1980).

Chart 2
Selected Real Effective Exchange Rates Expressed as Value of Dollar



the supply of exports may not adjust instantaneously to changes in the explanatory variables, each explanatory variable is expressed as a distributed lag. Then, a market equilibrium was assumed and a reduced form was obtained; this reduced form is expressed in general terms as:

$$(1)\quad \ln EX_t = \alpha + \sum_{i=0}^{p} \beta_i \ln FGNP_{t-i} + \sum_{j=1}^{q} \gamma_j \ln (USXP/GNPDEF)_{t-j} + \sum_{k=1}^{r} \delta_k \ln RER_{t-k} + \sum_{m=0}^{s} \theta_m \ln CAP_{t-m} + \varepsilon_t,$$

where:

EX = U.S. real exports,
FGNP = index of foreign real GNP,
USXP = U.S. export unit value index,
GNPDEF = U.S. GNP deflator,
RER = real trade-weighted exchange rate (foreign currency/$), and
CAP = rate of U.S. capacity utilization.[12]

The real exchange rate was included to measure U.S. prices relative to those in the rest of the world (expressed in dollars), taking into account price-level differences across countries.

Results from least squares estimation of equation 1 over the period I/1975 to III/1986 using each of the six exchange rate indexes are given in table 4.[13] Each set of results differs only by the real exchange rate measure used in the estimation. The regression results in table 4 indicate how well the alternative real exchange rate indexes explain movements in real U.S. exports.

[12]Lag lengths were selected using techniques presented in Batten and Thornton (1984).

[13]The sample period actually begins in I/1973; eight observations are lost in the lag-length selection process.

Table 4

Results for U.S. Merchandise Export Equations

Exchange Rate	ΣlnFGNP	Σln(USXP/GNPDEF)	ΣlnRER	lnCAP	$\bar{R}^2$/SE	DW	ρ
SDR	1.416*	0.425	−0.706*	0.016	0.970	1.59	0.497
	(13.88)	(1.23)	(5.30)	(0.08)	0.019		(3.93)
	0-3	1-8	1-5	0			
FRB	1.592*	−0.370	−0.712*	−0.180	0.971	1.68	0.397
	(15.95)	(0.76)	(5.33)	(0.88)	0.019		(2.97)
	0-3	1-8	1-8	0			
MG-15	2.002*	−0.789	−1.363*	−0.061	0.973	1.83	0.458
	(12.96)	(1.65)	(5.96)	(0.32)	0.018		(3.54)
	0-3	1-8	1-8	0			
7-Gr	1.697*	−0.289	−1.158*	−0.281	0.971	1.72	0.313
	(17.00)	(0.88)	(7.30)	(1.40)	0.019		(2.26)
	0-3	1-8	1-8	0			
MG-40	2.071*	−1.192*	−1.534*	0.022	0.973	1.77	0.485
	(12.00)	(2.12)	(5.69)	(0.11)	0.018		(3.81)
	0-3	1-8	1-8	0			
X-101	1.750*	0.089	−0.794*	−0.271	0.963	1.54	0.524
	(10.59)	(0.23)	(4.76)	(0.90)	0.021		(4.22)
	0-4	1-8	1-5	0			

NOTE: The items listed under coefficient column headings are, in order: coefficient estimate, absolute value of t-statistic (in parentheses), and lags estimated.

*Statistically significant at the 5 percent level.

On the basis of the summary statistics and estimated coefficients, table 4 offers little guidance in distinguishing the performance of one index from another. The equations display roughly similar explanatory power (based on $\bar{R}^2$ and standard error) and all exhibit positive first-order autocorrelation.[14] The estimated income and price (exchange rate) elasticities are statistically significant, and their signs meet *ex ante* expectations. In general, the estimated coefficients of the supply-side variables (relative export prices and the rate of capacity utilization) are not statistically significant.

There are some marked differences, however, in the magnitude and timing of the response of real U.S. exports to changes in the real trade-weighted value of the dollar. Depending upon the exchange rate index chosen, this response takes place over a range of five to eight quarters. Moreover, export demand can be said to be inelastic (FRB and SDR), unit-elastic (MG-15, X-101 and 7-Gr) or elastic (MG-40).[15] Because policymakers are chiefly interested in how much and how quickly U.S. exports respond to a change in the dollar's value, the wide qualitative and quantitative diversity among the estimated coefficients in table 4 is troublesome.

The Import Model

A similar generic model was constructed for U.S. real non-petroleum imports. U.S. demand for foreign-produced goods was assumed to be a function of U.S. real income and the relative price of U.S. goods to foreign-produced goods. The foreign supply of imports was assumed to be a function of the price of

[14]Correcting for first-order autocorrelation had virtually no effect on the parameter estimates. Also, including a lagged dependent variable on the right-hand side of the equation appeared to "correct" the autocorrelation without affecting the estimated parameters. Furthermore, all statistically significant coefficients of the lagged dependent variable were significantly less than one.

[15]This, of course, is based on testing the null hypothesis that

$$\sum_{k=1}^{r} \delta_k = 1.$$

Table 5
Results for U.S. Non-Petroleum Imports Equations

Exchange Rate	ΣlnGNP	Σln(U.S.MP/FCPI)	ΣlnRER	lnCAP	$\bar{R}^2$/SE	DW	ρ
SDR	2.551*	−1.126*	1.700*	0.368	0.996	2.26	—
	(44.98)	(6.97)	(11.46)	(0.88)	0.019		
	0-4	1-3	1-6	0			
FRB	2.248*	−1.198*	1.209*	0.666	0.996	2.35	—
	(29.11)	(7.10)	(11.04)	(1.49)	0.018		
	0-5	1-3	1-6	0			
MG-15	2.428*	0.034	0.804*	0.011	0.992	1.75	—
	(20.51)	(0.15)	(4.48)	(0.02)	0.027		
	0-4	1-6	1-2	0			
7-Gr	2.129*	−1.134*	1.854*	−0.545	0.995	2.01	—
	(21.74)	(5.80)	(9.71)	(0.97)	0.020		
	0-6	1-3	1-6	0			
MG-40	2.267*	−0.256	1.132*	0.644	0.993	1.73	—
	(21.55)	(1.57)	(8.50)	(0.76)	0.025		
	0-8	1	1-4	0			
X-101	2.204*	−0.257	0.925*	0.514	0.993	1.84	0.440
	(13.62)	(1.35)	(5.46)	(0.61)	0.024		(3.35)
	0-6	1	1-8	0			

NOTE: The items listed under coefficient column headings are, in order: coefficient estimate, absolute value of t-statistic (in parentheses), and lags estimated.

*Statistically significant at the 5 percent level.

imports relative to the foreign general price level and the utilization of productive capacity abroad. The real exchange rate again was used as the measure of U.S. prices relative to those abroad. In the import model, however, changes in the real exchange rate should have a positive impact. That is, a rise in the real exchange rate indicates that U.S. prices are rising relative to those abroad; hence, U.S. consumers should substitute relatively more foreign-produced for U.S.-produced goods.

Generating a reduced-form estimating equation in the same manner as before yields:

$$(2)\ \ln IM_t = \alpha + \sum_{i=0}^{p} \beta_i \ln GNP_{t-i} + \sum_{j=1}^{q} \gamma_j \ln (USMP/FCPI)_{t-j} + \sum_{k=1}^{r} \delta_k \ln RER_{t-k} + \sum_{m=0}^{s} \theta_m \ln FCAP_{t-m} + \varepsilon_t,$$

where:

IM = U.S. real non-petroleum imports,
GNP = U.S. real GNP,
USMP = U.S. non-petroleum import unit value index,
FCPI = index of foreign CPI, and
FCAP = rate of foreign capacity utilization.

The results from estimating this equation for each exchange rate index, with appropriate lag length selections, are reported in table 5. Once again, the equations differ little on the basis of the summary statistics and estimated coefficients. Also once again, the estimated exchange rate effects on U.S. imports vary widely: the adjustment lag varies from two to eight quarters and import demand is either unit-elastic (FRB, MG-15, X-101 and MG-40) or elastic (SDR and 7-Gr) depending on the specific index. The results in tables 4 and 5 indicate that changes in the dollar's real value affect the U.S. merchandise trade deficit; the estimated magnitude and timing of the effects, however, differ substantially across the exchange rate indexes examined.[16]

[16]An investigation of the last eight in-sample errors for each equation, however, reveals that most lie within one standard error of zero. Hence, the in-sample results do not indicate that any exchange rate index outperforms any other one.

Table 6

Out-of-Sample Forecast Summary Statistics (estimation interval: I/1975–III/1984; forecast interval: IV/1984–III/1986)

Exchange Rate Index	Mean Error	MAE	RMSE
EXPORT EQUATIONS			
SDR	0.006	0.026	0.028
FRB	−0.009	0.030	0.035
MG-15	−0.052	0.058	0.069
7-Gr	0.007	0.015	0.018
MG-40	−0.039	0.051	0.061
X-101	0.048	0.048	0.053
IMPORT EQUATIONS			
SDR	−0.015	0.034	0.042
FRB	−0.024	0.038	0.046
MG-15	−0.019	0.081	0.090
7-Gr	−0.027	0.056	0.064
MG-40	−0.005	0.067	0.074
X-101	0.036	0.081	0.103

Because we do not know the actual exchange rate elasticities for exports and imports or the correct adjustment lag, *ex ante*, our only guide in choosing an exchange rate index is its empirical performance. The results, however, suggest that there was no notably superior index. Thus, the new indexes do not appear to add much, if anything, to our knowledge about the response of trade flows to changes in the exchange rate.[17]

OUT-OF-SAMPLE FORECAST ERRORS

An alternative criterion for choosing among alternative exchange rate indexes is their relative performance in predicting trade flows beyond the range of data used to estimate the coefficients for equations 1 and 2. This out-of-sample predictive criterion emphasizes another practical application of an exchange rate index: if the actual path followed by the dollar's value had been known in advance, how well could changes in export and import flows have been predicted? To examine this issue, equations 1 and 2 were re-estimated for the I/1975–III/1984 period, and out-of-sample errors were calculated for exports and imports for the eight quarters between IV/1984 and III/1986. Summary statistics for these out-of-sample predictive errors are reported in table 6; the errors are plotted in charts 3 and 4.

The table reports the mean error, the mean absolute error (MAE) and the root-mean-squared error (RMSE). For the U.S. export equations in the table's upper half, the 7-Gr index had the lowest MAE and RMSE values and the second-smallest mean error. Performing nearly as well were the FRB and SDR indexes. In contrast, out-of-sample predictions using the X-101 and MG-40 indexes, which were designed to give broader coverage to trade flows, show larger errors.

A look at the individual export forecast errors in chart 3 allows several interesting comparisons. First, the performances of the FRB, SDR and 7-Gr indexes are noticeably and consistently better than those of the other three indexes. Second, the relatively poor performance of the X-101 index stands out clearly: it consistently underpredicts exports.

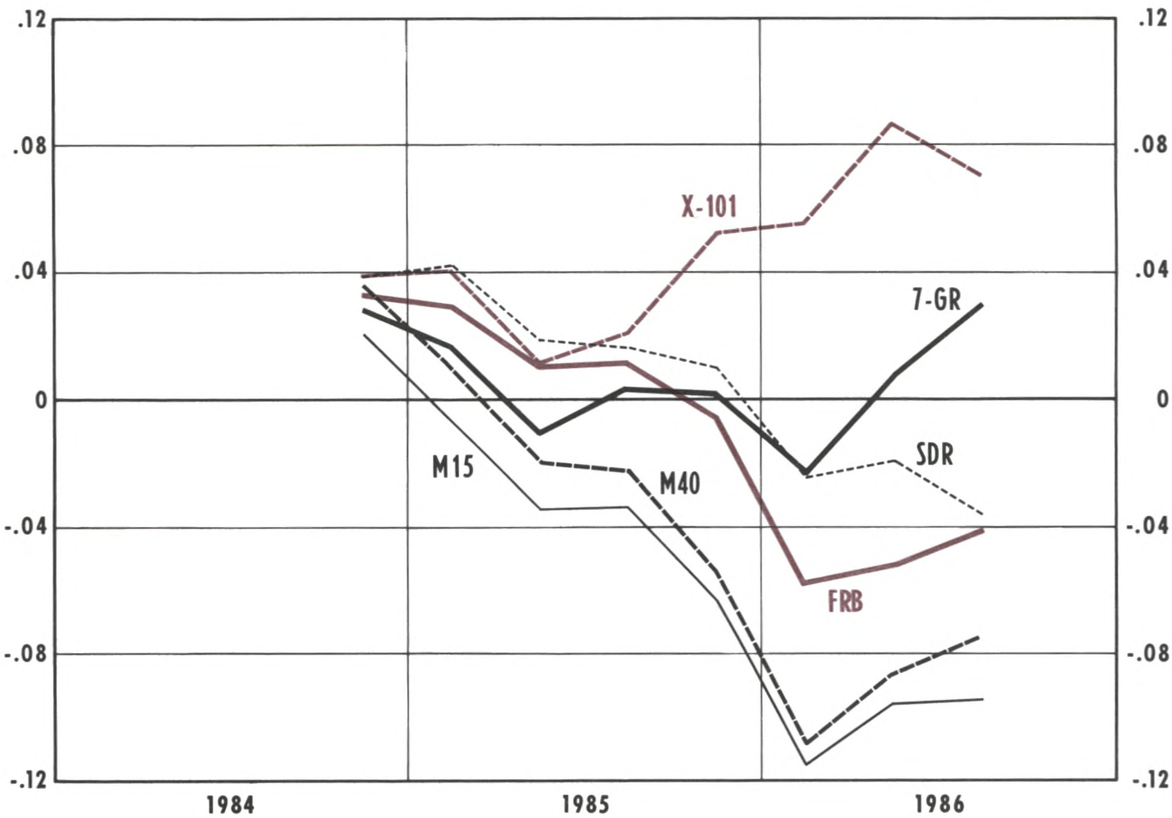
The two Morgan Guaranty indexes also perform relatively poorly, generally overpredicting exports. Surprisingly, however, the broader Morgan index (MG-40) performs just about as badly as the narrow Morgan index (MG-15). If broader indexes genuinely represent more accurate measures of the foreign exchange value of the dollar, the MG-40 should have outperformed the MG-15. Moreover, the FRB index, whose coverage is similar to the MG-15, outperformed both Morgan indexes.[18]

The out-of-sample error statistics for the U.S. nonpetroleum import equations tell a similar story. The narrow SDR and FRB indexes have the smallest MAE and RMSE values, while error statistics for the broader X-101 and MG-40 indexes are several times larger. In fact, as table 6 indicates, the X-101 index, which has the broadest coverage of trade flows, generally has the worst forecasting performance for the indexes examined. Conversely, the narrowest index, the SDR, has the best error statistics for imports and second-best

[17]Testing for the temporal stability of the estimated exchange rate elasticity for the various indexes during the floating exchange rate period may indicate the superiority of one or more indexes over the others. Given the lack of parsimony in the parameterization of the estimated equations and the relatively short sample period, however, this investigation could not be performed here.

[18]Since the FRB and MG-15 indexes differ primarily in the use of multilateral (FRB) vs. bilateral (MG-15) weights, it may be that the weighting scheme used is more important than the countries included in the index. The use of different price indexes to deflate the FRB and MG-15, however, may also affect the results.

Chart 3
Out-of-Sample Errors for Export Equations



for exports. Error statistics for the 7-Gr and FRB indexes are only slightly worse than those for the SDR.

The individual import forecast errors in chart 4, while less disparate than those of the export equations, offer similar comparisons. Although all exchange rate indexes underpredict imports by the end of the forecast period, the FRB and SDR indexes generally exhibit the best performances; the performance of the X-101 index is generally the worst, with the two Morgan indexes and the 7-Gr somewhere in between.

Overall, the out-of-sample results in table 6 and charts 3 and 4 provide no support for the notion that increasing the number of currencies in an exchange rate index improves its out-of-sample forecasts of trade flows. If anything, the results here suggest that the narrow indexes perform marginally better.[19]

THE RESULTS FROM NON-NESTED TESTS

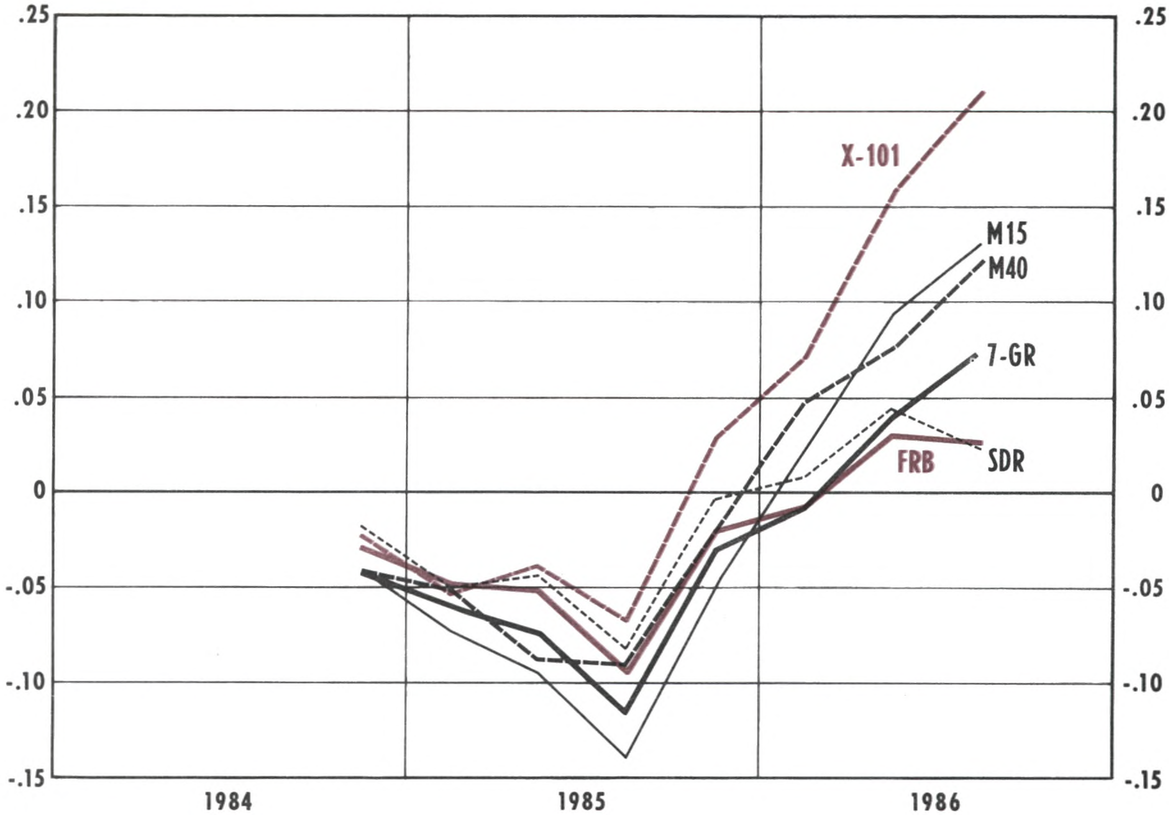
The fundamental question is whether the new indexes contain more (or better) information about the impact of changes in the dollar's value on trade flows. If the trade equations specified for the old and new indexes were nested, testing whether the new indexes add significantly to the information of the old indexes would be a straightforward operation.[20] The specified relationships between exports and imports and various measures of the exchange rate, however, are not nested and require an alternative approach to hypothesis testing.

The test employed to investigate whether the new indexes add significantly to the information in the old

[19]It is possible that including more currencies in an index adds noise to the measure from superfluous currency movements largely unrelated to trade.

[20]A nested test is one in which all of the information contained in the null hypothesis is also contained in the alternative. For example, the standard t-test that an estimated coefficient is statistically different from zero is a nested test.

Chart 4
Out-of-Sample Errors for Import Equations



indexes is the J-test.[21] One specification of the trade equation is hypothesized to be true and a second specification, using a different exchange rate measure, is hypothesized as the alternative specification. The J-test requires estimating the alternative specification and generating a vector of fitted values for the dependent variable (exports or imports). The specification proposed under the null hypothesis is then estimated with this vector of fitted values from the alternative specification as an additional explanatory variable. If the alternative measure of the exchange rate adds explanatory power to the specification containing the hypothesized "true" measure, the estimated coefficient of the vector of predicted values will be significantly different from zero. The conclusion drawn from this result is that the specification with the alternative exchange rate index is preferred to that with the hypothesized true index. To complete the test, the hypothesized true (null) and alternative indexes are reversed and the same procedure is repeated. The initially specified alternative can be preferred to the null only if the null specification does not add explanatory power to the alternative in the second stage of the test. If the null does add explanatory power in the second stage, then the test does not allow the choice of one specification over the other.

[21]See Davidson and MacKinnon (1981). The J-test establishes one specification as the null hypothesis, then tests whether an alternative specification adds to the explanatory power of the specification under the null hypothesis. For example, assume that we want to test the specification,

$$H_0: y = f(x, z) + \varepsilon_1,$$

against the alternative,

$$H_1: y = g(w, z) + \varepsilon_2.$$

The J-test is conducted simply by estimating

$$y = (1 - \phi)f(x, z) + \phi\,\hat{g} + \varepsilon,$$

where $\hat{g}$ is the vector of predicted y under the alternative hypothesis, and testing whether ϕ is significantly different from zero using a conventional t-test. If the data are better fit to f(x, z), then ϕ should not be different from zero. Alternatively, if ϕ is different from zero, then g(w, z) adds to the explanatory power of f(x, z). To complete the test, the process is repeated by reversing the null and alternative hypotheses and repeating the same testing procedure.

Table 7
J-Test Results for Export Equations

Exchange Rate Index Under Null Hypothesis	Exchange Rate Index Under Alternative Hypothesis					
	SDR	FRB	MG-15	7-Gr	MG-40	X-101
SDR	—	3.63*	4.46*	3.76*	4.29*	2.15*
FRB	2.14*	—	3.09*	1.37	3.00*	1.20
MG-15	1.51	1.72	—	1.99*	1.77	2.49*
7-Gr	2.14*	1.27	3.19*	—	3.09*	0.97
MG-40	1.75	1.91	1.75	2.10*	—	2.61*
X-101	4.35*	4.20*	5.85*	4.04*	5.56*	—

*Statistically significant at the 5 percent level.

Table 8
J-Test Results for Import Equations

Exchange Rate Index Under Null Hypothesis	Exchange Rate Index Under Alternative Hypothesis					
	SDR	FRB	MG-15	7-Gr	MG-40	X-101
SDR	—	7.18*	3.01*	6.98*	3.93*	5.95*
FRB	0.42	—	−0.32	0.95	0.27	1.11
MG-15	1.23	6.23*	—	5.66*	3.11*	4.66*
7-Gr	2.12*	2.70*	1.57	—	1.16	0.71
MG-40	1.87	5.78*	2.40*	4.83*	—	3.85*
X-101	2.80*	5.81*	2.61*	4.39*	2.44*	—

*Statistically significant at the 5 percent level.

Tables 7 and 8 present t-statistics for the J-tests conducted. The left-hand columns of the tables list the exchange rate indexes hypothesized as "true" under the null hypothesis. The other columns show t-statistics, which indicate whether the specification with an alternative exchange rate index adds significant information to the specification employing the index in the left-hand column.

The results in table 7 for the export equations are ambiguous in the sense that no index or set of indexes clearly dominates the others. Of the 30 t-statistics reported, 20 are significant and four more are nearly significant at the 5 percent level. Moreover, there are no consistent patterns in the t-statistics. For example, each alternative index adds significantly to the information in the SDR index but the SDR index adds only to three of the five alternatives. Each alternative index similarly adds to the X-101 index and the X-101 adds only to three of the remaining five. In contrast to the SDR results, however, the three indexes to which the X-101 adds information are not the same three to which the SDR index adds information. The remaining results in table 7 also lack the transitivity that would permit drawing any conclusions about a dominant index or set of indexes with greater information content.

The results for the import equations in table 8, however, yield clearer conclusions. The FRB index adds to the information of all other indexes in the import equation, while none of the other indexes adds to the information in the FRB measure. On this J-test criterion, the 7-Gr index has the second-best performance, with only two indexes (FRB and SDR) adding to its information and the 7-Gr adding to the information of all measures but the FRB index. Consistent with earlier results, the two indexes with the broadest coverage of currencies, the X-101 and MG-40, are dominated by the other indexes: all five indexes add to the information of the X-101 and four of five contribute to the MG-40. Consequently, the answer to the simple question, "Does greater coverage of currencies, *per se*, add to the information content of an exchange rate index?" is clearly no.

CONCLUSIONS

Several new indexes of the dollar exchange rate have been developed in the past year. The justification for their construction was that the distribution of U.S. trade flows had changed dramatically since the 1970s and, for that reason, existing exchange rate indexes, based on trade with industrialized countries, did not reflect the recent increased importance of trade with LDCs and Pacific-rim countries.

The key test of an exchange rate index, however, is not its intuitive justification but its practical utility. A consistent set of tests applied to the major existing indexes indicated that the new broader measures performed no better than the old measures. In fact, on the basis of forecasting performance, they performed worse than the existing, more narrowly based exchange rate indexes. Additional tests, which examined the marginal information content of the new indexes, also found a traditional, narrow measure of the dollar's value to dominate the newer indexes. Hence, the new exchange rate indexes do not appear to provide better answers to old questions about trade flows.

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Has Programmed Trading Made Stock Prices More Volatile?

G. J. Santoni

If there must be madness, something may be said for having it on a heroic scale.
— John Kenneth Galbraith, *The Great Crash*, p. 69.

MANY people believe that stock prices have become considerably more volatile in recent years. Typical descriptions have characterized stock market behavior as "careening through" trading ranges, subject to "wild gyrations," and the product of "unexpected insanity."[1]

The presumed source of the volatility is a trading strategy called "programmed trading."[2] This strategy, which essentially involves trading on small and short-lived price differences for the same group of stocks in the spot, futures and options markets, is not new. The introduction of stock *index* futures around 1982 and the application of computer techniques to monitor price differences and trigger trades between markets, however, are novel. These two innovations have reduced the cost of transacting among the markets, which has resulted in increased trading activity. The increased activity, the size of the trades made by individual players and the behavior of stock prices on days when stock index futures and options contracts mature (triple witching days) have led many observers to conclude that this trading strategy has increased stock price volatility.[3]

The alleged increase in volatility has led both to closer scrutiny by the Securities and Exchange Commission and to calls for legislative action.[4] In response to these concerns, the Chicago Mercantile Exchange voted recently to impose a 12-point daily price change limit on its Standard and Poor's 500 stock index futures contract and to move the expiration of the contract from the close to the opening of trading on quarterly expiration days. The latter was also adopted by the Chicago Board of Options Exchange for its Standard and Poor's 500 stock index option.

This paper examines the principles of trading between the spot and futures markets for stocks and the

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[1]See "Abreast of the Market" (1987) and Clark (1987). Other examples can be found in the *Wall Street Journal* on the following dates: January 16; January 20; January 23.

[2]See, for example, Stoll and Whaley (1987), Laderman and Frank (September 29, 1986); Laderman, et. al (April 7, 1986); Stoller (February 9, 1987) and McMurray (February 12, 1987).

[3]See, for example, Laderman, et. al. (April 7, 1986) who assert that "Program trading, by its very nature, causes wild swings in the markets. . ." p. 32; and "Program trading is a mixture of irony and mystery. It breeds volatility." p. 33. "Triple witching" is a reference to the third Fridays of March, June, September and December. Stock index futures contracts and options on the futures expire on these days.

[4]See Laderman and Frank (September 29, 1986), p. 102. Stoller (February 9, 1987) not only attacks programmed trading but all speculative activity. Borrowing from John Kenneth Galbraith (1955), he notes that "Wall Street, in these matters, is like a lovely and accomplished woman who must wear black cotton stockings, heavy woolen underwear, and parade her knowledge as a cook because, unhappily, her supreme accomplishment is as a harlot." p. 24.

Glossary of Terms

"Arb": Arbitrageur. A person who simultaneously buys and sells the same good in two different markets.

Basis: The difference between the price of a futures contract and the price of an equal quantity of the cash instrument.

Basis Point: 1/100 of one percent.

Bear Straddle: A spread in which the instrument with the nearby maturity is sold and a similar instrument with a more distant maturity is purchased.

Bull Straddle: A spread in which the instrument with the nearby maturity is purchased and a similar instrument with a more distant maturity is sold.

CBT: Chicago Board of Trade. This exchange trades the Major Market Index Futures (MMI).

Hot Money: The money (wealth) tied up in program trading accounts.

IMM: International Monetary Market. This Chicago exchange trades the Standard and Poor's 500 Index futures.

Interest Elasticity: A ratio of the percentage change in the price of a financial instrument to the percentage change in the interest (discount) rate.

Unwind: To reverse an earlier transaction.

KCBT: Kansas City Board of Trade. The exchange trades the Value Line Index Futures.

NYFE: New York Futures Exchange. This exchange trades the New York Stock Exchange Index Futures.

Programmed trading: The use of computer programs to analyze and trigger trading between stock index futures contracts, options on the index and the basket of stocks contained in the index.

Spreading: The simultaneous purchase and sale of two similar financial instruments of different maturity.

The .01 Effect: Measures the change in the dollar value of an instrument that results from a change of one basis point in its yield. This depends on the interest elasticity of the instruments.

Triple Witching Hour: The time when options and futures on stock indexes expire. This happens on the third Fridays of March, June, September and December.

claim that stock prices have become more volatile since stock index futures were first introduced. In addition, the paper examines whether programmed trading has contributed to increased stock price volatility.

The paper focuses on stock index futures rather than options because the market for options has been less active than the market for futures so the concerns noted above have focused on the more active futures market.[5]

STOCK INDEX FUTURES CONTRACTS

Trading in stock index futures contracts was first introduced by the Kansas City Board of Trade on February 24, 1982. In April of the same year, the Chicago Mercantile Exchange, began trading a futures contract based on the Standard and Poor's Index of 500 common stocks. The introduction of both contracts was successful. By the end of 1982, daily trading volume in the Standard and Poor's futures contract, the most successful of the two, was running at about 20,000 contracts.[6]

The success of the first two contracts induced other major exchanges to introduce similar instruments.

[5]See Belongia (1983) for a general discussion of options markets. Kawaller (1986), p. 1 and 3, gives a general description of options on financial futures. Black and Scholes (1973) present a formal analysis of option trading. Cinar (1987) discusses the effect of options on stock prices.

[6]See Schwarz, Hill and Schneeweis (1986), pp. 87–88.

Table 1
Stock Index Futures Contracts

Underlying Instrument	Exchange	Trading Hours	Contract Size	Months Traded	Price Quoted In	Minimum Fluctuation	Value of Minimum Fluctuation
Major Market Index	CBT	8:15–3:15	Index times $250	monthly	Index points	.05	$12.50
Value Line Index	KCBT	9:00–3:15	Index times $500	3,6,9,12	Index points	.05	$25.00
S and P 500 Index	IMM	9:00–3:15	Index times $500	3,6.9,12	Index points	.05	$25.00
New York Composite Index	NYFE	10:00–4:15	Index times $500	3,6,9,12	Index points	.05	$25.00

Underlying Instrument	Last Trading Day	Margins Initial[1]	Average Daily Volume[1]
Major Market Index	3rd Friday of contract month	$4,500	18,000
Value Line Index	Last business day of contract month	$6,500	4,000
S and P 500 Index	3rd Friday of contract month	$6,000	60,000
New York Composite Index	3rd Friday of contract month	$3,500	15,000

[1]As of 1985.

The New York Futures Exchange, a unit of the New York Stock Exchange, began trading a futures contract based on the New York Stock Exchange Composite Index in September 1983. Most recently, in July 1984, the Chicago Board of Trade began trading a futures contract based on the Major Market Index.

The Standard and Poor's 500 futures contract, which has been adopted by institutional investors, has experienced the most success. For example, the estimated volume of trades in this contract was about 115,000 on April 14 of this year. The average daily trading volume of the S&P 500 contract has been running at about 4 to 5 times the daily trading volume in the contracts based on both the New York Stock Exchange and Major Market indexes and about 15 times the contract based on the Value Line Index.[7]

Characteristics of the Contracts

A futures contract on a stock index is an agreement between a seller (short position) and buyer (long position) to a cash settlement based on the change in the stock index's value between the date the futures contract is entered by the two parties and some future date.[8] Table 1 summarizes some of the details regarding each of the stock index futures contracts mentioned above (see the shaded insert on page 22 for a general discussion of futures).

Table 2 presents the trading ranges for futures contracts on the Standard and Poor's 500 Index (S&P Futures) on February 6, 1987. The delivery dates of the contracts traded were the third Fridays of March, June and September of 1987. Notice that open interest is

[7]In addition, the Chicago Mercantile Exchange is currently trading a futures contract based on 100 stocks in the Standard and Poor's 500 Index (the "Mini" S&P). Trading volume in this contract is very thin compared with those mentioned in the text.

[8]See Schwarz, Hill and Schneeweis (1986), p. 9. Stock index futures differ from commodity futures in that settlement of the former is always by cash. Stock index futures contracts make no provision for physical delivery of the stocks that are included in the index.

Table 2

Trading Ranges for the Standard and Poor's 500 Futures Contract, February 6, 1987[1]

	S&P 500 Index (CME) $500 times index					
Month	Open	High	Low	Settle	Change	Open interest
March	282.50	283.20	280.35	281.20	−1.15	104,412
June	284.10	284.80	281.90	282.80	−1.15	7,131
September	284.90	285.90	283.40	284.10	−1.10	226

Estimated volume 85,705
S&P 500 index for stocks traded in the spot market closed at 280.04

[1]*Wall Street Journal*, February 9, 1987.

greatest in the March (nearby) contract. The market is relatively thin for the more distant contracts. The March contract opened at 282.50 and traded in the range of 283.20−280.35 during the day. It closed at 281.20. Since the value of the futures contract is $500 times the index, the value of the March contract fluctuated between a high of $141,600 and a low of $140,175.

The value of the contract at the close was $140,600 (= $500 × 281.20) which represented a decline in its value of $575 from its close at $141,175 (= $500 × 282.35) on the previous day. Traders who maintained long positions in this contract from the close on February 5 through the close on February 6 lost $575 (= $500 × 1.15) per contract and this amount was deducted from their margin accounts at the close of business on the 6th. The reverse was true for traders who maintained short positions over the time interval.

The Basis

In addition to the information about the futures contracts, table 2 also indicates that the Standard and Poor's 500 Index for stocks traded on the spot market (S&P Index) closed at 280.04 on February 6, 1987. Notice that this amount is different than the amounts recorded at the close for all three of the S&P Futures contracts. The difference between the values of the S&P Futures contracts and the S&P Index is called the *basis*; it can be measured in dollars or index points. For example, at the February 6 close, the basis for the March contract was about $580 (= $500 [281.20 − 280.04]) or 1.16 index points (= 281.20 − 280.04).[9] The basis differs systematically across the three futures contracts; it is larger for more distant delivery months. The qualitative relationship between the prices of the S&P Index and the three S&P Futures contracts shown in table 2 is generally the one that is observed; that is, the value of the S&P Futures is larger than the S&P Index, and the difference increases for more distant contracts. A similar qualitative relationship exists between the other stock index futures contracts discussed above and their respective indexes.[10]

WHAT DETERMINES THE BASIS?

Whenever the basis deviates substantially from its equilibrium (or theoretical) value, profitable trading opportunities exist and arbitrageurs will attempt to capture them. Program trading is a method of discovering and exploiting these profit opportunities. Since the opportunities can arise when the equilibrium basis changes, it is important to understand how the equilibrium basis is determined and what things cause it to change.

[9]The basis is "about" $580 because the New York Stock Exchange closes at 4:00 p.m. Eastern Standard Time while the International Monetary Market closes 15 minutes later at 3:15 p.m. Central Standard Time.

[10]The Value Line Index may represent an exception to this general statement because of the averaging method used to calculate it. See Modest and Sundaresan (1983), pp. 19–20.

Futures: A General Discussion

What is a Futures Contract?

A futures contract is an agreement between a seller and a buyer to trade some well-defined item (wheat, corn, Treasury bills) at some specified future date at a price agreed to *now*, but paid in the future at the time of delivery.

There are three prices that must be kept straight when discussing these contracts: the spot price, the forward price and the futures price. The spot price is the price of the item today for delivery today. The price of the item in the future for delivery then is called the forward price. The price of the item today for delivery in the future is called the futures price. The futures price is specified in the futures contract. Essentially, it is a prediction of the forward price at maturity of the contract.[1]

The Relationship Between Spot and Futures Prices

The futures price of a commodity is equal to the spot price plus the cost of storage, insurance and foregone interest earnings associated with holding the good over the interval of the contract. A similar relationship exists between the spot and futures prices of financial instruments (like stock index futures). Since the storage and insurance costs of holding these financial instruments is very low, however, the spread between spot and futures prices is largely determined by the interest cost.[2]

It Pays To Be Right

Because futures markets typically are very active and are open to virtually anyone who can meet fairly modest capital requirement rules, futures prices represent an aggregate guess about the forward price of the item. Of course, because it is a guess, it typically will be wrong.[3] When the forward price that is realized is higher than the futures price that was agreed on, the buyer of the futures contract gains because he can purchase the item at the previously agreed upon futures price and immediately sell it at the higher current spot price. The seller of the futures contract loses because he must sell the item whose current spot price is higher than the price he previously agreed to sell at when he entered the futures contract. The reverse occurs when the forward price that is realized is less than the futures price that was agreed upon.

Some Common Criticisms of Futures Markets

It may appear that futures markets are simply a convenient form of gambling on forward prices. This has been a common criticism of futures markets along with the allegation that trading in futures increases price variation in the spot market.[4] Speculative bets about price changes, however, are not unique to futures market trading. Economic decisions to buy or sell any storable good, by their nature, are speculative bets about the future course of the price. Furthermore, futures markets serve some valuable social functions such as allocating the consumption of storable goods over time as well as providing a means, through hedging, to reduce the risk of unexpected price changes.[5]

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[1]See, for example, Working (1977), pp. 25–31.

[2]See, for example, Schwarz, Hill and Schneeweis (1986), pp. 326–46; Figlewski (1984), pp. 658–60; Cornell and French (1983), pp. 2–4; and Modest and Sundaresan (1983), pp. 22–23.

[3]While typically wrong, the futures price will not *consistently* under- or over-predict the forward price. That is, the futures price is an unbiased predictor. If this were not true, it would be possible for traders to profit by exploiting the bias which would quickly eliminate it. See Fama (1970).

[4]See Working (1977), p. 293; Cagan (1981), p. 178; and Green (1986), p. 80, for a discussion of these common criticisms of futures markets. This paper examines the second allegation for the case of stock index futures.

[5]For discussion of the social functions fulfilled by futures markets see Working (1977), pp. 25–31 and pp. 267–97; Alchian and Allen (1977), pp. 132–39; and Cagan (1981).

The equilibrium difference between the S&P Index and S&P Futures (the equilibrium basis) is related to the equilibrium differences between the spot and futures prices of each of the stocks in the Standard and Poor's Composite Index.[11] Consequently, understanding the basis for individual stocks is helpful in analyzing the basis for S&P Futures contracts.

The Cost of Carry

In equilibrium, the difference between the spot price of a stock and its expected price at some future date is determined by the cost of holding the stock (termed "carrying the stock forward") from the present to the future date. This is called "the cost of carry."

As mentioned above, the storage and insurance costs of carrying stock is very low. However, a person who purchases stock gives up the rate of return he would have received if he invested in the next best available alternative. Economists call this foregone rate of return the opportunity cost of the investment; finance analysts call it the cost of capital. Both agree that it is equal to the market rate of interest (return) adjusted for the systematic risk associated with holding the particular stock.[12]

In order to focus on one thing at a time, suppose the stock that is being carried forward pays no dividends and that the cost of capital is 12.5 percent per year.[13] Assume that it is now March 20, 1987 and the trader wants a forecast of the stock's forward price on June 19 — 91 days from now. If the spot price of the stock on March 20th is $50, the foregone income that could be earned by investing the $50 at 12.5 percent for three months is $\$50\,(1.125)^{.25} - \$50 = \$1.49$; this is the cost of carry. The March 20th spot price plus the cost of carry is a forecast of the stock's forward price on June 19 (91 days from now). In this example, the forecast of the stock's price on June 19th is $51.49 (= $50.00 + $1.49).

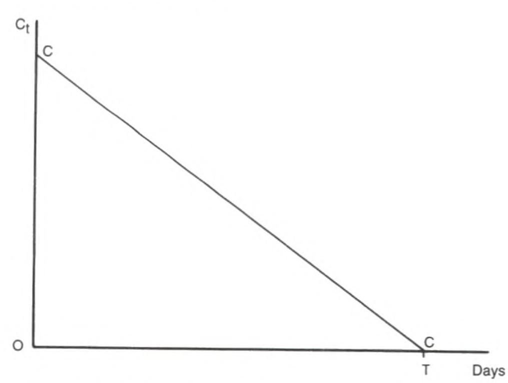
The Cost of Carry with Dividends

Computing the cost of carry is only slightly more complicated if the stock pays dividends. Suppose that the stock in the previous example is scheduled to pay a dividend of $.50 on April 21, 1987. The dividend reduces the cost of carry by slightly more than $.50 because the dividend paid on April 21 can be invested between April 21 and June 19. Consequently, the value of the dividend as of June 19 is slightly higher than $.50.[14] For the example considered, the cost of carry is $\$50\,(1.125)^{.25} - \$.50\,(1.125)^{.167} - \$50 = \$.98$. Notice that the dividend payment reduces both the cost of carry (from $1.49 to $.98) and the March 20th forecast of the stock's price on June 19th (from $51.49 to $50.98).

The Cost of Carry Is Lower for Nearby Delivery Dates

This discussion helps explain why the basis observed in table 2 is lower for futures contracts with nearby delivery dates. Because the holding period is shorter, the interest earnings foregone are less for nearby delivery dates. Similarly, as each contract approaches its delivery date, the cost of carrying the stock shrinks for the period remaining until delivery, other things the same; the cost of carry is zero on the delivery date. This is shown in figure 1. Figure 1 as-

Figure 1
The Cost of Carry



$$C_t = P_t(1+i)^{(T-t)} - D_{t+\alpha}\,(1+i)^{(T-t-\alpha)} - P_t$$

Where: C_t = the cost of carry at t
T = the delivery date
i = the cost of capital
P_t = the stock's spot price at t
$D_{t+\alpha}$ = the expected dividend receipt α days from t

[11]The discussion focuses on the Standard and Poor's index not only for convenience but also because the Standard and Poor's futures contract is the most widely traded; it accounts for about 75 percent of all trading in stock index futures. See, *Wall Street Journal* (March 2, 1987).

[12]See Brealey and Meyers (1984), p. 133. Systematic risk is given by β, which is a measurement of the sensitivity of the investment's return with respect to the market return. Roughly, β is the percentage change in the present value of the investment project divided by the percentage change in some market index of capital values such as the Standard and Poor's composite index *ibid.*, pp. 166–67. The cost of capital, i, is calculated as $i = \beta(i_m - i_f) + i_f$, where i_m and i_f are the market and risk free rates of return.

[13]See Cornell and French (1983), Modest and Sundaresan (1983) and Figlewski (1984) for a formal analysis of the cost of carry.

[14]This adjustment may seem trivial. When one is computing the basis for a stock portfolio that runs into the millions of dollars, as is the case for programmed trading, however, this adjustment can be very important. Notice that .167 = 60/360 where 60 is the number of days between the dividend receipt on April 21 and June 19.

sumes that the cost of capital (i) and the dividends (D) the stock is expected to pay are unchanged during the holding period.

The Cost of Carry Is Uncertain

Since expected dividends can change during the holding period, the cost of carry is not known with certainty. The only thing known with certainty is that the cost of carry will be zero on the day the futures contract is scheduled for delivery.

A change in the expected dividend will cause the line showing the cost of carry in figure 1 to rotate through the point labeled T. An increase in D causes the cost of carry to rotate downward, while a decrease in D causes the cost of carry to rotate upward.[15]

The Cost of Carry and the Basis

The expected cost of carry and the basis are closely related.[16] To illustrate this for a simple case, suppose for a moment that the S&P Index contains only one share of stock. Suppose that the March 20th spot price of the share is $50 (the level of the index is 50) and that the expected cost of carry is $1.50 per share for the next three months (from March 20th to June 19th). If the current price of the S&P Futures contract dated for June delivery is $52.00, the $2.00 basis (= $52.00 − $50.00) exceeds the $1.50 expected cost of carry. The arbitrageur will sell (go short in) June futures at a price of $52.00 per contract and buy (go long in) spot shares of the stock at $50.00. He does this because he expects the price of the June futures to fall to $51.50 (the spot price plus the expected cost of carry). At that price, he can cover his futures position (by purchasing a June futures) at a cost of $51.50 per contract. His gain is $.50 per contract — the difference between the sale price of the futures contract ($52.00) and the cost of covering the contract ($51.50).[17]

The arbitrageur's long, spot position serves to hedge his short, futures position against unexpected changes in the price of the stock. For example, suppose both the June futures price and the spot price rise by $3.00 immediately after the arbitrageur sells the futures and buys the stock spot. The June futures price rises to $55.00 per contract and the spot price increases to $53.00 per share. After the price change, the basis ($2.00 = $55.00 − $53.00) still exceeds the expected cost of carry ($1.50) by $.50 so the arbitrageur expects the price of the June futures to fall to $54.50 per contract.[18] At that price he will cover his short position at a loss of $2.50 per contract (= $52.00 − $54.50). This loss, however, is more than offset by his $3.00 per share gain (= $53.00 − $50.00) on his spot position. His net gain is $.50 (= $3.00 − $2.50) — the same as in the previous case. By hedging in the spot market, the arbitrageur protects the expected gain from unexpected changes in the price of the stock.

On the other hand, suppose the price of the June futures is $51.00. In this case, the $1.00 basis (= $51.00 − $50.00) is less than the $1.50 expected cost of carry. The arbitrageur will short the stock and go long in the June futures. The arbitrageur expects the price of the June futures to rise to $51.50 per share. At that price, he will sell his June futures contract at a gain of $.50 per contract (= $51.50 − $51.00). Again, his short spot position hedges his expected gain against unexpected changes in the price of the stock. Since virtually any-

[15]The cost of carry generally will vary with changes in the cost of capital, i. Whether a direct or indirect relationship exists, however, is problematic. To see this, let

(1) $E(t)P(T) = F(t) = P(t)e^{(i-\delta)(T-t)}$

(2) $P(t) = \dfrac{E(t)\pi}{i}$

(3) $B(t) = F(t) - P(t)$.

where

$E(t)P(T)$ = The period t expectation of the forward price at T.

$F(t)$ = The futures price in period t of a contract dated for delivery at T.

$P(t)$ = The spot price in period t.

i = The cost of capital.

δ = The expected dividend rate.

$E(t)\pi$ = The period t expectation of the perpetual stream of profits (π) assumed to be of constant amount in each period.

$B(t)$ = The basis in period t.

Substitution gives

$$B(t) = \frac{E(t)\pi}{i}\left[e^{(i-\delta)(T-t)} - 1\right]$$

$$\frac{\partial B(t)}{\partial i} = -\frac{E(t)\pi}{i^2}[\quad] + \frac{E(t)\pi}{i}(T-t)e^{(i-\delta)(T-t)}$$

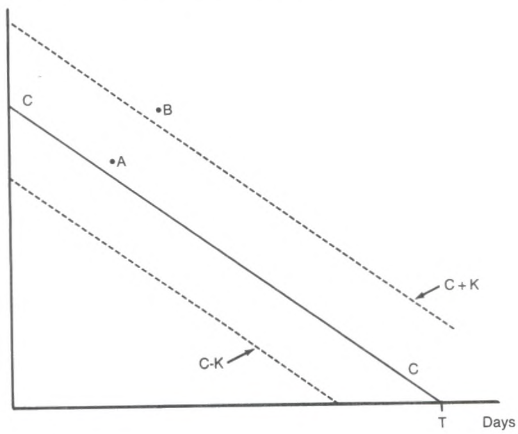
$$\frac{\partial B(t)}{\partial i} = P(t)\{e^{(i-\delta)(T-t)}[(T-t) - 1/i] + 1/i\} \lessgtr 0.$$

[16]See, for example, Cornell and French (1983), pp. 2–3. The example assumes that the equilibrium spot price is given so that the futures price adjusts to the cost of carry. In fact, spot and futures prices are determined simultaneously.

[17]The arbitrageur always has the alternative of holding the stock until the June delivery date of the futures contract at which time the stock is sold and the proceeds are used to settle the futures contract. Since the arbitrageurs' investment in the stock is expected to be $51.50 per share as of the settlement date (= $50.00 + $1.50), expected profits are $.50 per share.

[18]In fact, if the interest rate does not change, the expected cost of carry will rise slightly because of the higher spot price.

Figure 2
The Cost of Carry and Transaction Costs



A profitable trading opportunity exists when:
1) The basis is greater than the cost of carry plus transaction cost (C + K)
2) The basis is less than the cost of carry minus transaction cost (C − K)

Where:
C = the cost of carry
K = transaction cost

one can take advantage of these trading opportunities, large deviations of the basis from the cost of carry do not persist.

Small differences between the basis and cost of carry may persist, however, if the transactions cost of making the appropriate trades is greater than the expected gain. In terms of figure 1, transaction costs can be represented by bands around the line representing the cost of carry. This is shown in figure 2. The vertical distance between the solid line and the dashed lines represent the transaction cost. If the basis deviates from the cost of carry but remains within the bands (as represented by point A, for example), no profitable arbitrage trading is possible. If the basis moves outside the bands (to point B, for example), arbitrageurs will exploit the profitable trading opportunities caused by this large discrepancy. The trading will continue until the basis has been driven back within the bands.

TRADING STOCK INDEX FUTURES

The analysis discussed above is directly applicable to trading among the stocks that make up the S&P Index and the S&P Futures contract. Rather than one stock, however, the S&P Index represents a basket of 500 stocks. The S&P Index multiplied by $500 is analogous to the spot price of the stock in the previous discussion and the S&P Futures multiplied by $500 minus the S&P Index multiplied by $500 is the basis.[19] In principle, the cost of carry is calculated the same way as for an individual stock. There are two important practical differences, however.

First, because the S&P Index represents a well-diversified basket of stocks, it typically is assumed that the risk of unanticipated changes in the value of this basket is roughly equal to the market's risk. Consequently, the cost of capital for the S&P Index is the market rate of return.[20]

A second important practical difference is that the trader must track the dividend policies of 500 companies and the dates on which the shares trade ex-dividend in order to compute the cost of carry. These calculations must be made quickly and accurately because profitable trading opportunities that result from differences between the basis and cost of carry persist only for a short time.

Because both the monitoring and transaction costs increase with the number of companies included in the arbitrage portfolio, traders do not track all 500 stocks in the S&P Index. Instead, they identify a subset of the 500 stocks whose combined value has closely followed the value of the index in the past.[21] Thus traders accept some additional risk because the values of their narrower portfolios are unlikely to move precisely with the S&P Index. The added risk is accepted to reduce the expense of tracking the cost of carry for the broader portfolio.

Of course, computer programs are another way to reduce the expense of calculating and continuously updating the cost of carry as new information becomes available. "Program trading" refers to computer programs that compute the cost of carry and signal profitable trading opportunities. Programmed trading is a less costly (more efficient) method of exploiting profitable trading opportunities between the spot and futures markets.

INDEX FUTURES AND THE VOLATILITY OF STOCK PRICES

Various commentators have alleged that trading between the stock index futures market and the spot

[19]Recall that the value of an S&P Futures contract is $500 times the index. See table 1.

[20]That is, β is assumed to equal 1 so that $i = \beta(i_m - i_f) + i_f = i_m$.

[21]See Schwarz, Hill and Schneeweis (1986), p. 91.

Table 3

A Comparison of Percentage Changes in the Standard and Poor's 500 Index Pre- and Post-April 1982

Panel A: Means and Standard Deviations of %ΔS&P 500 Index

	Pre-April 1982		Post-April 1982			
Period	Mean	Standard Deviation	Mean	Standard Deviation	Differences in Means	Ratio of Variances
Weekly[1]	.130	1.68	.306	1.74	.176	1.07
Daily[2]	.004	.95	.069	.88	.065	1.17

Panel B: Means and Standard Deviations of %ΔS&P 500 Index: Settlement vs. Nonsettlement Days

	Settlement Days		Nonsettlement Days			
Period	Mean	Standard Deviation	Mean	Standard Deviation	Differences in Means	Ratio of Variances
Daily[3]	.150	.97	.069	.88	.081	1.21

where: %ΔS&P 500 Index = Δln (S&P 500 Index) 100

[1]The data begins on the first week of January 1975 and ends on the last week of December 1986; it excludes data from April 1982.
[2]The data begins on 1/2/80 and ends on 12/31/86; it excludes data from April 1982.
[3]The data begins on 5/1/82 and ends on 12/31/86.
*Statistically significant at the 5 percent level.

market for stocks has increased the volatility of stock prices. This criticism has a long history.[22] Our analysis, however, does not imply that stock prices will exhibit greater volatility as a result of this trading. Rather, it suggests that such trading results in a closer correspondence between prices in the spot and futures markets. Since there is no reason to suspect, *a priori*, that this trading increases the volatility of prices in the spot market, we must rely on the data to help answer this question.[23]

The following analysis addresses three key questions: 1) Has stock price variability increased since stock index futures began trading early in 1982? 2) Are stock prices more variable on days when futures contracts are scheduled for delivery (triple witching days)? 3) Is stock price variability related to trading activity in stock index futures?

[22]See Working (1977), pp. 267–97.

[23]*Ibid.*, p. 295.

Percentage Changes In the S&P 500: Pre- and Post-April 1982

The Standard and Poor's futures contract began trading on April 21, 1982. This is the most active contract and accounts for about 75 percent of all trading in stock index futures.[24]

Table 3 compares the period before and after April 1982 using weekly and daily percentage changes in the Standard and Poor's 500 Index. Percentage differences are employed to control for the general increase in the level of the index from 1975 through 1986.[25]

Panel A of table 3 examines the mean and standard deviation of weekly and daily percentage changes in

[24]See, *Wall Street Journal* (March 2, 1987).

[25]The index rose from an average level of 86.18 in 1975 to an average level of 236.34 in 1986. A one-point change in the index represented a much larger percentage change in 1975 (about 1.2 percent) than a one-point change in 1986 (about .4 percent).

the index. As indicated, the mean of the weekly percentage change in the index prior to April 1982 was .130 percent. After April 1982, the mean rose to .306 percent, an increase of .176 percentage points in the later period. In the case of the daily data, the mean of the daily percentage change increased by .065 percentage points in the later period. Neither increase is statistically significant at conventional confidence levels (t-scores are 1.30 and 1.39, respectively). The differences in the means before and after April 1982 could easily have been produced by chance variation in the data.

Comparing the means, however, masks much of the *variation* in the data, because increases in the index are offset by decreases when the mean is computed. The standard deviation is a better indicator of variation because it measures the spread in the data around the mean.[26] For example, the standard deviation of the weekly data before April 1982 is 1.68. If these percentage changes in the index are normally distributed, about 67 percent of the weekly observations fall within the range of .13 ± 1.68 (or −1.56 percent to 1.80 percent). The standard deviation of the weekly data after April 1982 is 1.74 which is about the same as for the earlier period. In fact, the two are not significantly different in a statistical sense (the ratio of the variances = 1.07). A similar conclusion holds for the daily data. In this case, the standard deviation is somewhat smaller in the more recent period, but is not significantly smaller in a statistical sense.[27]

Panel B of table 3 compares variation in the index on days when S&P 500 Futures contracts mature (settlement days) to variation on all other days (nonsettlement days) for the post-April-1982 period. In the case of settlement days, the data are percentage changes in the S&P 500 Index from the close on the day before a settlement day to the close on the settlement day. For nonsettlement days, the data are percentage changes in the daily closing value of the index excluding the changes on settlements days. As indicated in panel B, the mean percentage change is larger on settlement than on nonsettlement days; but the difference between the two is not statistically significant at conventional confidence levels (t-score = .36). Similarly, the standard deviation is larger on settlement days (.97 vs. .88), but is not significantly larger in a statistical sense (the ratio of the variances = 1.21). Thus, the data in table 3 suggest that the share prices of companies included in the S&P Index did not become statistically more variable on average after the S&P Futures contract began trading nor were they more variable on settlement (triple witching) days.

Intra-Day Variation: Pre- and Post-April 1982

The above data measures price variation from day-to-day. Some commentators have expressed concern about intra-day movements in stock prices. The data in panel A of table 4 examine one measure of the intra-day price spread in the S&P Index for pre- and post-April 1982 data: the difference between the daily high and low of the index divided by the close and multiplied by 100.[28]

Panel A indicates that the mean intra-day spread was 2.03 percent before April 1982 and 1.38 percent after. The difference, −.65 percent, is statistically significant (t-score = 17.29) and indicates that the intra-day percentage spread declined after April 1982.

Panel B examines whether the post-April 1982 intra-day price spreads have been unusually large on triple witching days.[29] The data indicates that the mean intra-day percentage spread is slightly larger on triple witching days than on nonsettlement days (1.56 vs. 1.38); the difference, however, is not statistically significant at conventional confidence levels (using the pooled variances, the t-score = 1.48).

To summarize, the data in table 4 indicate that there was a statistically significant decline in the intra-day percentage price spread in the post-April 1982 period. There was no statistically discernible difference, however, between the spreads on triple witching days vs. other post-April-1982 trading days.

Price Variation and Trading Activity in S&P Futures

The data in table 5 help assess whether stock price variability is related to trading activity in S&P Futures contracts. The data are correlation coefficients for daily trading volume in S&P Futures contracts (V) and

[26]See Wonnacott and Wonnacott (1977), pp. 24–25.

[27]In addition, both the mean absolute deviation (MAD) and mean absolute value (MAV) of the weekly and daily percentage changes in the index were examined for the two periods. Like the standard deviation, these measure variation and, for this data, each measure tells a similar story. As in the case of the standard deviation, both the MAD and MAV are slightly higher for the weekly data (about 2 percent higher) and slightly lower for daily data (about 11 percent lower) in the post-April 1982 period.

[28]Scaling the difference between the high and low by the daily low rather than the close produces virtually identical results.

[29]See, for example, Stoller, and Laderman and Frank (September 29, 1986), pp. 96–97.

Table 4
A Comparison of Intra-Day Price Spreads

Panel A: Means Pre- and Post-April 1982

	Pre-April 1982 Mean	Post-April 1982 Mean	Differences in Means
Intra-Day Price Spread[1]	2.03	1.38	−.65*

Panel B: Means on Settlement and Nonsettlement Days: Post-April 1982

	Settlement Days Mean	Nonsettlement Days Mean	Differences in Means
Intra-Day Price Spread[2]	1.56	1.38	.18

Intra-Day Price Spread = [(H-L)/C]100

where: H = the daily high of the S&P Index
L = the daily low of the S&P Index
C = the daily close of the S&P Index

[1]The data begins on 1/2/80 and ends on 12/31/86; it excludes data from April 1982.
[2]The data begins on 5/1/82 and ends on 12/31/86.
*Statistically significant at the 5 percent level.

several measures of price variation in the S&P Index: the daily percentage change in the S&P Index ($\dot{P}$), the absolute value of the daily percentage change in the S&P Index ($A\dot{P}$) and the intra-day percentage price spread (S). Respectively, these correlations indicate whether the volume of trades in S&P Futures generally is associated with an increase or decrease in the S&P Index, larger or smaller changes (either up or down) in the S&P Index, and larger or smaller intra-day price spreads.

An examination of table 5 indicates that the coefficient of correlation for V and $\dot{P}$ is not significantly different from zero in a statistical sense. The same holds in the case of V and $A\dot{P}$. This data suggests that neither the direction nor the magnitude of changes in the S&P Index are associated with trading volume in the S&P Futures market. The coefficient of correlation for V and S, however, is negative and significantly different from zero in a statistical sense; larger trading volume in S&P Futures contracts generally was associated with smaller intra-day price spreads. The table 5 data are not consistent with the claim that trading activity in S&P Futures was associated with increased variation in the S&P Index.

CONCLUSION

Numerous commentators have claimed that stock prices have been more variable since stock index futures contracts began trading. The alleged increase in volatility led to both closer scrutiny of the market by the Securities and Exchange Commission and calls for legislative action. The presumed increase in stock price volatility has been attributed to programmed trading — the practice of trading between the spot and futures markets for stocks. While this trading strategy is not new, the introduction of stock index futures contracts around 1982 and the application of computer programming techniques to trigger trades between the markets are novel.

This paper discusses the theory that underlies programmed trading and examines various measures of stock price variation. The results of the analysis are *not* consistent with the claim that trading activity in the S&P Futures contract is associated with increased price variation in the spot market for stocks.

While closer scrutiny and regulation of trading in stock index futures markets may be justified on other grounds, the evidence presented here suggests that

Table 5

Correlations Between Volume and Measures of Variation in the S&P Index (Daily data: May 1982–December 1986)

	Daily Volume[1]
Percentage Change in the S&P Index	−.006
Absolute Value of the Percentage Change in the S&P Index	.049
The Intra-Day Price Spread	−.286*

[1]Total daily volume for all delivery months.
*Statistically significant at the 5 percent level.

regulation based on the proposition that it has increased price volatility in the spot market would be misdirected.

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Agricultural Banks: Causes of Failures and the Condition of Survivors

Michael T. Belongia and R. Alton Gilbert

THE number of bank failures has risen sharply in recent years. From 1943 to 1981, no more than 17 commercial banks ever failed in a single year. Since 1982, when 34 banks failed, the number of failures has risen each year, reaching 144 in 1986. The failed banks have been concentrated increasingly among small, rural banks in general and agricultural banks in particular. In the years 1984 through 1986, about half of the 340 failed banks were agricultural banks, those with ratios of agricultural loans to total loans above the unweighted national average. Agricultural banks make up about one-third of all banks.[1]

Although the current downturn in the farm economy has been both extensive and protracted, the number of agricultural bank failures in recent years represents only a small percentage of all agricultural banks. This article examines the financial condition of both the surviving and failed agricultural banks to determine why some banks have failed while most have survived. The results have important implications for the ability of banks in rural areas to continue to finance local farm business.

REASONS FOR AGRICULTURAL BANK FAILURES

The rise in failures among agricultural banks reflects the continuing financial distress of farmers in the 1980s. Although agriculture has been a declining industry for some time, its downturn since 1981 has been unusually abrupt and severe.[2] The financial distress in the agricultural sector has its roots in the accumulation of farm debt in the 1970s. As chart 1 shows, the price of farmland and the value of farm debt rose sharply and persistently throughout the 1970s.

The growth of farm income, however, did not keep pace with the rise in farm debt. Some farmers borrowed heavily to purchase higher priced land in anticipation of future appreciation; others borrowed to offset their declining real returns to investments in farming and to finance current consumption. These trends left farmers with heavy debt burdens as they entered the 1980s.

In 1981, these trends changed abruptly. A severe and protracted worldwide recession, which lowered foreign incomes sharply, reduced export sales of U.S. farm products and real net farm income. At the same time, the rate of inflation and expectations of future

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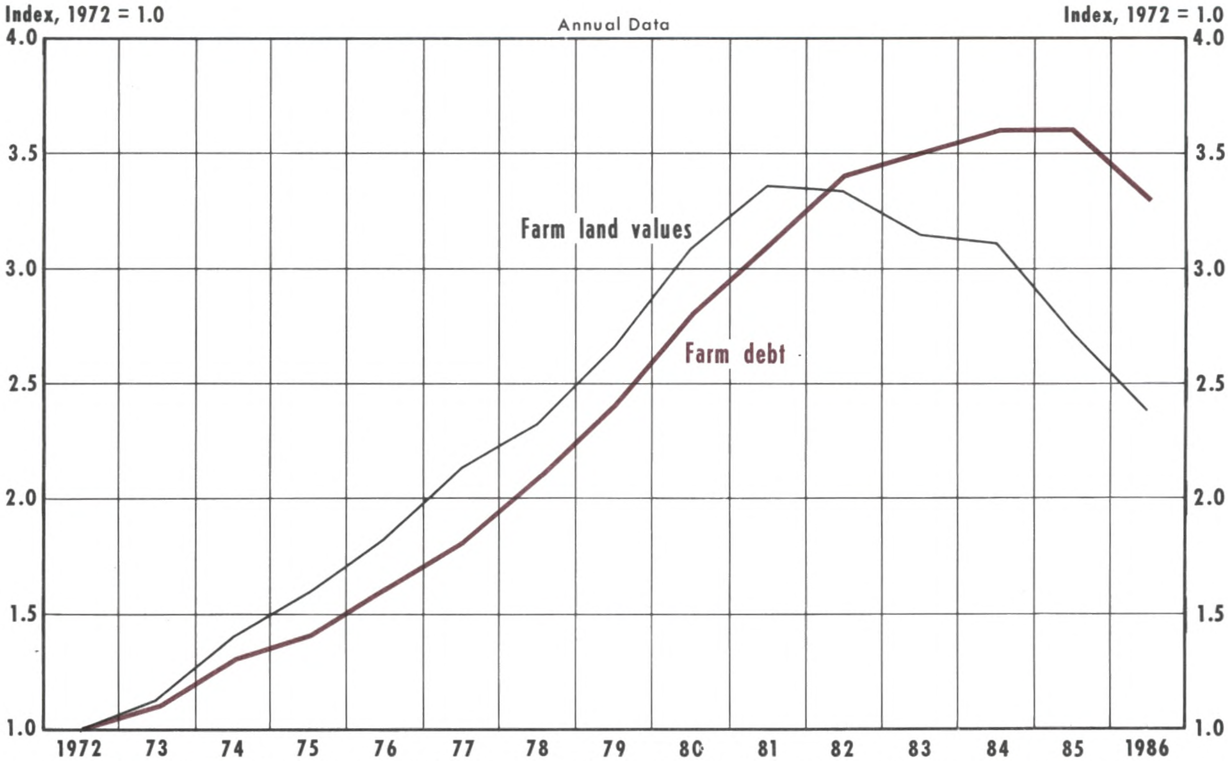
Paul Crosby provided research assistance.

[1]In recent years, the unweighted average ratio of agricultural loans to total loans for all commercial banks has been around 17 percent. This paper uses 17 percent throughout as the criterion for identifying agricultural banks. Melichar (1987) reports that, on December 31, 1986, there were 4,700 banks that had ratios of agricultural loans to total loans above the unweighted national average of 15.7 percent.

[2]See Belongia and Gilbert (1985) and Belongia (1986) for more detail on changes in farm prices, income and asset values since 1981. Belongia and Carraro (1985) discuss the deterioration in portfolio quality for major farm lenders over the same period.

Chart 1
Farm Land Values and Farm Debt



NOTE: The survey of land prices is conducted early in each calendar year. The debt reflects farm debt (excluding CCC loans) at the end of the prior calendar year to match the timing of debt and land values as closely as possible.

inflation suddenly were reduced, lessening the demand for assets like farmland, which are viewed as hedges against inflation. With declining returns to the business of farming and diminished expectations of appreciation in farmland prices, the demand for farmland fell and prices declined. Finally, the 1981 tax bill may have raised the real rate of interest which, in a standard model of asset prices, also would tend to reduce land prices.[3]

With lower export sales and lower income, many farmers could not generate sufficient cash flow to service their debts. Moreover, with land values declining sharply, farmers could not pay off their debts by selling their land. As a result, banks have recorded losses on loans to such farmers.[4] The banks with relatively large losses have failed.

[3]See, for example, Holland (1984) for arguments and evidence on this issue.

[4]Estimates of farm debt unlikely to be repaid and the consequences of allowing different groups to bear the losses are found in Bullock (1985).

THE SELECTION OF AGRICULTURAL BANKING DATA

The analysis of banking data begins with the selection of counties in which agricultural banks failed between January 1, 1984, and December 9, 1986. From the set of all farm bank failures, many banks were deleted. For example, banks in states that permit bank branching beyond the county of a bank's headquarters were eliminated because income and balance sheet data are not available on the individual branches. Banks in other states were excluded because there were no failures of agricultural banks. The remaining sample includes counties in the 10 states listed in table 1.

Table 1 indicates the number of farm bank failures that occurred in the 10 states from 1984 through 1986. To check for clustering of failures in particular regions of a state, the table also lists the number of counties in which farm bank failures occurred. As the table indicates, multiple failures within a county during the

Table 1

Numbers of Farm Bank Failures and Counties in which Failures Occurred: 1984–86

State	Failures	Counties
Alabama	1	1
Colorado	5	5
Illinois	4	4
Iowa	23	20
Kansas	29	25
Minnesota	12	12
Missouri	17	15
Texas	12	12
Wisconsin	1	1
Wyoming	1	1
TOTAL	105	96

three-year period were limited to Iowa, Kansas and Missouri. Even in these states, such failures were spread across nearly equal numbers of counties. Only two counties (one in Iowa in 1985 and another in Kansas in 1986) experienced more than one bank failure in a single year.

BANK PERFORMANCE BEFORE THE FARM SECTOR DECLINE

The next stage of the analysis compares the performance in 1981 of the agricultural banks that failed between 1984 and 1986 with that of agricultural banks in the same counties that had not failed as of June 1986. We then analyze the condition of the surviving agricultural banks in 1986.

There were 519 agricultural banks in June 1981 in the 96 counties identified in table 1; 105 failed between 1984 and 1986, and 414 still were in operation as of June 1986. The first comparison assesses whether the banks that ultimately failed were in relatively good financial condition in 1981. If they were not, their failure may have been largely unrelated to the farm sector decline in recent years.

Table 2 presents several indicators of asset composition and financial performance for the failed and surviving banks. Loan and asset ratios are as of June 1981, whereas returns on equity (ROE) and total assets (ROA) are based on averages for the year 1981.[5] In 1981, the banks in these two groups appeared to be similarly able to absorb loan losses: they had comparable primary capital/assets ratios of 9.52 percent and 9.11 percent. Furthermore, returns on assets and equity were not significantly different, at the 5 percent level, for the two groups of banks. Thus, these banks generated similar earnings and had a similar capacity to absorb losses in the value of their assets.

Because discussions of the financial distress in the agricultural sector generally emphasize the effects of declining farmland prices, we might expect the agricultural banks that have failed to be among those with relatively high percentages of their loans secured by farm real estate. This, however, is not the case. Loans secured by farm real estate accounted for only 5 percent of total loans at the surviving banks in 1981 and only 4 percent of total loans at the banks that subsequently failed. While table 2 shows that the surviving banks invested smaller percentages of their loans in farm production loans not secured by farm real estate, the difference is statistically significant at only the 10 percent level.

As of June 1981, banks that failed had slightly higher ratios of commercial and industrial loans to total loans, but these ratios are not significantly different for the failed and surviving banks. The surviving banks had significantly higher ratios of nonfarm real estate loans to total loans than the failed banks. Thus, the reasons why some banks have failed while others have survived cannot be tied directly to the declines in real estate prices in rural areas.

Differences in the composition of investments indicate that, in June 1981, the banks that ultimately failed chose securities with higher default risk than the banks that have survived. The failed banks had higher

[5]Data for only 102 failed banks are presented because data for three banks identified as failures could not be traced back to 1981. There also was a problem with the data for one solvent bank; thus, only 413 observations could be used.

Report of Condition data for June 30 are used to calculate loan and asset ratios because most farm loans are booked by this time of each year but are paid off in the third and fourth quarters. June 30 data thus avoid the problems of omitting some loans (as first-quarter data would do), loan repayments and end-of-year "window-dressing." Annual averages are used for ROE and ROA data, however, to avoid possible distortions from using what typically is a good quarter for earnings to calculate annualized rates of return.

Table 2

Descriptive Statistics for Agricultural Banks That Failed between 1984–86 and Those That Survived

	Solvent Banks (n = 413)		Failed Banks (n = 102)	
Variable	Mean	Standard deviation	Mean	Standard deviation
Agricultural loans/total loans	50 % (1.54)	18	53 %	19
Farm real estate loans/total loans	5 (1.34)	4	4	5
Farm non-real-estate loans/total loans	45 (1.84)	18	49	20
Commercial and industrial loans/total loans	17 (1.22)	10	18	11
Nonfarm real estate loans/total loans	17 (3.82)	11	12	8
Total loans/total assets	53 (5.44)	12	60	12
Federal government securities/total investments[1]	60 (2.86)	21	53	24
State and local government securities/total investments[1]	26 (2.15)	18	30	22
Primary capital/assets	9.52 (1.08)	2.43	9.11	5.87
Return on equity (ROE)	14.64 (1.16)	6.30	15.48	7.59
Return on assets (ROA)	1.36 (0.41)	0.66	1.33	0.70

NOTE: All loan and asset ratios are June 1981 data. ROE and ROA are based on net income after taxes. Annual average values for assets and equity capital are calculated by giving the December 1980 and December 1981 Report of Condition values weights of one-eighth and the March, June and September values weights of one-fourth. The t-statistics in parentheses are for null hypotheses that the mean values for solvent and failed banks are equal.

[1]For the purposes of this paper, investments are defined to include all securities plus federal funds sold.

ratios of state and local government securities to total investments and lower ratios of federal government securities to total investments.

The difference between the ratios of total loans to total assets at failed and surviving banks yields the highest t-statistic. In June 1981, the ratio of loans to assets was 60 percent, on average, for the banks that failed, but only 53 percent for the surviving banks. Thus, the agricultural banks that have failed had relatively higher ratios of loans to assets in 1981.

CONTROLLING FOR DIFFERENCES IN LOCAL ECONOMIC CONDITIONS

Before attributing cause-and-effect to higher loan ratios and bank failure, however, it should be noted that this relationship might be spurious. For example, most failed banks could have been located in areas with stronger loan demand in 1981 and larger losses in subsequent years. Conversely, most surviving banks could be located in counties with lower loan demand

Table 3

Within-County Differences Between Agricultural Banks That Failed and Those That Survived: June 1981

Variable	Mean	Standard deviation	Minimum	Maximum
Farm real estate loans/total loans	−0.4% (1.31)	6.07	−21%	37%
Farm non-real-estate loans/total loans	4.7 (4.41)	21.37	−59	67
Total loans/assets	8.7 (11.18)	15.51	−44	54

NOTE: t-statistics in parentheses for differences in means.

in 1981 and lower loss rates since then. A closer look at the data, controlling for the potential effects of local economic factors, is required to investigate this possibility.

Local influences on bank performance can be held constant in a variety of ways. One is to compare the loan ratios for June 1981 of each bank that subsequently failed with those of banks located in the same counties that survived. If the lower loan ratios at the surviving banks displayed in table 2 reflect differences in loan demand, the spreads between loan ratios at failed banks and surviving agricultural banks in the same counties will tend to be small and not significantly different from zero.

This, however, is not the case. The ratios of non-real estate farm loans to total loans were about 5 percentage points higher, on average, at the banks that subsequently failed than at the surviving banks in the same counties; this difference is statistically significant at the 5 percent level (see table 3). The banks that subsequently failed also had ratios of total loans to total assets that were almost 9 percentage points higher, on average, than the surviving banks located in the same counties. In contrast, differences between ratios of farm real estate loans to total loans were essentially zero numerically and not significant statistically.

Comparisons of failed and surviving banks located in the same counties sharpen rather than reduce the distinctions between the failed and surviving banks. The banks that failed had accepted greater risks than other banks in the same counties by investing higher percentages of their assets in loans generally and more of their loans in farm loans.

There also is evidence that the agricultural banks which maintained relatively high ratios of loans to assets tended to make poorer quality loans. Melichar found that, as of December 31, 1985, the banks with higher ratios of loans to deposits tended to have higher ratios of nonperforming loans to total loans.[6] Thus, the distinction between the failed and surviving banks based on their ratios of loans to assets may reflect differences in loan quality as well as the risk inherent in operating banks with relatively high ratios of loans to assets.

PERFORMANCE OF THE SURVIVING BANKS

Table 4 presents data for banks that were still in business as of year-end 1986; the smaller number of observations, 400, reflects problems with the data for some banks, which were deleted. Although still solvent, earnings at these surviving institutions declined substantially over the five-year period, as comparisons with the 1981 ROE and ROA figures indicate. Losses also led to a numerically small but statistically significant reduction in the average capital ratios of these institutions. The average capital/assets ratio of 8.94 percent in 1986, nonetheless, is substantially above regulatory guidelines for a minimum ratio of primary capital to total assets of 5.5 percent.[7]

Table 4 also indicates reductions in the ratios of both agricultural loans to total loans and of total loans

[6]Melichar (1986), pp. 445–46.

[7]See Gilbert, Stone and Trebing (1985).

Table 4

Descriptive Statistics for Solvent Banks: June 1981 and June 1986 (n = 400)

Variable	June 1981 Mean	June 1986 Mean	June 1986 Minimum	June 1986 Maximum
Agricultural loans/total loans	49.89% (2.00)	47.39%	1.96%	97.19%
Total loans/assets	52.50 (9.06)	44.77	9.66	82.26
Primary capital/assets	9.52 (3.19)	8.94	2.96	23.41
Return on equity (ROE)[1]	14.64 (14.24)	0.006	−94.96	32.83
Return on assets (ROA)[1]	1.36 (15.55)	0.20	−6.62	3.77

NOTE: t-statistics in parentheses for the difference between mean values in 1981 and 1986.
[1]ROE and ROA are annual average rates of return.

Table 5

Surviving Banks: Measures of Performance in 1986 for Those with Positive and Negative Earnings

	Mean	Standard deviation	Minimum	Maximum
BANKS WITH POSITIVE EARNINGS (n = 285)				
Total loans/assets	42.66%	13.64	9.76%	82.25%
Return on equity	9.49	5.34	0.24	32.83
Primary capital/assets	9.52	2.69	5.36	23.41
Problem loans/capital[1]	11.13	13.71	0	74.67
BANKS WITH ZERO OR NEGATIVE EARNINGS (n = 115)				
Total loans/assets	49.99%	11.47	9.66%	81.35%
Return on equity	−23.49	23.01	−94.96	0
Primary capital/assets	7.50	2.48	2.76	18.08
Problem loans/capital[1]	43.23	37.61	0	191.76

NOTE: All ratios based on data for June 1986, except return on equity, which is for the year 1986.
[1]Problem loans are defined as those more than 30 days past due or in nonaccrual status.

to assets that are statistically significant. Thus, the surviving banks, which had assumed lower risk than the failed banks in 1981 by investing smaller shares of their assets in loans, reduced their exposure to losses on loans even more during the following five years.

A Closer Look at the Condition of Survivors

The result in table 4 that surviving banks, on average, had a zero return on equity in 1986 might imply that it is only a matter of time before many of them join the ranks of the 102 failures in the sample. Such a conclusion, however, would be hasty, as the data in table 5 indicate.

If the 400 surviving banks are divided into groups with positive and negative ROE for 1986, we find that the surviving banks fall into the disparate categories of *very healthy* or *very troubled*. The 285 banks with positive earnings in 1986 had significantly lower ratios of loans to assets than the banks with negative earnings. The top portion of table 5 indicates that over 70 percent of the survivors had positive ROEs in 1986 and an average ROE of 9.49 percent; while down from the 1981 ROE average, it nonetheless compares favorably with the 1986 national averages for both agricultural and nonagricultural banks. The banks with positive earnings also have higher capital ratios. Moreover, further significant reductions in earnings and capital ratios appear unlikely, since the ratio of problem loans to primary capital is 11 percent, on average, for this group of banks. The remaining 115 banks, or 29 percent of the survivors, are in poor financial condition. The bottom portion of table 5 shows ROE to be an average of −23 percent, and these banks are likely to have additional losses; on average, their problem loans exceed 40 percent of their capital.

As a further check on the financial health of the surviving agricultural banks, the 400 solvent banks were grouped on the basis of the ratio of problem loans to capital for June 1986 data. The mean value for this ratio was 20.36 percent. Table 6 indicates that 68 percent of these banks have a problem loan/capital ratio less than 20 percent; for about 12 percent of the banks, problem loans are greater than 50 percent of capital. These figures suggest that, while problem loans are likely to have large, adverse effects on future earnings for some institutions, they do not appear to threaten the solvency of most of the surviving banks.

Table 6

Distribution of Surviving Banks by the Ratio of Problem Loans to Primary Capital

Problem loan/ capital ratio	Number of banks	Percent of total[1]	Cumulative percentage[1]
0–10%	202	50.5%	50.5%
11–20	71	17.8	68.3
21–30	43	10.8	79.1
31–40	22	5.5	84.6
41–50	16	4.0	88.6
51–60	14	3.5	92.1
61–70	9	2.3	94.4
71–80	6	1.5	95.9
81–90	3	0.8	96.7
91–100	3	0.8	97.5
> 100	11	2.8	100.3

[1]Figures may not sum to 100 percent due to rounding.

IMPLICATIONS OF BANK FAILURES FOR FARMERS

Because farmers typically borrow from banks in their own communities, a final question of interest is whether sound farm banks still remain in counties in which agricultural banks have failed. As of the fourth quarter of 1986, at least one agricultural bank showed positive earnings in 87 of the 96 counties. Moreover, the average ratio of primary capital to total assets was 9.06 percent for these banks. Thus, there remains at least one agricultural bank in sound financial condition in over 90 percent of the counties in which an agricultural bank has failed.[8]

It is important to add, however, that the remaining agricultural banks have relatively low ratios of total loans to total assets. The healthy agricultural banks in the 87 counties had average ratios of total loans to total assets of 40 percent as of December 31, 1986. Conversely, many banks that had higher ratios of loans to assets have failed.

CONCLUSIONS

Agricultural banks that failed in recent years were not in weaker condition before the recent years of financial stress in the agricultural sector. In 1981, both the banks that later failed and those that survived had similar profit rates and capital ratios. The banks that failed, however, had invested higher percentages of their assets in loans, in particular agricultural production loans, and lower percentages of their investments in federal government securities. Each difference exposed the banks to a relatively higher risk of losses.

About 70 percent of the surviving agricultural banks remained in relatively strong financial condition in 1986. The other surviving banks reported large losses and large amounts of troubled loans relative to their capital. The banks in relatively strong condition in 1986 also had the lowest ratios of total loans to assets among the surviving banks. Finally, while over 90 percent of the counties in which agricultural banks have failed still are served by at least one agricultural bank in sound financial condition, these remaining banks have relatively low ratios of loans to assets.

[8]In calculating the number of counties with agricultural banks in December 1986, the investigation is not limited to the 400 surviving banks that were agricultural banks in 1981. Some surviving banks reduced the share of their loans to farmers below 17 percent by 1986, and others that were agricultural banks in 1986 either were not in business in 1981 or were not classified as agricultural banks at that time.

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