Turn, Turn, Turn: Predicting Turning Points in Economic Activity

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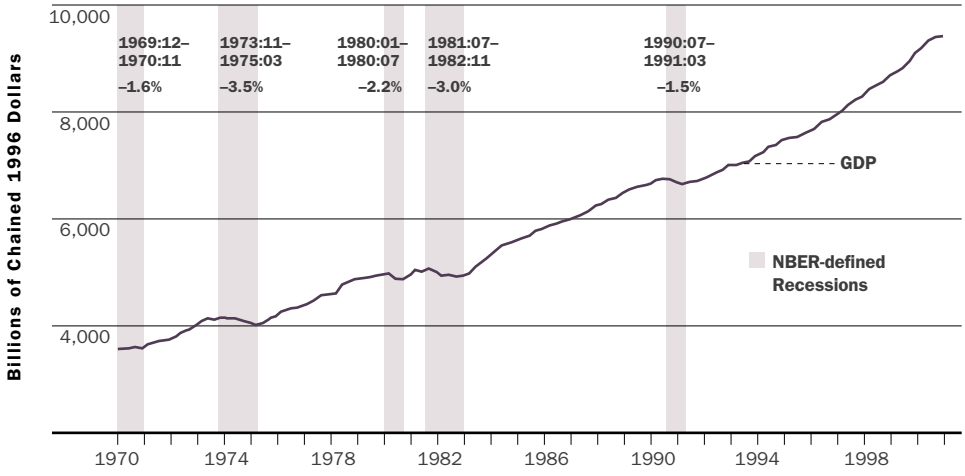
JULY 31, 2000: THE PRELIMINARY DATA FOR SECOND QUARTER REAL GROSS DOMESTIC PRODUCT (GDP) SHOW THAT THE ECONOMY IS GROWING AT A RATE OF ALMOST 6 PERCENT. THE LONGEST POSTWAR EXPANSION MARCHES ON. "NEW ECONOMY" PROPHETS CELEBRATE THE DEATH OF THE BUSINESS CYCLE—NAMELY, THE SEQUENCE OF UPS AND DOWNS, UNEVEN IN strength and duration, that have, so far, characterized economic activity.

January 31, 2001: Preliminary real GDP growth for the fourth quarter is barely above 1 percent, more than 4 percentage points below what is was only two quarters before and about 7 percentage points below its level in the third quarter of 1999. Much of the press, and some forecasters, predict that the first quarter of 2001 may be the beginning of a recession. Whether this is the case or not is on the minds of many policymakers while this article is being written.

The current state of the economy, not to mention the stock market, is certainly a far cry from what it was a few months ago. The recent gyrations in the economy and in the stock market remind us that the business cycle may not be dead—yet. They also remind us that economic conditions may change fast and somewhat unpredictably. This article focuses on providing some evidence on econometric models' ability to forecast these sudden changes in the business cycle, also called turning points.

A model that can correctly predict turning points would clearly be useful to the business community and the general public. Investment decisions are made with an eye toward future economic conditions. The clearer the crystal ball, the wiser the decision. Policymakers would also benefit from the ability to forecast turning points. As late as May 2000 the Fed raised interest rates by 50 basis points to 6.5 percent, the last of a sequence of federal funds rate increases, totaling 1.75 percent, that started in June 1999. The increase in target rates at that time was justified by the strength of the economy and the dangers posed by a potential comeback in inflation.[1] Without in any way implying that such a policy move has "caused" the current slowdown in activity, one could reasonably argue that policymakers might have behaved differently then had they known what was to come. These suppositions bring us to the main question of this article: How good is the state of the art in turning point forecasting?

CHART 1 Real GDP Growth 1970–2000



Notes: Percentages are declines in real GDP during the recessions.

Sources: GDP data from the Bureau of Economic Analysis, U.S. Department of Commerce; recession dates from the National Bureau of Economic Research (NBER)

The first section of the article discusses the definition of turning points in economic activity. The article then describes different approaches to turning point forecasting and their relative advantages and disadvantages. Next, the article assesses the performance of the Atlanta Fed Bayesian vector autoregression (BVAR) model in terms of forecasting turning points relative to a well-known alternative. The Atlanta Fed research department uses its BVAR model as a tool for forecasting and policy analysis. The model appears to be moderately successful, relative to other models, in forecasting real activity (see Robertson and Tallman 1999). However, as discussed later in this article, predicting particular events—like turning points—is not necessarily the same as day-to-day forecasting. The Atlanta BVAR model is geared toward the latter task. If the model turns out not to be adequate for the former task, it may be appropriate to supplement the BVAR model with a model that is specifically designed to forecast turning points.

Defining Turning Points

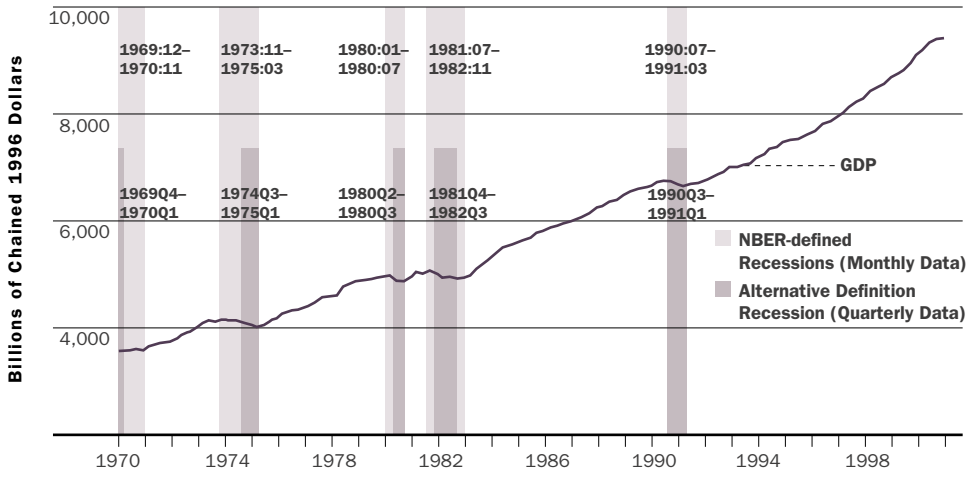
Everybody knows, roughly speaking, what a recession is. Not everybody knows what a turning point in real GDP is. The two are in fact closely related. According to a rule popularized by Arthur Okun and widely used in the press, the beginning of a recession (the end of an expansion) is defined as the first of two consecutive quarters of decline in real GDP. By analogy, the end of a recession (or the beginning of an expansion) is marked by the first of two consecutive quarters of real GDP growth (see Harding and Pagan 1998). The beginning and end of a recession are turning points in real GDP: the beginning represents a *peak* in real GDP while the end represents a *trough*.

Chart 1 illustrates this pattern. The chart plots real GDP from 1959 to the present as well as the National Bureau of Economic Research (NBER) recessions (shaded areas). In July 1990, at the beginning of a recession, real GDP starts to decline. Since real GDP is going down, its value in July 1990 is the highest attained for the next few quarters—a peak in real GDP. The chart shows that real GDP declines until March 1991. After that month, the recession ends and real GDP starts rising again. The value of GDP attained in March 1991 is lower than its value in any quarter of the preceding recession or the following expansion, so March 1991 is referred to as a trough in real GDP.

To be precise, the definition of recessions and expansions used by the NBER is not as simple as the one given above. The NBER recession and expansion dates are determined by the NBER Business Cycle Dating Committee. The members of the committee are guided in their decision by the widely quoted Burns and Mitchell definition of business cycles:

> Business cycles are a type of fluctuation found in the aggregate economic activity of nations

CHART 2 Real GDP Growth 1970–2000



Sources: See sources for Chart 1; alternative recession dates calculated by the Federal Reserve Bank of Atlanta

that organize their work mainly in business enterprises: a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; this sequence of changes is recurrent but not periodic; in duration business cycles vary from more than one year to ten or twelve years; they are not divisible into shorter cycles of similar character with amplitudes approximating their own. (1946, 3)

Burns and Mitchell's definition emphasizes three important business cycle characteristics, known as the three Ds: duration, depth, and diffusion. A recession has to be sufficiently long (duration); it has to involve a substantial decline in output (depth); and it has to affect several sectors of the economy (diffusion). Faithful to the generality and complexity of Burns and Mitchell's definition, the NBER committee eschews numerical rules like the "two quarters of decline in real GDP" rule given above. Nonetheless, Chart 2 shows that after 1970 the recession and expansion dates determined using the "two quarters" rule are a good approximation of the NBER recession and expansion dates. The only difference is that NBER-defined recessions tend to be longer than recession defined using the two quarters rule. The NBER considers months of stagnant or very moderate growth as belonging to recessions rather than to expansionary periods. However, for practical purposes, turning points defined using the popular two quarters rule and NBER-defined turning points are not too far apart.

Predicting Turning Points: The Leading Indicators

The most well known predictors of turning points in economic activity are the series known as Leading Economic Indicators (LEI). The leading indicators were originally proposed in 1938 by Burns, Mitchell, and their colleagues at the NBER on the basis of their tendency to lead the cycle, as their name suggests (see Mitchell and Burns 1983). Until December 1995, the Leading Economic Indicators were produced by the Bureau of Economic Analysis at the Department of Commerce. Since that date, they have been produced by The Conference Board, a private, nonprofit organization.[2]

The box lists the series that are currently part of the LEI. The current list has changed from that originally proposed by Burns and Mitchell. Over

1. A May 16, 2000, press release from the Federal Open Market Committee (FOMC) stated, "Against the background of its long-term goals of price stability and sustainable economic growth and of the information already available, the Committee believes the risks are weighted mainly toward conditions that may generate heightened inflation pressures in the foreseeable future."
2. The Conference Board also produces a list of Coincident and Lagging Economic Indicators as well as the Consumer Confidence Index.

BOX

Index of Leading Economic Indicators

(1) Average weekly hours, manufacturing

(2) Average weekly initial claims for unemployment insurance

(3) Manufacturers' new orders, consumer goods and materials (in 1996 dollars)

(4) Vendor performance, slower deliveries diffusion index

(5) Manufacturers' new orders, nondefense capital goods (in 1996 dollars)

(6) Building permits, new private housing units

(7) Stock prices, 500 common stocks

(8) Money supply, M2 (in 1996 dollars)

(9) Interest rate spread, ten-year Treasury bonds less federal funds

(10) Index of consumer expectations

Source: The Conference Board

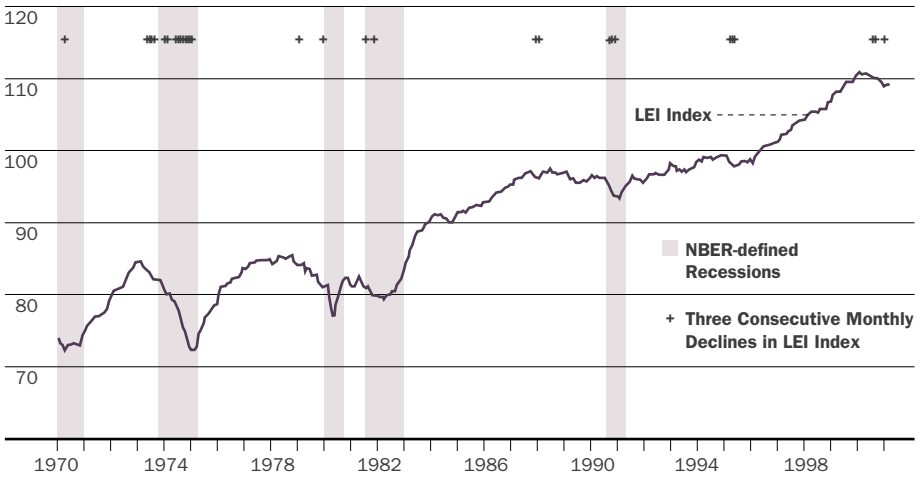
time, as new information about turning points has become available, series have been added or dropped out. A leading indicator that has recently received much attention in the press is the Index of Consumer Expectations, produced by the University of Michigan, which measures consumers' optimism and their willingness to spend and invest. This indicator has recently made the headlines because the sharp fall in consumer sentiment toward the end of 2000 and the beginning of 2001 raises the question of whether the beginning of a recession is imminent.

Policymakers, the press, and the public analyze the leading indicators series to gauge whether a recession is forthcoming. Leading indicators have an advantage over more complex econometric models: the index can be readily understood and interpreted. Popular discussion often neglects the fact that the leading indicators suffer from some of the very same problems as the more complex econometric models. The series representing the leading indicators were chosen on the basis of their ability to predict past recessions. Using the econometric lingo, they were chosen on the basis of their *in-sample* performance—that is, their ability to predict, with hindsight, recessions that have already occurred. Whether the leading indicators are able to predict future recessions (*out-of-sample* performance) is a different matter. Indeed, one of the reasons the Leading Economic Indicators list is periodically revised is that each new recession shows that some of the series were not good predictors after all (see Moore 1983 and Conference Board 1997 for a history of the revision process). For example, the only two series that have survived the test of time from the original Mitchell and Burns list of indicators are "average weekly hours, manufacturing" and the "S&P 500 Index."[3] All other series from their original list have been discarded.[4] Of course, some of the series that are in the current list may at some point share the same destiny.

In fairness to the Leading Economic Indicators, some literature shows that they have predictive power, not only in-sample but also out-of-sample (see Moore 1983; Zarnowitz and Braun 1988). However, such predictive signals coming from the leading indicators are hard to decipher, just like the pronouncements of the Delphic oracle.[5] For starters, leading indicator series often give conflicting signals. For example, in the last few months consumer sentiment has been plummeting, but building permits for new houses have been quite strong. Which indicators should one trust?

To avoid this problem, forecasters often rely on the Leading Economic Indicators Index, which is a weighted average of all leading indicators. Forecasters pay particular attention to turning points in the index: by the very nature of leading indicators, turning points in the index should anticipate turning points in economic activity. Still, turning points in the index are not always easy to recognize. Chart 3 plots the LEI Index along with the NBER recessions (shaded areas).[6] One can see that the 1973 recession is the only case in which a peak in the index clearly leads to a peak in economic activity. It is much harder to recognize turning points in the index prior to the 1981 or 1990 recessions. A rule often used to identify turning

CHART 3 Index of Leading Economic Indicators



Sources: Conference Board; NBER

points in the index is the so-called three-consecutive-declines rule: three consecutive declines in the LEI Index signal a turning point, suggesting that a downturn in economic activity may be imminent. The plus (+) signs in Chart 3 designate the third month in each sequence of three consecutive declines in the index. The patterns in the chart suggest that the three-consecutive-declines rule was helpful in predicting the 1973 recession, gave mixed signals prior to the 1980 recession, and was not helpful at all prior to the 1981 and 1990 recessions. In addition, the rule gave false signals in 1987 and 1995.

Other rules may perform better than the three-consecutive-declines rule. Diebold and Rudebusch (1989) use a more sophisticated approach to capture turning points in the index (also see Neftci 1982). This approach uses a regime-switching model to compute at each point in time the probability of a turning point in the index. Since in each period the probability is updated using the most recent index data release, this method is called the sequential-probability-of-turning-point approach. Diebold and Rudebusch find that this approach performs reasonably well, and certainly better than the three-consecutive-declines rule, in predicting postwar U.S. recessions.

In summary, the evidence suggests that leading indicators may be useful in predicting recessions. At the same time, the emphasis placed by the press on the latest LEI figures seems to be exaggerated. Like a Delphic oracle, leading indicators give valuable signs. However, interpreting those signs is less clear-cut than it would appear from reading the press. Additional tools may be needed to refine the accuracy of turning point prediction.

Predicting Turning Points: Econometric Models

An alternative approach to forecasting turning points in economic activity is to use econometric models. Within this approach, there are two different ways of tackling the problem of predicting turning points. One way is to rely on statistical models that are built to predict future values of economic variables, one of which is real GDP. The other way is to build a model that focuses directly on predicting the event of interest—in this case, turning points. For the first category of models, predicting turning points is a by-product of day-to-day forecasting. For the second category, it is the

3. To be precise, Mitchell and Burns's original list used a different index of stock prices—the Dow-Jones index of industrial common stock prices (see Moore 1983).
4. For instance, "change in sensitive material prices and change in unfilled orders for manufactured goods . . . were finally deleted in 1996. Each of these deletions followed the recognition that the component was not as reliable a leading indicator as originally thought" (Conference Board 1997, 5).
5. "The lord whose is the oracle at Delphoi neither utters nor hides his meaning, but shows it by a sign" (Heraclitus, Fragment 93, Diels-Kranz numeration).
6. The series for the LEI Index was obtained from Haver.

very goal of the model. This section describes the merits and faults of the two approaches and briefly discusses their underpinnings in the history of economic thought.

Econometric models are widely used to produce forecasts of economic time series. These models differ substantially from one another in terms of their econometric methodology, the variables that are being forecast, and the importance of judgmental factors. Some well-known examples of econometric models are the structural models in the Cowles Foundation tradition. These models usually employ a large number of equations, with each block of equations representing a specific aspect of economic behavior (household behavior, firm behavior, and so forth).[7] Several commercial forecasting models, like the Penn-MIT model, the Fair model, and the Macro-Advisors model, belong to this category. Another set of models commonly used for forecasting is vector autoregression (VAR) models (often Bayesian VARs, in the Litterman 1980 tradition), like the one currently in use at the Atlanta Fed. VAR models differ from structural econometric models in several ways, but mainly in their identifying assumptions (see Sims 1980 and Stock and Watson forthcoming for a discussion of VARs).[8] Finally, a third set of econometric models used in forecasting is the dynamic factor models, pioneered by Sargent and Sims (1977). In particular, Stock and Watson (1989) use a dynamic factor model to create indexes of the coincident and leading indicators that capture the information present in the Coincident and Leading Economic Indicators already mentioned.

The evidence suggests that leading indicators may be useful in predicting recessions. At the same time, the emphasis placed by the press on the latest LEI figures seems to be exaggerated.

All these various models embody, implicitly or explicitly, a so-called extrinsic view of business cycles. According to this view, the underlying structure of the economy does not change from a recession to an expansion. The underlying structure is stable and can be described, or at least approximated, by a linear probabilistic model. From the extrinsic point of view, the main difference between recessions and expansions lies in the sign (negative or positive), and possibly in the size and duration, of the shocks that hit the economy (see Stock and Watson 1989 and Diebold and Rudebusch 1996 for a discussion of this point). In contrast, traditional business cycle research tends to view recessions and expansions as being intrinsically distinct; according to this "intrinsic" view, turning points represent shifts in the economic behavior of agents and are not simply the result of a large negative shock in economic activity.[9] In terms of forecasting, one implication of the intrinsic view is that day-to-day forecasting and predicting turning points may be different businesses altogether.

While there is no systematic record of the ability to predict turning points for all existing structural models and VARs, the common wisdom is that most of these models share a dismal record in predicting recessions.[10] Perhaps in response to this poor performance, a different approach to turning point forecasting, pioneered by Estrella and Hardouvelis (1991) and then followed by Estrella and Mishkin (1998) and Chin, Geweke, and Miller (2000), was recently developed.[11] This approach recognizes that the set of variables that helps predict "routine" ups and downs in output may not necessarily be of much use in predicting recessions. Likewise, statistical models that are used in forecasting future values of economic time series may not be too useful in predicting a specific event, like a recession.[12] Instead of using a linear regression model, the above-mentioned authors directly model the probability of a recession using a *probit* model. In a probit model the variables included in the model and their respective coefficients are chosen not on the basis of their ability to track past movements in real GDP but on the basis of their ability to indicate the likelihood of past recessions.

The main strength of this approach is that it is geared specifically toward predicting turning points. The very strength of the approach, however, is also its main weakness. The probit model focuses on recessions, and recessions are rare events. Econometric models aimed at tracking real GDP have numerous observations at their disposal. Models aimed at pinning down recessions have only a handful.

Probit models suffer an additional disadvantage relative to econometric models when it comes to policy analysis. As emphasized in the press and in the policy debate, policymakers' actions may affect the likelihood of a recession. Policymakers need to assess how their actions change the probability that the economy may encounter a recession a few quarters down the road. Unfortunately, these issues cannot be addressed quantitatively in the context of probit models, which do not distinguish between policymakers' actions and shocks coming

from elsewhere in the economy. Identified econometric models like the VAR, however, allow for such a distinction. Within the framework of identified models one can ask the question, If the Fed had lowered interest rates by an additional 50 basis points in March, would the likelihood of a recession be significantly lower (see Leeper and Zha 2001)? The reliability of the answer, of course, depends on how good the underlying identification assumptions and the forecasting ability of the model are. Yet the capability to perform such important thought experiments gives identified econometric models an edge over probit models and leading indicators.

A Comparison of Techniques

The ultimate test for all forecasting models lies in their out-of-sample accuracy. This section compares the predictive ability of the Atlanta Fed BVAR model with that of both the Leading Economic Indicators Index and the turning point model proposed by Estrella and Mishkin.

The Atlanta Fed model is a Bayesian VAR that incorporates six variables: the federal funds rate, the consumer price index (CPI), M2, oil prices, unemployment, and real GDP.[13] All these variables are available since 1959 and enter the model in logarithms, with the exception of the unemployment rate and the fed funds rate, which enter in levels. All the variables except GDP are available on a monthly frequency; monthly GDP is computed by interpolating quarterly GDP. Following the Bayesian tradition, the model uses priors (that is, it combines prior information with sample data to estimate equation parameters) to deal with the large number of coefficients and the issue of nonstationarity (see Robertson and Tallman 1999 for a detailed description of the model, the priors, and the data).

Chart 4 plots the probabilities of a recession in the next eight quarters computed from January 1970 to March 2001 using the Atlanta Fed Bayesian VAR model. Chart 4 also shows the Leading Economic Indicators Index. Plus (+) signs indicate the third month for each sequence of three consecutive declines in the index. As discussed above, the three-consecutive-declines rule is often used to detect turning points in the index.

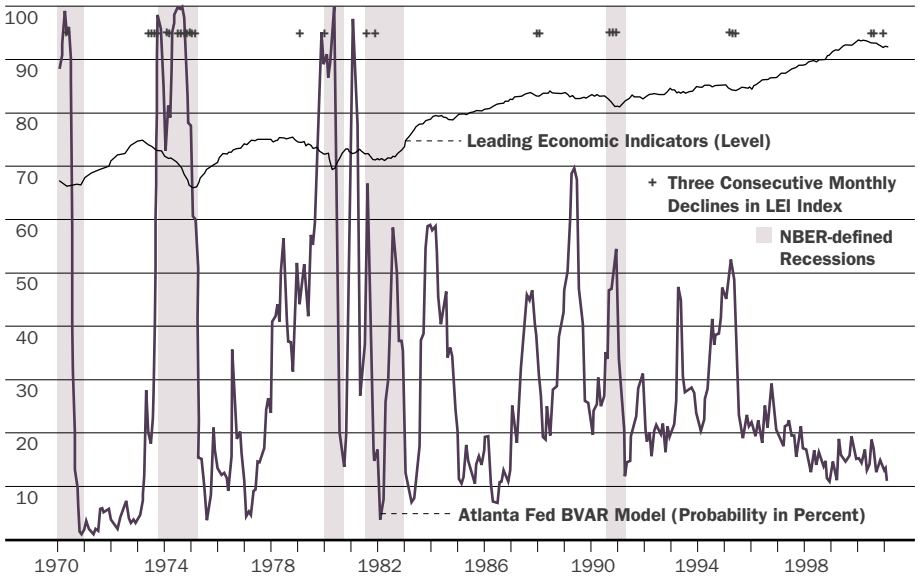
The probabilities shown in Chart 4 are out-of-sample probabilities of a recession. The probability of a recession in the next eight quarters computed for, say, January 1970 is computed by performing the following steps:

(1) estimating the model using only the data that were available in January 1970;[14]
(2) using a Monte Carlo procedure, generating 2,000 draws from the probability distribution of the forecasts of future real GDP (the draws are obtained by randomly sampling from the joint distribution of forecast errors);
(3) for each draw, determining whether a recession (defined as two consecutive quarters of negative real GDP growth) will occur in the next eight quarters or not; and
(4) computing the percentage of draws for which a recession occurs, thus providing an estimate of the probability of a recession.

Relative to turning point models, like the one proposed by Estrella and Mishkin, the Atlanta Fed BVAR model is far less precise in indicating the exact timing of a recession.

7. See Fair (1994) for a discussion of the Cowles Foundation tradition.
8. In structural econometric models an identification problem can arise in estimating simultaneous equations when it is impossible to distinguish from the data which equation is being estimated. To eliminate this problem, structural models often impose the restriction that variables factored into one block of equations—say, the household block—not be used in other blocks, either contemporaneously or with lags. The proponents of VARs claim that these restrictions have little or no ground in modern general equilibrium theory and prefer models with fewer variables but also fewer restrictions.
9. Regime-switching models (see Hamilton 1989) somewhat bridge the extrinsic and intrinsic views: these models recognize that the parameters describing the economy may change from a recession to an expansion; at the same time, the models assume a linear probabilistic structure within regimes. Bayesian turning point models also bridge the two views as they assume linearity with time-varying parameters (see Zellner and Hong 1988).
10. For example, Stock and Watson (1992) discuss how their model missed the 1990 recession.
11. This approach has an antecedent in the "experimental recession index" developed by Stock and Watson (1989, 1992).
12. Chin, Geweke, and Miller, also proponents of this approach, state that "An unwritten rule of forecasting is that accuracy is enhanced by forecasting directly what is of interest—in this case turning points" (2000, 3).
13. The model was originally designed by Tao Zha (Zha 1998).
14. The probabilities are computed starting in 1970 because prior to that date too few data are available for the estimation.

CHART 4
Probability of a Recession in the Next Eight Quarters



Sources: Conference Board; NBER; BVAR model from the Federal Reserve Bank of Atlanta

It is important to remark two features of this procedure. First, the model is estimated using only the data available up to that month. For instance, from January to March 1970 the model uses only the series for real GDP up to the fourth quarter of 1969 because the real GDP figures for a given quarter become available only in the month after the end of that quarter. The model uses the most recent vintage of revised data, not the data that were actually available in January 1970, but the experiment tries to duplicate "real-time" forecasting as closely as possible.[15]

The second important feature of the procedure is that it estimates the probability of a recession occurring in any of the next eight quarters, including the current quarter. There are two reasons for estimating the probabilities this way. First, it allows comparison of the accuracy of the signals from the BVAR model with those from the Leading Economic Indicators Index. Chart 3 shows that the timing of turning points in the LEI Index relative to turning points in economic activity varies considerably from recession to recession. In other words, a turning point in the index signals that some time in the near future a recession may be starting but does not give a precise signal of when it may begin. To make a fair comparison, the same leeway is allowed for the BVAR model in terms of the timing of recessions. Second, from the perspective of policymakers, determining the precise timing of a recession is, arguably, less important than determining the likelihood of a recession in the near future.

The patterns in Chart 4 suggest that the predictive ability of the BVAR model, both in absolute terms and relative to the LEI, is less dismal than one would expect given that the model is not geared toward predicting recessions and that it includes only one of the LEI series (M2) among its variables. The BVAR signals ahead of time both the 1973 and 1980 recessions. The probability of the 1973 recession rises above 50 percent only a few months prior to the beginning of the recession while the signal from the LEI is more timely. For the 1980 recession, the warnings from the BVAR appear more clear-cut than the warnings from the index.[16] For the 1981 recession, the BVAR sends a very clear signal at the beginning of the year while the index sends none. However, the BVAR signal is not steady in that the probability decreases below 50 percent immediately prior to the recession. Finally, both the BVAR and the index miss the 1990 recession. The recession probability computed by the BVAR rises to 70 percent in 1989 but then declines below 30 percent and rises again only well into the recession. In terms of false signals, the BVAR and the three-consecutive-declines rule are roughly at the same level. The probability of a recession computed by the BVAR rises, incorrectly, above 50 percent in 1984 and in 1995. The three-consecutive-declines rule sends false signals in 1987 and 1995.

While visible patterns in the data are helpful, forecasters would like to have a more quantitative measure to compare predictive abilities. Diebold and Rudebusch (1989) provide two such measures. The first, called a quadratic probability score (QPS), is computed as follows:

$$\text{QPS} = 1/T \sum_{t=1}^{T} 2(P_t - R_t)^2,$$

where P_t is the probability assigned by the model and R_t is an indicator function equal to 1 if a recession is occurring within the next eight quarters and equal to 0 otherwise.[17] If the forecasting model is right all the time, in the sense that the model assigns a probability of 1 when a recession is going to occur and of 0 otherwise, the QPS takes a value of 0. If the forecasting model is wrong all the time, in the sense that the model assigns a probability of 0 when a recession is going to occur and of 1 otherwise, the QPS takes a value of 2. The second measure is called the log probability score (LPS) and is computed as follows:

$$\text{LPS} = -1/T \sum_{t=1}^{T} [(1 - R_t)\ln(1 - P_t) + R_t \ln(P_t)].$$

While the QPS penalizes small and large forecasting errors proportionally—a model that makes several small mistakes may have the same score as a model that makes few very large mistakes—the LPS penalizes large mistakes more heavily.

In order to compare the predictive ability of the BVAR model to that of the LEI Index, the three-consecutive-declines rule must be transformed into recession probabilities. Following Diebold and Rudebusch, this transformation is accomplished in two ways. The first transformation, denoted as 3CD, associates a value of 1 to P_t (a 100 percent probability of a recession) whenever a plus (+) appears on Chart 4 and a 0 otherwise. The second transformation, denoted as 3CDa, is just like the first except that a linear decay method is added. Values of P_t equal to 1 are followed by values of P_t equal to 0.8, 0.6, 0.4, and 0 (unless another plus [+] occurs, in which case P_t returns to 1). Table 1 shows the QP and the LP scores for the BVAR model and the two transformations of the three-consecutive-declines rule.[18] The table shows that the BVAR model has a better forecasting ability than the three-consecutive-declines rule, regardless of the transformation, for both the QPS and the LPS.

TABLE 1
Comparison in Forecasting Scores: Probability of a Recession within the Next Eight Quarters (1970–98, Monthly)

	QPS	LPS
BVAR	.37	.59
3CD	.67	2.32
3CDa	.56	1.82

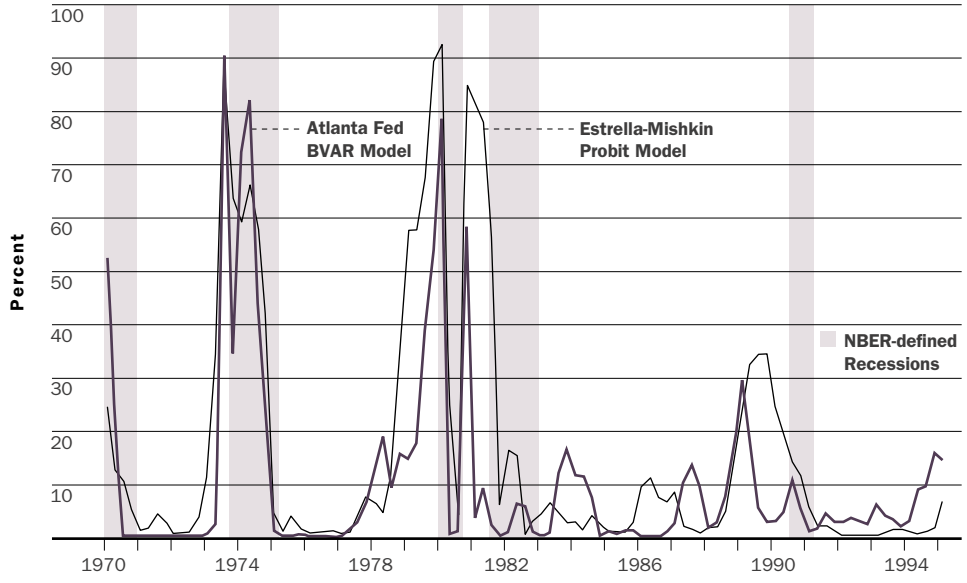
Note: The table compares the forecasting accuracy in terms of assessing the likelihood of a recession within the next eight quarters for the Atlanta BVAR model and for two variants (3CD, 3CDa) of the "three-consecutive-months-decline" rule. The forecasting accuracy is assessed using both the quadratic probability score (QPS) and the logarithmic probability score (LPS). The scores are computed using the sample 1970:01–1998:12.

The three-consecutive-declines rule is a naive rule for signal extraction. A more sophisticated use of the information from the LEI Index, like the sequential-probability-of-turning-point approach described in Diebold and Rudebusch (1989) and mentioned above, may well lead to a better predictive ability than the one obtained using the naive rule. The patterns revealed in charting the results from the sequential-probability-of-turning-point measure of Diebold and Rudebusch (379) suggest that its performance is comparable to that of the BVAR model. The Diebold and Rudebusch model predicts more timely the 1973 recession, behaves similarly to the BVAR's probability prior to the 1980 recession, and fails to predict the 1981 recession.[19]

Estrella and Mishkin (1998) focus on their probit model's ability to forecast recessions exactly k quarters ahead (where k ranges from one to eight) as opposed to assessing the likelihood of a recession occurring in any of the next k quarters. For the sake of comparing the two models, the probabilities of a recession exactly k quarters ahead are also computed using the BVAR model. Chart 5 shows the probabilities of a recession four quarters ahead computed

15. See Filardo (1999) for a comparison of different turning point prediction models using "real-time" data.
16. The recession probability computed by the BVAR rises steadily as the recession approaches while the three-consecutive-declines rule posts only two plus signs: one well before the recession and one immediately prior to it.
17. In essence, R_t is a time series of 1's and 0's indicating whether a recession is beginning within the next eight quarters (1) or not (0).
18. The scores are computed using the sample 1970:01–1998:12.
19. Diebold and Rudebusch's sample stops in 1988, so the two models cannot be compared for the 1990 recession. Also, Diebold and Rudebusch use the LEI Index available in 1988, which is different from the current index.

CHART 5 Probability of a Recession Four Quarters Ahead



Sources: NBER; probabilities calculated by the Federal Reserve Bank of Atlanta

according to both models.[20] The probabilities are computed at a quarterly frequency for both the Estrella-Mishkin and the BVAR model. Specifically, for the BVAR the probability of a recession four quarters ahead was computed using only the data available at the end of each quarter, which is roughly the same information set used in Estrella and Mishkin. From Chart 5 it appears that the Estrella-Mishkin model outperforms the BVAR, especially in terms of predicting the timing of the recession. For all recessions after 1970, the signal from the Estrella-Mishkin model is more timely and more precise than that from the BVAR, particularly for the last three recessions.

Table 2, which gives the QP and LP scores for the BVAR and Estrella-Mishkin models during the 1970:1–1995:1 period, shows that the Estrella-Mishkin model compares favorably to the BVAR. Over shorter horizons, like two quarters, the BVAR's performance worsens considerably relative to that of the Estrella-Mishkin model.

To improve the forecasting ability of the BVAR model, the six-variable version was augmented with an extra variable chosen from those economic series that should, at least in principle, have predictive content. These forward-looking series are the stock market index (S&P 500), the University of Michigan Consumer Sentiment Index, and the spread between a ten-year bond and a three-month Treasury bill (see Estrella and Mishkin 1998 for a discussion of why this spread is a useful predictor of recessions). Interestingly, none of these variables was found to add noticeably to the BVAR model's predictive ability in turning point forecasting.

In summary, it appears that the BVAR model compares favorably with respect to the LEI Index in turning point forecasting, especially when relatively naive rules like the three-consecutive-declines rule are used to extract information from the index. The BVAR compares unfavorably to the Estrella-Mishkin model in terms of predicting the exact timing of future recessions. In providing early signals of recessions beginning sometime within the next two years, the BVAR model seems to hold its ground although its signals are less precise and less timely than those from the Estrella-Mishkin model.[21]

Conclusion

This article first examines the concept of turning points in economic activity and discusses them in relation to the better-known concepts of "recession" and "expansion." The study then describes different approaches to turning point forecasting and analyzes their relative advantages and disadvantages. Specifically, the article focuses on the Leading Economic Indicators and on econometric models, including turning point models, and assesses their out-of-sample accuracy in predicting recessions.

The article finds that the Atlanta Fed's BVAR model forecasts contain information on future recessions that appears superior to that embodied in the LEI Index (at least when simple rules like the three-consecutive-declines rule are used to extract information from the

TABLE 2
Comparison in Forecasting Scores: Probability of a Recession Four Quarters Ahead (1970–95, Quarterly)

	QPS	LPS
BVAR	.31	.95
Estrella-Mishkin	.19	.32

Note: The table compares the forecasting accuracy in terms of assessing the likelihood of a recession four quarters ahead for the Atlanta BVAR model and for the Estrella-Mishkin model. The forecasting accuracy is assessed using both the quadratic probability score (QPS) and the logarithmic probability score (LPS). The scores are computed using the sample 1970:1–1995:1.

index). Since the outcome of the naive rules is what usually makes headlines, one implication of these results is that it may not be wise to rely too much on the latest LEI number, as filtered by the press.

Relative to turning point models, like the one proposed by Estrella and Mishkin, the Atlanta Fed BVAR model is far less precise in indicating the exact timing of a recession. In general, the quality of the warning signals from models that are specifically designed to forecast turning points appears to be better than that from the BVAR model. This conclusion suggests that it is worthwhile to supplement the BVAR with a turning point model.[22]

To determine whether these conclusions are valid one simply has to wait for more evidence. The next recession should provide some clues.

20. Estrella and Mishkin's paper shows the results for two and four quarters ahead. The four-quarter horizon is perhaps more relevant for policymakers than the two-quarter horizon given the lags with which monetary policy operates. For this reason, Chart 5 focuses on the results for the four-quarter horizon.

    This study tried to replicate Estrella and Mishkin's results using a different software. By and large this attempt was successful, as can be seen by comparing Chart 5 with Figure 4 in Estrella and Mishkin (1998, 54). Nonetheless, some small disparities remain. Also, the timing convention in Chart 5 is different than that used in Estrella and Mishkin's Figure 4. Chart 5 plots the probabilities for the quarter in which the forecasts are produced. Figure 4 plots the probabilities for the quarter that is being forecast.
21. Coming from an Atlanta Fed economist, this conclusion may remind some readers of the Neapolitan proverb, "Pure o scarrafone è bello a mamma suia" (Even the cockroach looks beautiful to his mother).
22. By using both models policymakers can exploit the benefits from the "portfolio diversification" of forecasts.

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Regional Research and Development Intensity and Earnings Inequality

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OVER THE PAST TWO DECADES EARNINGS AND INCOME INEQUALITY HAVE INCREASED SUBSTANTIALLY. DURING THIS SAME PERIOD, INVESTMENT IN TECHNOLOGY HAS ALSO RAPIDLY INCREASED, LEADING SOME TO CONCLUDE THAT "WE HAVE WITNESSED THE CREATION OF A NEW ECONOMY" (PRESIDENT 2001, 19). THIS "NEW ECONOMY" IS MARKED BY RAPID productivity growth, rising incomes, low unemployment, and moderate inflation, resulting in part from advances in technology (President 2001). The new economy, with its advancements in technology, creates a "rising tide that lifts all boats." However, economists have also argued that technological change is the leading cause of the increase in earnings inequality because it favors high-skilled workers relative to low-skilled workers (President 1997). In this instance, not all workers benefit equally from the strength of the new economy. This article examines the effect of technology—the engine of the new economy—on earnings and income inequality.

Between 1979 and 1994, earnings and income inequality increased in the United States not only between groups defined by schooling and experience but also within these groups (Levy and Murnane 1992; Bound and Johnson 1992; Juhn, Murphy, and Pierce 1993; Katz and Autor 1999; Ginther 2000). Between-group inequality can be measured by the college wage premium, the ratio of the mean or median earnings of college graduates over the mean or median earnings of high school graduates. By 1993 the median male college wage premium grew to over 70 percent (President 1997). Within-group or residual earnings inequality is measured as the inequality of earnings within groups defined by schooling and experience; it can also be calculated by measuring the dispersion in earnings residuals after controlling for these factors in a regression model. The within-group component accounts for approximately two-thirds of the overall increase in earnings inequality (Katz and Autor 1999).

Studies show that this increase has not been uniform across regions of the country. Bound and Holzer (1996) report significant geographic variation in the degree of earnings deterioration for less-educated

workers during the 1980s. Topel (1994) argues that rising inequality from 1972 to 1990 did not occur at the same pace in all areas and that distinctly local factors affected relative wages. McCall (2000) documents that within-group wage inequality across regions varies more widely today than over the past several decades and uses regional variation in labor market conditions and levels of inequality to examine the relationship between the two.

Explanations for the increase in inequality include shifts in the relative supply of and demand for skilled workers, changes in economic institutions, and technological change, with most economists viewing technological change as the strongest contributing factor (President 1997). As a result, this article focuses on technology's role in explaining the increase in earnings inequality and uses regional variation in technological investment to examine regional income differences and earnings inequality.

The Correlation between Technology and Inequality

Many researchers cite skill-biased technology change as the reason for changes in between-group earnings inequality and the rising relative wages of college graduates. Katz and Murphy (1992) examine the change in the earnings distribution from 1963 to 1987, concluding that an increase in the relative demand for more skilled workers was responsible for the observed changes in earnings; they also identify technological change as a likely cause of this increase in relative demand. Berman, Bound, and Griliches (1994) argue that the shift in demand from unskilled workers to skilled workers reflects production labor–saving technological change. Berman, Bound, and Machin (1998) find evidence for skill-biased technological change in developed countries and show that the proportion of skilled workers increased in most industries despite rising or stable relative wages. Acemoglu (1999) argues that a larger proportion of skilled workers causes a change in the composition of jobs as employers respond by creating appropriate jobs.

The effect of technology on within-group earnings inequality is less clear. Bound and Johnson (1992) examine between- and within-group earnings inequality using data from 1973, 1979, and 1988. After examining alternative explanations, such as shifts away from manufacturing employment and the decreasing power of unions, they attribute observed changes in the earnings distribution to skill-biased technological change—a measure approximated by the residuals from a mean wage regression. Juhn, Murphy, and Pierce (1993) examine the timing and magnitude of changes in wage distribution using data from 1959 to 1988. They conclude that this increase in within-group inequality, measured by residuals from a mean regression, reflected increasing returns to unobserved skills that are uncorrelated with years of schooling and experience. They, too, suggest skill-biased technological change as the leading cause of increased within-group earnings inequality.

Even though researchers point to technology as the leading explanation for the increase in within-group earnings inequality, "direct evidence of the importance of skill-biased technological change in explaining trends in within-group inequality is difficult to come by," according to the 1997 *Economic Report of the President* (174). The report also points out that many researchers simply attribute any residual within-group inequality to skill-biased technological change because it is so difficult to establish a cause-effect relationship empirically.

Furthermore, McCall (2000) finds little evidence that increased technology affects within-group wage inequality when measured at the local labor market level. Mishel and Bernstein (1996) are skeptical of the often-expressed view that technological change can account for recent increases in the relative earnings of more educated and experienced workers. They report evidence that technology was more favorable to men in the bottom half of the earnings distribution in both the 1980s and the 1990s than in the 1970s, directly contradicting the notion that those with lower earnings were being left behind because their skills did not keep up with technological change. They also point out that the conclusion that skill-biased technological change is largely responsible for increased inequality rests on an assumption that the effect of technology began to accelerate during the 1980s, meaning that there should be a discernable rise in the rate of technological expansion, either qualitatively or quantitatively. Mishel and Bernstein find no support for an accelerated technology effect working against men in the bottom half of the earnings distribution during this period.

The major obstacle to empirical work on the relationship between technology and earnings inequality is the difficulty associated with quantifying and measuring technology. This article uses research and development (R&D) expenditures within a state to evaluate the effect of technological change on income and earnings inequality. R&D expenditures have been used extensively in other studies that evaluate technology's effect on earnings. For example, Allen (2001) uses R&D expenditure as a proxy for technology, pointing out that this measure is widely used by such agencies as the Bureau of Labor Statistics and the Organisation for Economic

Co-operation and Development to identify which industries qualify for high-tech status. Previous studies have employed other technology proxies, such as the usage of various forms of high-tech capital, growth in the capital-labor ratio, growth in total factor productivity, the recentness of capital, and the number of computers used per worker. Of these measures, Allen (2001) reports the strongest correlation between R&D expenditure and returns to schooling, based on an analysis of 1979 and 1989 wage differentials by industry. Bartel and Sicherman (1999) also use R&D expenditures as one of several measures of technology by industry to examine the wage premium associated with technology. They suggest that the wage premium associated with technological change reflects the sorting of more skilled workers into high-tech industries, and they confirm that the demand for skilled workers has risen.

This article builds on previous research and examines the correlation between technology and inequality by exploiting interstate differences in technology, proxied by R&D expenditures. In 1995 six states accounted for half of the nation's expenditure on R&D (Bennof and Payson 1998). This statistic demonstrates that significant geographic variation in technology can be used to clarify the role technology plays in the wage structure and earnings inequality. While earnings and income inequality increased between 1979 and 1994, real expenditure on research and development over the same time period grew rapidly in many states, contributing to a growing regional technology gap. If technology is the major factor contributing to between- and within-group earnings inequality, there should be a clear pattern in the regional data, with those areas experiencing the greatest gains in technology also experiencing the largest increases in earnings and income inequality, other things being constant.

The analysis conducted in this article shows that workers in states with high levels of technological investment earn a wage premium. In addition, the analysis indicates that states with lower levels of technological investment are correlated with higher measures of between-group earnings inequality as measured by the college wage premium—likely the result of the relative scarcity of skilled workers in low-technology states. After controlling for unobserved differences in economic conditions across states, the analysis shows that higher rates of technological investment are weakly correlated with increased family income inequality; however, these effects dissipate when additional covariates are added to the model. Finally, this article evaluates the effect of technology on within-group male earnings inequality. The results show that technology explains approximately one-third of the increase in within-group inequality. Thus, technological investment is correlated with inequality; however, the effects are smaller than expected. These results indicate that technology is not the sole factor contributing to the marked increase in earnings inequality.

The Data

This article uses two data sets to examine the effect of technology on income and earnings inequality. The first set examines technology's role in explaining income inequality. It contains income inequality measures, demographic characteristics, macroeconomic conditions, and R&D expenditures for a panel of fifty states and the District of Columbia. Family income inequality is measured by the Gini coefficient—an index ranging from zero (perfect equality) to one (absolute inequality)—using data from the 1970, 1980, and 1990 decennial censuses.[1] Additional variables include unemployment rates, average Aid to Families with Dependent Children (AFDC) payments, and other state-level variables collected from the U.S. Census Bureau's *Statistical Abstracts* (various years), as well as *Social and Economic Characteristics* from 1970, 1980, and 1990. AFDC payments, median family income, and R&D expenditures were converted to constant dollars using the personal consumption expenditure deflator with 1992 as the base year.

The evidence presented here leads to the conclusion that changes in technology do affect the wage structure, but the effects are smaller and affect wage inequality differently than expected.

The second data set examines the effect of technological change on male earnings inequality. The data are extracted from the outgoing rotation group data from the Current Population Survey (CPS) for 1979 and 1994 (Bureau of Labor Statistics 1979, 1994). This study uses log weekly earnings, and all earnings figures are reported in 1992 dollars, using regional consumer price indices to deflate nominal wages. The CPS survey does not provide measures of actual work experience; thus, potential experience

1. The Gini index values were calculated using a program provided by the Census Bureau and data on income shares from the decennial censuses.

measured by age minus schooling minus six is used instead. Since the potential experience formula is more accurate for workers with a strong attachment to the labor force, only male workers are used in this study. Additional variables include years of schooling and indicators for ten industry and eight regional categories.[2]

Both data sets include state-level measures of real R&D expenditures that were computed using data from the National Science Foundation Division of Science Resource Studies. Total state expenditures on R&D have been reported by the National Science Foundation (NSF) since 1987; however, these data are not available for earlier years. This measure is the sum of expenditures on R&D by the federal government, industry, and universities and colleges.

In order to evaluate the effect of state R&D expenditures on earnings inequality over the time period studied and to have consistent variable definitions over time, this study creates measures of total state expenditures from the three component measures collected by the NSF: total federal, university, and industrial expenditures on R&D. The NSF has compiled information on federal government and university and college R&D expenditures for the fifty states and District of Columbia yearly beginning in 1972. Industrial expenditures on R&D make up the largest component of total R&D and are available in odd-numbered years starting in 1977. Total R&D expenditures by state are the sum of total federal, university, and industrial expenditures in odd-numbered years.[3] When even-numbered years are used in the analysis, data from the nearest odd-numbered year for total state expenditures on R&D are used.[4] To avoid disclosing information about individual companies, some states did not make data available on industrial expenditures on R&D in some years. When a state's industrial R&D is not reported, this study adds federal expenditures on industrial R&D (one component of total industrial R&D) to create the state total. In these cases, total state R&D expenditures will be understated and changes in R&D expenditures are potentially overstated.

Mishel and Bernstein (1996) argue that increasing inequality can be attributed to technological change only if there is an acceleration of technology's effects on earnings. To evaluate whether it is the level of or change in technology expenditures that contributes to increased income and earnings inequality, this study constructs two measures of R&D expenditures. The first measure divides R&D expenditures for the year by gross state product (GSP). The second measure is the percentage change in real R&D expenditures. In the CPS data sets, this variable is the change in R&D expenditures between 1977 and 1979 for the 1979 data and the change in R&D expenditures between 1979 and 1993 for the 1994 data.[5]

Tables 1 and 2 contain descriptive statistics for both data sets. Earnings inequality, R&D expenditures, and years of schooling increased between 1979 and 1994 in the CPS samples. The log of average real weekly earnings fell between 1979 and 1994 while the standard deviation increased significantly. Even though the size of R&D expenditures divided by gross state product is small, the increase between 1979 and 1994 was substantial; the same holds true for changes in R&D expenditures.

Empirical Methods

This study uses three empirical approaches to evaluate technology's impact on income and earnings inequality. In the first approach, the CPS data from 1979 and 1994 are used to make two simple earnings comparisons for groups of high- and low-technology states. The first measure used is the technology premium, defined as the median earnings of workers in high-technology states divided by the median earnings of workers in low-technology states. This measure is used to examine how earnings vary depending on R&D intensity for the state. Estimates of the technology premium control for differences in industrial composition by grouping the data according to industry. The second measure calculated is the median college wage premium in

TABLE 1
Mean Characteristics by State

Gini Coefficient	0.511 (0.118)
Unemployment Rate	5.344 (1.584)
Real Average AFDC Payments	453.703 (182.644)
Real Median Family Income	39.676 (7.492)
Number of Single-Parent Households	22.131 (7.605)
R&D/GSP	0.019 (0.034)
Real R&D Expenditures	2,077,035 (3,094,747)

Note: Standard deviations appear in parentheses.

Sources: U.S. Census Bureau *Statistical Abstract of the United States*, various years, and *Social and Economic Characteristics* 1970, 1980, 1990; National Science Foundation Division of Science Resource Studies

TABLE 2
Mean Characteristics of 1979 and 1994 CPS Outgoing Rotations Group Data

	1979	1994
Years of Schooling	12.754	13.324
	(2.905)	(2.588)
Potential Experience	18.494	19.138
	(12.928)	(11.033)
Log Real Weekly Earnings	6.352	6.207
	(0.468)	(0.571)
R&D/GSP	0.019	0.024
	(0.012)	(0.019)
Change in R&D	0.104	0.912
	(0.220)	(2.387)
Sample Size	64,281	61,364

Note: Standard deviations appear in parentheses.

Sources: Bureau of Labor Statistics 1979, 1994; National Science Foundation Division of Science Resource Studies

high- and low-technology states. This measure evaluates the correlation between technological investment and between-group earnings inequality.

Designation as either a high-technology state or low-technology state is based on the rankings of the two R&D expenditure measures. Over time, those states with the largest absolute investment in technology have remained roughly the same. According to the National Science Foundation, "each of the ten states that ranked highest in terms of 1991 R&D performance was also among the top ten in 1975, although the order of their ranking has shifted somewhat. The largest three (California, New York, and Michigan) were unchanged from 1975" (National Science Foundation 1995).[6] The groupings of high- and low-technology states are somewhat arbitrary and differ significantly depending on whether the change in R&D expenditures or the ratio of R&D expenditures to gross state product is used.[7]

To create high- and low-technology states measured by R&D divided by GSP, this study selected the five highest-technology states in 1994 and 1979. In order to maintain similar sample sizes, ten low-technology states were selected for 1994 and nine were selected for 1979. To create high- and low-technology states measured by change in R&D expenditures, this study selected the eight states with the highest change in technology between 1994 and 1979. Nine low-technology states were selected for 1994 and seven were selected for 1979. The study uses these rankings (see the appendix) to evaluate whether significant differences in wages and inequality exist across high- and low-technology states.

In the second approach, the study uses the state panel data set to regress the transformed Gini coefficient on variables that contribute to inequality. The Gini coefficient measures income inequality within states and can take values ranging from zero to one. A Gini coefficient of zero indicates perfect equality (equal distribution of income) and a Gini of one indicates perfect inequality. As shown by Hayes, Slottje, and Shackett (1992), the difficulty associated with using the Gini index in a regression equation can be avoided by transforming the index.[8] A regression equation can then be estimated using the transformation of the Gini index as the dependent variable. The analysis begins by using the Dadres (1998) specification of family income inequality that regresses the transformed Gini coefficient on log family income and its square, the unemployment rate, average real AFDC payments, and the number of single-parent households. This model controls for the effects of welfare generosity and macroeconomic conditions on family income inequality; the study adds to it controls for census years and R&D expenditures. To control for unobserved heterogeneity

2. The CPS data are top-coded, biasing estimates of mean wages. Median comparisons are not affected by top coding. When used in regression models, 1.5 percent of observations are trimmed from the top and bottom tails of the 1979 and 1994 CPS samples in order to avoid biased estimates of means and variances caused by top coding. Top coding assigns one income level for some top percentage of individuals in the CPS. The nominal top code for weekly earnings was $999 in 1979 and $1,923 in 1994.
3. Some federal R&D dollars are allocated for industrial and university R&D; thus, net federal expenditures equal to total federal expenditures less federal expenditures on industrial and university R&D are used in creating total R&D expenditures by state.
4. In the 1970 wave of the state panel data set, R&D expenditures and gross state product data are available only beginning in 1977. The 1977 measure is used in this data set. The 1981 and 1991 measures are used to measure R&D within states in 1980 and 1990. R&D expenditures in 1993 are used as the measure of R&D in 1994.
5. This study accounts for changes in R&D expenditures in the state panel data set by using fixed-effects estimation and real R&D expenditure levels. R&D expenditures were deflated by the personal consumption expenditure deflator.
6. This result holds using the sum of the components of state R&D created in this study.
7. The appendix lists the high- and low-technology states ranked by R&D/GSP and change in R&D expenditures.
8. Since the Gini is a zero-to-one function, it has a truncated normal disturbance that violates the standard assumptions needed for ordinary least squares (OLS) estimation. This problem can be avoided by using ln [(1 – Gini)/Gini] as the dependent variable.

across states, the study estimates models that control for state fixed effects.

The third empirical approach evaluates the effect of technological change on within-group earnings inequality. This analysis starts by using a baseline specification from Juhn, Murphy, and Pierce (1993).[9] Since technology also varies by industry and region, the analysis adds dummy variables for industry and region to the baseline model. Next, the analysis adds technology measures to control for technology and interaction terms between education and technology to the specification in order to capture the residual earnings inequality not explained by these factors. The study calculates two within-group earnings inequality measures using the residuals from the wage equations described above: the standard deviation and the difference between the 90th and 10th percentiles of the residuals. These inequality measures relate to inequality within groups defined by the control variables in the wage equations.

Results

R&D Expenditures and the Technology Premium. The technology premium, defined as the median earnings of male workers in high-tech states divided by the median earnings of male workers in low-tech states, is presented in Tables 3 and 4. In Table 3, the ranking is based on the ratio of R&D expenditure to gross state product; the designation in Table 4 reflects the change in R&D expenditure for the 1977–79 and 1979–94 periods. A technology premium is indicated when the estimates in Tables 3 and 4 are greater than one.

When technology is measured as the ratio of R&D to gross state product (Table 3), there is a signifi-

TABLE 3
Technology Premium by Industry Ranked by R&D/GSP

Industry	1979	1994
Agriculture, Forestry, and Fishing	1.002 (0.972, 1.021)	1.029 (1.009, 1.048)
Mining and Construction	0.980 (0.970, 0.991)	1.003 (0.991, 1.011)
Durable Manufacturing	1.034 (1.028, 1.045)	1.070 (1.063, 1.077)
Nondurable Manufacturing	1.010 (1.005, 1.016)	1.024 (1.017, 1.035)
Transportation, Communications, and Utilities	0.990 (0.983, 0.996)	1.014 (1.006, 1.023)
Wholesale and Retail Trade	1.012 (1.002, 1.018)	1.025 (1.016, 1.032)
Finance, Insurance, and Real Estate	1.016 (0.988, 1.029)	1.017 (1.000, 1.027)
Personal and Entertainment Services	0.995 (0.974, 1.029)	1.011 (0.994, 1.035)
Business Services	0.990 (0.970, 1.011)	1.055 (1.039, 1.072)
Professional Services and Public Administration	1.009 (1.003, 1.014)	1.016 (1.010, 1.024)
All Industries	1.011 (1.008, 1.011)	1.030 (1.029, 1.035)

Note: The technology premium is defined as median earnings in high-technology states divided by median earnings in low-technology states. Numbers greater than one indicate the presence of a technology premium. Numbers in parentheses are bootstrapped 95 percent confidence intervals from 500 subsamples.

Sources: Bureau of Labor Statistics 1979, 1994; National Science Foundation Division of Science Resource Studies

TABLE 4
Technology Premium by Industry Ranked by Change in R&D

Industry	1979	1994
Agriculture, Forestry, and Fishing	0.963 (0.943, 0.995)	1.009 (0.995, 1.033)
Mining and Construction	0.969 (0.963, 0.979)	0.985 (0.977, 0.996)
Durable Manufacturing	1.042 (1.033, 1.048)	1.049 (1.042, 1.056)
Nondurable Manufacturing	0.979 (0.971, 0.991)	1.004 (0.988, 1.016)
Transportation, Communications, and Utilities	0.988 (0.981, 0.995)	1.004 (0.996, 1.012)
Wholesale and Retail Trade	0.989 (0.985, 1.000)	1.010 (1.000, 1.018)
Finance, Insurance, and Real Estate	0.998 (0.976, 1.022)	1.014 (0.994, 1.029)
Personal and Entertainment Services	0.985 (0.961, 1.017)	0.985 (0.963, 1.006)
Business Services	0.984 (0.970, 1.007)	1.013 (1.000, 1.033)
Professional Services and Public Administration	0.991 (0.983, 0.995)	1.012 (1.002, 1.017)
All Industries	0.993 (0.992, 0.996)	1.013 (1.010, 1.019)

Note: The technology premium is defined as median earnings in high-technology states divided by median earnings in low-technology states. Numbers greater than one indicate the presence of a technology premium. Numbers in parentheses are bootstrapped 95 percent confidence intervals from 500 subsamples.

Sources: Bureau of Labor Statistics 1979, 1994; National Science Foundation Division of Science Resource Studies

cant increase in the technology premium between 1979 and 1994 for all industries combined and for durable and nondurable manufacturing; transportation, communication, and utilities; and business services. In 1994 the technology premium for all industries combined is 3 percent, indicating that workers in high-technology states earn 3 percent more than those in low-technology states. In addition, the technology premium is statistically significantly greater than one in nearly all of the industry categories in 1994, meaning that high-technology states are correlated with higher median earnings in almost all of the industries analyzed.

When technology is measured as the change in R&D investment (Table 4), there is a statistically significant increase in the technology premium between 1979 and 1994 for all industries; transportation, communications, and utilities; and professional services and public administration. In 1994, the technology premium for high-technology states measured by the change in R&D is 1 percent. Furthermore, measuring technology as the change in R&D yields a surprising result: only four industries have technology premiums that are significantly greater than one, so workers in states that have experienced the most rapid growth in research and development do not appear to benefit equally from technology in terms of higher earnings. These results indicate that the level of technology in a state relative to gross state product contributes to higher earnings, in turn contributing to greater earnings inequality between high- and low-technology states.

9. Log wages are regressed on a linear term in schooling, four schooling dummies, and a quartic in experience fully interacted with the schooling dummies.

R&D Expenditures and Between-Group Inequality. Between-group earnings inequality as measured by the college wage premium in high- and low-technology states is shown in Tables 5 and 6. In Table 5 the college wage premium increased significantly between 1979 and 1994 for all industries, durable manufacturing, and professional services and public administration in both low- and high-technology states. However, in both 1979 and 1994 the college wage premium is significantly greater in low-technology states than in high-technology states for all industries combined, indicating that when technology is measured as R&D divided by GSP, between-group inequality is somewhat higher in low-technology states.

In Table 6, where technology is measured as the change in R&D expenditures, there is a statistically significant increase in the college wage premium between 1979 and 1994 in low-technology states for all industries, in professional services and public administration, and in durable manufacturing. In addition, the college wage premium increased significantly in high-technology states for all industries combined during the same period. As in Table 5, the college wage premium is higher in low-technology states than in high-technology states for all industries combined.

In one sense the results in Tables 5 and 6 are at odds with the technology story that suggests that technology increases the relative demand for college-educated (high-skilled) workers, in turn contributing to higher wages and greater between-group earnings inequality. If technology is the major factor driving the increased relative demand for skilled workers,

TABLE 5
College Wage Premium by Industry Ranked by R&D/GSP

Industry	1979		1994	
	Low-Tech	High-Tech	Low-Tech	High-Tech
Agriculture, Forestry, and Fishing	1.056 (1.023, 1.127)	1.121 (1.090, 1.150)	0.981 (0.955, 1.069)	1.129 (1.108, 1.171)
Mining and Construction	1.038 (1.019, 1.072)	1.041 (1.020, 1.056)	1.079 (1.051, 1.103)	1.054 (1.036, 1.067)
Durable Manufacturing	1.067 (1.060, 1.075)	1.031 (1.012, 1.052)	1.091 (1.080, 1.101)	1.086 (1.065, 1.105)
Nondurable Manufacturing	1.054 (1.044, 1.072)	1.052 (1.037, 1.066)	1.092 (1.068, 1.114)	1.084 (1.058, 1.113)
Transportation, Communications, and Utilities	1.029 (1.021, 1.048)	1.044 (1.016, 1.053)	1.045 (1.034, 1.067)	1.042 (1.027, 1.058)
Wholesale and Retail Trade	1.047 (1.025, 1.071)	1.059 (1.043, 1.074)	1.079 (1.061, 1.094)	1.053 (1.039, 1.070)
Finance, Insurance, and Real Estate	1.097 (1.062, 1.147)	1.045 (1.014, 1.089)	1.082 (1.052, 1.112)	1.047 (1.015, 1.082)
Personal and Entertainment Services	1.084 (1.028, 1.108)	1.063 (1.016, 1.112)	1.053 (1.015, 1.093)	1.029 (0.997, 1.056)
Business Services	1.115 (1.075, 1.152)	1.047 (1.013, 1.086)	1.058 (1.037, 1.084)	1.054 (1.018, 1.086)
Professional Services and Public Administration	1.060 (1.052, 1.072)	1.045 (1.033, 1.057)	1.081 (1.073, 1.091)	1.072 (1.059, 1.090)
All Industries	1.055 (1.048, 1.058)	1.033 (1.031, 1.040)	1.080 (1.075, 1.085)	1.066 (1.061, 1.073)

Note: The college wage premium is defined as median earnings of workers with sixteen or more years of schooling to median earnings of workers with twelve years of schooling in states ranked by technology. Numbers greater than one indicate a college wage premium. Numbers in parentheses are bootstrapped 95 percent confidence intervals from 500 subsamples.

Sources: Bureau of Labor Statistics 1979, 1994; National Science Foundation Division of Science Resource Studies

one would expect to see higher college wage premiums in high-technology states. This study finds the opposite—higher levels of technology investment are associated with lower measures of between-group earnings inequality. However, this result may stem from skill-biased technological change having a greater impact in low-technology states where skilled labor is relatively scarce. When technology is measured by R&D divided by gross state product, average education levels are higher in seven of the ten industries studied in high-technology states; using the change in R&D as the technology measure, this result is true for eight of ten industries. In addition, when both technology measures are used, the college wage premium is greater in 1979 in low-technology states in the majority of industries. Taken together, these differences imply that the relative scarcity of skilled workers causes the higher college wage premium in low-technology states.

R&D Expenditures and Family Income Inequality. Another consideration is whether technology measured by R&D expenditures is correlated with family income inequality. Table 7 uses the ratio of R&D to gross state product as the technology measure. The models in Table 7 regress the transformed Gini coefficient on the ratio of R&D to gross state product and additional covariates suggested by Dadres (1998). Given the transformation of the dependent variable, one interprets a negative coefficient as being correlated with increased family income inequality.

In Table 7, model 1 regresses family income inequality on technology. The negative sign on R&D divided by GSP indicates that increased investment

TABLE 6
College Wage Premium by Industry Ranked by Change in R&D

	1979		1994	
Industry	Low-Tech	High-Tech	Low-Tech	High-Tech
Agriculture, Forestry, and Fishing	1.077 (1.045, 1.118)	1.113 (1.067, 1.156)	1.112 (1.075, 1.143)	1.121 (1.096, 1.173)
Mining and Construction	1.053 (1.007, 1.072)	1.045 (1.028, 1.069)	1.067 (1.040, 1.094)	1.053 (1.035, 1.083)
Durable Manufacturing	1.070 (1.056, 1.076)	1.057 (1.034, 1.072)	1.088 (1.078, 1.099)	1.078 (1.056, 1.103)
Nondurable Manufacturing	1.070 (1.049, 1.091)	1.053 (1.042, 1.074)	1.107 (1.087, 1.126)	1.088 (1.061, 1.106)
Transportation, Communications, and Utilities	1.027 (1.014, 1.038)	1.028 (1.005, 1.047)	1.071 (1.037, 1.083)	1.040 (1.034, 1.055)
Wholesale and Retail Trade	1.052 (1.040, 1.068)	1.054 (1.029, 1.070)	1.070 (1.053, 1.096)	1.067 (1.053, 1.086)
Finance, Insurance, and Real Estate	1.083 (1.031, 1.116)	1.073 (1.021, 1.111)	1.131 (1.092, 1.166)	1.080 (1.036, 1.121)
Personal and Entertainment Services	1.064 (1.015, 1.092)	1.041 (0.988, 1.097)	1.079 (1.021, 1.115)	1.040 (1.014, 1.088)
Business Services	1.084 (1.039, 1.130)	1.050 (1.023, 1.095)	1.083 (1.059, 1.101)	1.058 (1.026, 1.107)
Professional Services and Public Administration	1.054 (1.035, 1.058)	1.043 (1.027, 1.057)	1.093 (1.079, 1.093)	1.061 (1.049, 1.080)
All Industries	1.042 (1.037, 1.048)	1.042 (1.035, 1.045)	1.084 (1.078, 1.090)	1.065 (1.060, 1.072)

Note: The college wage premium is defined as median earnings of workers with sixteen or more years of schooling to median earnings of workers with twelve years of schooling in states ranked by technology. Numbers greater than one indicate a college wage premium. Numbers in parentheses are bootstrapped 95 percent confidence intervals from 500 subsamples.

Sources: Bureau of Labor Statistics 1979, 1994; National Science Foundation Division of Science Resource Studies

TABLE 7
Log of Family Income Inequality Regressed on Technology Measured by R&D/GSP and Change in R&D

Variables	Model 1 OLS	Model 2 OLS	Model 3 OLS	Model 4 Fixed Effects	Model 5 Fixed Effects
R&D/GSP	***–0.848***	0.229	0.202	***–0.482***	0.110
	(0.244)	(0.180)	(0.147)	(0.244)	(0.120)
Log Income		1.087	0.837		0.699
		(0.974)	(0.831)		(0.478)
Log Income Squared		–0.141	–0.100		–0.102
		(0.131)	(0.111)		(0.067)
Unemployment		0.001	–0.006		**0.009**
		(0.004)	(0.004)		(0.003)
AFDC Payments		**0.0001**	8.010E-05		3.260E-05
		(0.00005)	(0.000)		(0.000)
Single Parents		**–0.012**	**–0.012**		**–0.013**
		(0.001)	(0.001)		(0.002)
1970 Indicator			0.027		
			(0.025)		
1980 Indicator			**0.066**		
			(0.013)		
Constant	***0.527***	–1.371	–0.991	**0.520**	–0.459
	(0.014)	(1.800)	(1.551)	(0.008)	(0.846)

Note: Standard errors appear in parentheses. Numbers in bold are significant at the 1 percent level. Numbers in bold italics are significant at the 5 percent level.

Sources: U.S. Census Bureau *Statistical Abstract of the United States*, various years, and *Social and Economic Characteristics* 1970, 1980, 1990; National Science Foundation Division of Science Resource Studies

in technology is correlated with higher levels of family income inequality, and the estimate is significant at the 1 percent level. When models 2 and 3 include controls for real median log family income and its square, the state unemployment rate, real AFDC payments, the percentage of single-parent families in the state, and dummy variables that control for the year of the census (in model 3), the results indicate that technology has no significant effect on family income inequality. The state fixed-effects results are similar in models 4 and 5. Fixed-effects estimates allow one to control for unobserved differences in state economies. Once the model controls for state fixed effects, technology has a statistically significant effect at the 1 percent level on family income inequality when no other covariates are included in the model. Once the model controls for macroeconomic conditions, welfare generosity, and demographic characteristics in the state, the effect of technology changes sign and is no longer statistically significant.

Table 8 presents estimates using real R&D expenditures as the technology measure. Real R&D expenditures are used instead of the percentage change because the fixed-effects estimates are identified by the change in R&D expenditures over time, and this study focuses on estimating the effect of changes in R&D expenditures on income inequality. The coefficients on technology in models 4 and 5 can be interpreted as the effect of changes in technology on inequality. In all but one model, the coefficient on R&D expenditures is quite small and not significantly different from zero. The one exception is model 4, the fixed-effects model with no additional covariates, in which the coefficient on technology is small, negative, and statistically significant. However, after adding additional covariates in model 5, technology no longer has a statistically significant effect on family income inequality.

The results in Tables 7 and 8 indicate that investment in technology is weakly correlated with higher levels of family income inequality. If technology does

TABLE 8
Log of Family Income Inequality Regressed on Technology Measured by Real R&D Expenditures

Log Gini	Model 1 OLS	Model 2 OLS	Model 3 OLS	Model 4 Fixed Effects	Model 5 Fixed Effects
Real R&D	–5.76E-09	–3.73E-09	–3.68E-09	**–3.13E-08**	–3.26E-09
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log Income		0.958	0.708		0.554
		(1.005)	(0.914)		(0.486)
Log Income Squared		–0.120	–0.078		–0.082
		(0.136)	(0.124)		(0.069)
Unemployment		0.002	–0.004		**0.009**
		(0.004)	(0.005)		(0.003)
AFDC Payments		**1.428E-04**	9.870E-05		3.830E-05
		(0.000)	(0.000)		(0.000)
Single Parents		**–0.011**	**–0.011**		**–0.012**
		(0.001)	(0.001)		(0.002)
1970 Indicator			0.035		
			(0.025)		
1980 Indicator			**0.069**		
			(0.012)		
Constant	**0.523**	–1.200	–0.838	**0.576**	–0.208
	(0.015)	(1.841)	(1.678)	(0.014)	(0.860)

Note: Standard errors appear in parentheses. Numbers in bold are significant at the 1 percent level. Numbers in bold italics are significant at the 5 percent level.

Sources: U.S. Census Bureau *Statistical Abstract of the United States*, various years, and *Social and Economic Characteristics* 1970, 1980, 1990; National Science Foundation Division of Science Resource Studies

affect family income, it operates through labor market earnings. This weak correlation between technology and family income inequality may be the result of greater inequality in nonlabor income; once additional covariates are added to the models, the effect of technology is no longer statistically significant, indicating that technological change does not explain increasing family income inequality.

R&D Expenditures and Within-Group Inequality. Table 9 evaluates the effect of technology on within-group male earnings inequality using the 1979 and 1994 CPS Outgoing Rotations Group data. This analysis focuses on within-group earnings inequality because it is the largest component of inequality in the 1980s and 1990s, and there is little direct evidence of the effect of technology on within-group inequality. In this table, model 1 is specified as follows: log earnings are regressed on a linear term in schooling, four schooling dummies, a quartic in experience interacted with the schooling dummies for each year, and indicators for region (8) and industry (10). Models 2 and 3 include technology measured by the ratio of R&D expenditures to gross state product and the percentage change in R&D expenditures, respectively. Models 4 and 5 add interaction terms between technology and the schooling dummies in order to account for the skill-biased matching of technology and schooling level. Within-group inequality is measured by the standard deviation and the difference in the 90th and 10th percentiles of the residuals from the various models.

Model 1 serves as a baseline measure of the change in within-group inequality between 1979 and 1994. Using both the standard deviation and ninety-ten difference of the residuals, the results show that male within-group earnings inequality increased significantly between 1979 and 1994, as observed in the previous literature (Juhn, Murphy, and Pierce 1993; Ginther 2000). When measures of technology are included in models 2 and 3, measures of within-group inequality do not significantly decrease in either 1979 or 1994. Taken at face value, technology

TABLE 9
Technology's Effect on Within-Group Male Earnings Inequality

Standard Deviation of Residuals		Difference in 90th and 10th Percentile of Residuals	
1979	1994	1979	1994
Model 1: No Technology Measure Included			
0.372 (0.371, 0.374)	0.428 (0.426, 0.430)	0.954 (0.949, 0.960)	1.102 (1.094, 1.108)
Model 2: R&D/GSP			
0.371 (0.369, 0.372)	0.426 (0.424, 0.428)	0.948 (0.943, 0.954)	1.093 (1.087, 1.101)
Model 3: Change in R&D			
0.372 (0.371, 0.374)	0.428 (0.426, 0.430)	0.954 (0.949, 0.959)	1.101 (1.094, 1.108)
Model 4: R&D/GSP Interacted with Education			
0.352 (0.350, 0.354)	0.416 (0.414, 0.417)	0.893 (0.888, 0.900)	1.064 (1.057, 1.070)
Model 5: Change in R&D Interacted with Education			
0.353 (0.351, 0.354)	0.416 (0.414, 0.418)	0.896 (0.891, 0.902)	1.064 (1.057, 1.070)

Note: Standard deviations and ninety-ten differences are calculated from the residuals of a regression where log wages are regressed on a linear term in schooling, indicators for schooling (4), a quartic in experience interacted with schooling indicators, and indicators for industry (10) and region (8). Measures of technology are included in the specification where noted. Numbers in parentheses are bootstrapped 95 percent confidence intervals from 500 subsamples.

Sources: Bureau of Labor Statistics 1979, 1994; National Science Foundation Division of Science Resource Studies

has no effect on within-group earnings inequality in models 2 and 3. However, when technology is interacted with schooling in models 4 and 5, one observes a significant reduction in within-group earnings inequality. Putting these results into perspective using models 3 and 5, the standard deviation of the residuals increased 15 percent in model 3 and 18 percent in model 5 between 1979 and 1994. When the study compares the standard deviation of the residuals in models 3 and 5 in 1994, one sees that controlling for technology decreases within-group inequality by only 3 percent.

The results in Table 9 demonstrate that within-group earnings inequality has risen substantially over the study period. Technology explains about one-third of within-group earnings inequality and seems to operate in conjunction with schooling—a result similar to that found by Bartel and Sicherman (1999). Juhn, Murphy, and Pierce (1993), on the other hand, argue that skill-biased technological change increases the demand for unobserved skills that are uncorrelated with schooling and experience. The above results belie their conclusion. Skill-biased technological change operates through an interaction between technology and schooling, if at all.

Conclusion

The evidence presented here leads to the conclusion that changes in technology do affect the wage structure, but the effects are smaller and affect wage inequality differently than expected. First, workers in high-technology states earn a wage premium ranging between 1 percent and 3 percent compared to those in low-technology states. To the extent that technology-rich states became richer between 1979 and 1994, increased investment in

technology contributed to the observed increase in earnings inequality. Second, although college-educated workers in both high- and low-technology states earn a wage premium, this premium is higher for low-technology states, indicating that between-group earnings inequality is higher in states with less technology. However, these estimates of the college wage premium remain consistent with the possibility that skill-biased technological change causes increases in between-group inequality: technology improves wages for the high-skilled relative to the low-skilled as measured by the college wage premium, espcially in low-technology states. Finally, the evidence suggests that the role assigned to skill-biased technological change in explaining increasing within-group earnings inequality has been overstated. Based on the estimates in this study, two-thirds of the increase in within-group earnings inequality cannot be attributed to technology.

These conclusions should be tempered by the recognition that this study uses only one measure of technology that in some cases was measured with error. Taken together, these results suggest that skill-biased technological change is not the sole factor explaining increases in inequality between or within groups. Future research should consider additional measures of technology to look for more direct evidence that skill-biased technological change is important in explaining trends in inequality within groups.

APPENDIX

High- and Low-Technology Rankings of States

Ranked by R&D/GSP

High-Technology States

1979	1994
Michigan	Michigan
New Mexico	New Mexico*
Delaware*	Delaware
Maryland	Maryland
Massachusetts	Massachusetts

Low-Technology States

1979	1994
Arkansas	North Dakota*
Montana*	Arkansas
Alaska	Montana
Nevada	Alaska
Kentucky	Nevada
Wyoming*	Kentucky
Louisiana	Wyoming
Maine	Louisiana
South Dakota*	Maine
	South Dakota*

Ranked by Change in R&D

High-Technology States

1979	1994
District of Columbia	District of Columbia
Vermont	Vermont*
Hawaii*	Hawaii
Washington*	Washington
Idaho*	Idaho
South Carolina	South Carolina
Michigan	Michigan
North Carolina	North Carolina

Low-Technology States

1979	1994
Tennessee	Missouri
Alaska*	Alaska*
Kansas	Montana*
Kentucky	Tennessee
Wyoming*	Kansas
Maine	Kentucky
Nevada	Wyoming
	Maine
	Nevada

*The total industrial R&D expenditures are imputed using federal expenditures on industrial R&D.

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Managed Care for Brazil's Banks

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MUCH OF THE CONTEMPORARY FOCUS ON FINANCIAL SECTOR REFORM IN EMERGING MARKET ECONOMIES CENTERS ON THE NEED TO DO AWAY WITH RESTRICTIVE REGULATIONS AND ELIMINATE GOVERNMENT'S PRESENCE IN THE MARKETS THEMSELVES. YET REAL-WORLD PRACTICE IS QUITE VARIED. REGULATIONS ON CAPITAL FLOWS AND FINANCIAL instruments differ significantly across even those countries where substantial opening has already taken place. Moreover, while the predominant experience among emerging market economies is toward a lesser role for government in financial markets, the policy path chosen by individual governments to reach this goal has been neither linear nor uniform.

This article explores financial liberalization in Brazil by examining one key aspect of that country's reforms: the reform and opening of the domestic banking sector. Although initial efforts to liberalize trade began in the late eighties and early nineties, a series of economic and political concerns limited the extent of the reform. The biggest impediment to reform was the country's ongoing battle against inflation. The 1994 introduction of the Brazilian economic stabilization program known as the *Real* Plan provided the long-sought-after economic stabilization but did not automatically improve the outlook for the financial sector. Instead, policymakers were forced to initiate a managed restructuring of both the private and public banking sectors to prevent financial institutions from collapsing because of the loss of the generous revenue received from inflation-related activities. By the end of the decade the government had instituted broad banking sector reform and avoided the devastation of a systemic banking crisis.

Understanding the differing structures and constraints of financial markets in emerging market economies like Brazil may provide useful information to U.S. policymakers assessing the international environment. Further, the establishment of safe and sound financial systems in Latin America promotes economic stability in the region, thereby decreasing the chances that a financial crisis there would critically stress U.S. financial institutions.

A discussion of some of the mechanics and policy choices facing government decision makers in opening domestic financial sectors follows, along with an examination of the basic features of Brazil's financial liberalization efforts. Special consideration is given to elements of policy choice in banking sector reform because this review is helpful in understanding how domestic needs and interests interact with capital to determine policy. The final section of the article discusses Brazil's banking sector reform within the context of other important changes and policy objectives taking place in that country.

Policy Choices in Financial Sector Liberalization

Although open capital flows are perhaps the most well known aspect of financial sector liberalization, the process may include several other important changes. Beim and Calomiris

define financial liberalization as including a combination of the following elements: "1. Elimination of interest rate controls. 2. Lowering of bank reserve requirements. 3. Reduction of government interference in banks' lending decisions. 4. Privatization of nationalized banks. 5. Introduction of foreign bank competition. 6. Facilitation and encouragement of capital flows" (2001, 119).

Given that the financial sector is composed of several different but overlapping markets, any discussion of financial sector liberalization must address the objective and impact of reforms across markets. Principally, these areas would include the credit market, where banks allocate funds to both individuals and businesses, and the capital market, where institutions broker investment funds through financial instruments such as stocks and bonds. Reforms in the credit and capital markets will have strong spillover into monetary policy as well. Therefore, architects of financial sector liberalization must not only target change in these individual markets but also be attuned to the effects of spillover into other areas, including regulatory issues.[1]

A number of variables may influence decisions to change existing policy orientations or to construct new policies. In many cases, policy changes have been preceded by economic crises or prolonged downturns.

Many countries attempting financial sector liberalization have initially focused on capital account liberalization to facilitate the rapid entry of foreign funds into capital-starved domestic markets. In many instances, painful and costly financial crises have ensued as distortions were introduced into poorly regulated and sometimes fragile systems. In fact, a study by Kaminsky and Reinhart (1999) confirmed that financial liberalization may aggravate or stimulate underlying weaknesses in the banking sector and cause a situation where balance-of-payments problems become banking crises, or vice versa. These experiences demonstrate why policymakers must be attentive to counterbalancing any distortions by sequencing reforms and introducing regulations to promote financial stability. Johnston and Sundararajan (1999) and Eichengreen and Mussa (1998) contain excellent discussions of sequencing reforms and prudential regulation's critical role in preventing a crisis during the opening of the capital account.

A number of variables may influence decisions to change existing policy orientations or to construct new policies. In many cases, policy changes have been preceded by economic crises or prolonged downturns. Even in these situations, the content of the policy may be informed by a range of domestic and international factors. The next section outlines some of the principal decisions and variables facing policymakers weighing financial opening.

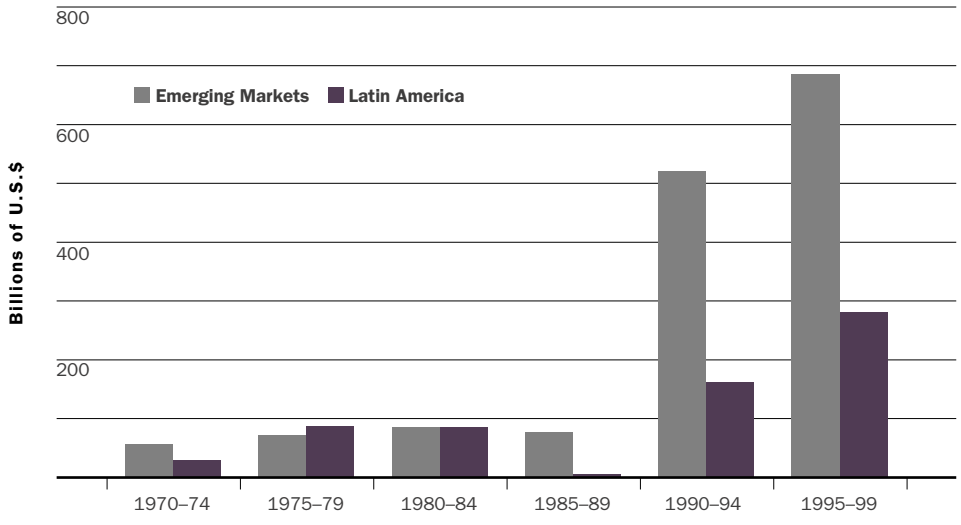
Considerations for Policymakers

Possible Risks. Critics of open capital accounts argue that liberalization exposes domestic financial sectors to a barrage of destabilizing short-term capital flows. As mentioned in the previous section, some countries that have opened their financial borders have experienced severe crises. Another criticism of open capital accounts is that open financial borders harm domestic business interests by exposing them to unfair competition from international firms possessing greater economies of scale and better technologies.

Other considerations may also enter into the decision to maintain protectionist barriers in the real economy or in the financial sector. Elected politicians in both developing and industrialized countries depend on support from a diverse set of constituency groups, and some of these groups might benefit from protectionist barriers or a delay in lowering existing restrictions. Therefore, a decision to establish or maintain some sort of financial barrier (or trade protection) should not necessarily be equated with favoritism or corruption. As noted above, opening sheltered financial markets to global capital can result in unwanted or unintended consequences, and countries in the process of opening need to establish policies that promote liberalization without triggering unnecessary volatility.

Possible Benefits. Proponents of liberalization counter that closed financial sectors are less productive because they do not maximize available resources and are not competitive. Therefore, without capital flows, financial markets are inefficient promoters of domestic development needs. A study by Mathieson and Rojas-Suárez on capital account liberalization offered the following summary: "When accompanied by appropriate macroeconomic and financial policies, a more open capital account may give rise to four efficiency gains: (1) unrestricted capital flows benefit the international economy by facilitating specialization in the production of financial services; (2) capital account convertibility creates dynamic efficiency by introducing competition in the financial industry from abroad and stimulating innovation; (3) if international financial markets

CHART 1
Net Private Capital Flows



Source: International Monetary Fund World Economic Outlook Database <http://www.imf.org/external/pubs/ft/weo/2000/02/data/index.htm>

price the risks and returns inherent in financial claims appropriately, global savings can be allocated to the most productive investments; and (4) for countries with limited access to private external finance, freedom of capital inflows and outflows may facilitate renewed access to international financial markets" (1993, 2).

Variables and Trends. Policymakers' interpretations of how to "operationalize" financial sector liberalization have varied widely. Quinn and Inclán's (1997) multicountry study demonstrated that, even though advanced economies have displayed an overwhelming tendency toward greater financial openness over a span of nearly four decades, these same economies practiced fundamentally different policies in key aspects of the financial system until very recently. Starting in the seventies, Europe's leading economies established universal banking laws effectively allowing firms to operate in a variety of financial markets (Coleman 1996), but the United States only recently began to permit banks to engage in both securities and insurance activities (*Gramm-Leach-Bliley Act* 2000).

Similarly, a survey by Lukauskas and Minushkin (2000) demonstrated the heterogeneous nature of financial liberalization policy among a diverse group of middle-income countries. These economies demonstrated that regulations on capital flows varied by country in regard to both entry and exit rules. Furthermore, the same policies also varied over time within the same country. Another survey found that just over 80 percent of developing countries used some form of restriction on foreign direct investment (Eichengreen and Mussa 1998, 10).

A policymaker's interpretation of the set and order of policies to pursue may be influenced by a number of important economic considerations. Two general trends are notable. The first is the increased movement of capital migrating across borders. This increase in the size and velocity of capital flows has transformed the policy environment. The International Monetary Fund has referred to this phenomenon as "one of the single most profound and far-reaching economic developments of the late twentieth and early twenty-first centuries" (Eichengreen and Mussa 1998, 1).

The volume growth in these flows is clearly demonstrated in Chart 1. Net private capital flows to emerging markets in general rose substantially over the past three decades, increasing from a total of U.S.$130 billion in the seventies to U.S.$1.2 trillion in the nineties. The large increases of the last decade have enticed some emerging market economies to open their capital accounts in an attempt to capture these funds (for example, international savings) and use them for national development purposes.

1. Although banks comprise only one of the subsets of the entire financial sector, banking sector reform has important implications for all financial institutions. Furthermore, banking sector reform is fundamental to financial liberalization. Thus, the terms "banking sector reform" and "financial liberalization" are often used synonymously in this paper.

During the nineties, when total flows were at very high levels, Latin American countries received an average of U.S.$44 billion per year. Regional giants Brazil and Mexico received the lion's share of these funds. At the same time, even though the volume of capital flows to Latin America grew substantially over the past thirty years, the region's share of the total amount has fallen dramatically, from around three-fourths in the seventies to just over one-third in the nineties. This decline is due to the fact that other geographic areas now receive these flows as well.

A second key consideration for policymakers is the changing composition of capital flows and the market outlook for emerging markets as an asset class. Much of the capital inflows to Latin America during the seventies took the form of bank loans. By the nineties, however, direct investment in production facilities and processes and portfolio funds (for example, equities and bonds) dominated private flows. Chart 2 shows the substantial increases in both portfolio and direct investment to Latin America. The chart also demonstrates the more volatile nature of portfolio flows, generally considered more liquid and short-term in duration than direct investment flows.

Opening sheltered financial markets to global capital can result in unwanted or unintended consequences, and countries in the process of opening need to establish policies that promote liberalization without triggering unnecessary volatility.

A corollary to the swings in investment composition is the tendency of investors to lump all emerging markets together as an asset class. This inclination has been especially evident during crisis periods such as the aftermath of Mexico's 1994 peso devaluation and the Asian and Russian economic downturns that began in 1997. During these periods investors tended to view all emerging market economies through a single lens despite fundamental differences in their performances, outlooks, and reform records. Developments such as these crises tend to produce an emerging-market see-saw effect: capital floods in during boom times and flows out rapidly during periods of scarcity. The sharp drop-off in portfolio flows to Latin America after the peso crisis (from U.S.$62 billion in 1994 to only U.S.$3 billion in 1995) illustrates the potential for volatility that policymakers confront when weighing liberalization policies.

Other Factors. The possibility of spillover is another important factor complicating the policymaker's task of defining appropriate policies. Spillover must be considered even within what is traditionally considered the financial sector because it includes an array of markets. Surges of capital inflows or outflows may affect both bonds and equities and have a critical effect on foreign exchange. Banks are not immune from these oscillations because, in addition to competing among each other for deposits and to make loans, they may also buy and sell stocks and bonds and participate in foreign exchange markets. Thus, changes in the investment outlook in one area can have a strong effect in other markets. Similarly, reforms enacted in one area can also have an effect (sometimes unintended) on other parts of the financial sector.

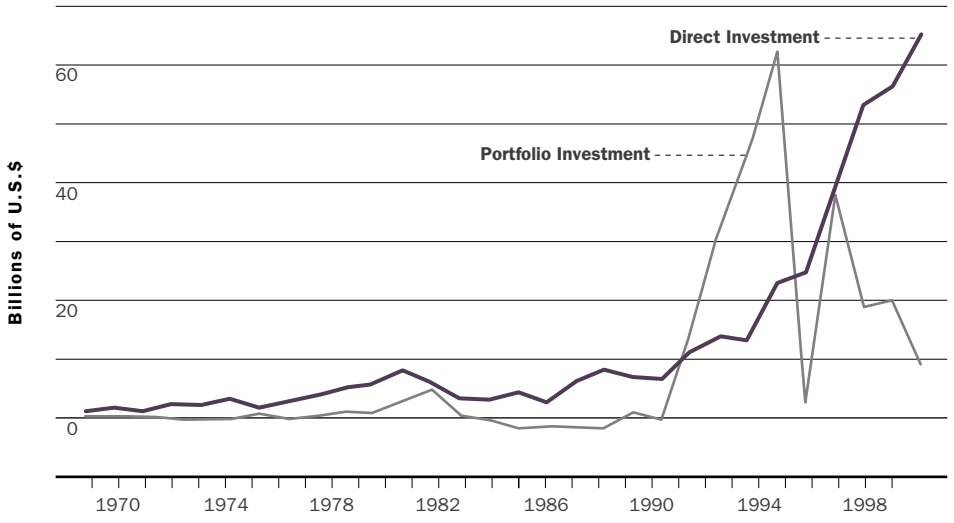
Other country-specific considerations also influence the pace and scope of financial liberalization policymakers choose. Although change exists in every political and economic system, like most developing nations, Latin America has undergone profound political and economic change over the past two decades. Many of the political systems in the region have undergone the transition from military dictatorships to elected, civilian rule during this period. Yet even though a formal system of democracy is now in place in most countries, the new rules of the game often clash with entrenched patterns of elite dominance. In addition, most economies are moving away from a closed, state-run system toward full openness and private ownership in both the financial sector and the real economy. Thus, financial liberalization is not an isolated policy change but a component of the larger processes of socioeconomic change called economic and political liberalization. Some studies have noted a positive relationship between capital flows and democracy as long as flows remain relatively stable (Armijo 1999).

Moreover, the extensive changes in the economic sphere alone may take decades to implement. As Fanelli and Medhora note, "liberalization of financial markets is a process that will develop over a significant period of time . . . because it is almost impossible to make a once-and-for-all announcement and instantly eliminate all the institutional features of financial repression" (1998, 5–6). In this sense, policy-oriented research seeks to understand the process of liberalization more than the outcome per se.

Financial Sector Reforms in Brazil

A review of the major developments in the sector since the formation of a modern financial system in the sixties is helpful in understanding the role of government and private actors in Brazil's economic growth. This review is also helpful in understanding how government policy choices

CHART 2
Latin American Net Private Capital Flows



Source: International Monetary Fund World Economic Outlook Database <http://www.imf.org/external/pubs/ft/weo/2000/02/data/index.htm>

enabled the gradual, managed reform that characterized the country's financial sector liberalization during the nineties.

Early Reforms. During the 1960s Brazil's military leaders laid the foundation of the country's modern financial system with new laws on banking reform, indexation, and capital markets. The 1964 Law of Banking Reform, which established the National Monetary Council as well as the Banco Central do Brasil, also imposed discipline on national currency creation by separating money creation and circulation. Previously, the Banco do Brasil, the federal government's primary fiscal agent, had been in charge of both money creation and management. New legislation on capital markets in 1965 attempted to stimulate credit and capital inflows through the development of the domestic market and new financial instruments. Another hallmark of the military's restructuring of the financial system was the 1964 introduction of indexation, or the practice of revaluing financial assets and liabilities to parallel price increases. Indexation soon became one of the most important facets of the financial system (Gleizer 1995).

These reforms were successful in helping the financial sector and the economy to grow, at least in the short term. Total financial assets grew from 23.6 percent of gross domestic product (GDP) in 1960 to 30.2 percent in 1970. Wholesale price increases fell sharply, rising only 31.3 percent between 1965 and 1970 after having grown 82.9 percent between 1960 and 1964. Nevertheless, even these lower levels of inflation were obstacles to long-term planning, and the economy was ultimately unable to withstand the negative effects of currency volatility, rising inflation, and a disabling shortage of long-term finance capital (Gleizer 1995).

According to Gleizer (1995), the lack of long-term capital was the biggest obstacle facing the military's economic policy in the sixties and seventies. Military reformers envisioned that private investment banks would meet this market need, but the high-inflation environment was a double-edged impediment. Continued high inflation deterred potential borrowers from assuming long-term, indexed liabilities and deterred lenders from taking uncertain, long-range positions. Ultimately, the government had to fill much of this void by using the state-run development banks to lend funds to the private sector to finance the country's development needs.

Credit provided by state-run development banks fostered targeted industries and allowed the military government to promote domestic manufacturing for both consumer and capital goods, facilitating the practice of import-substitution industrialization in Brazil. GDP grew at an average annual rate of 9.8 percent between 1970 and 1974. The impressive growth achieved during this period was offset, however, by rising uncertainties in the financial system.

The decade of the seventies was also the period when financial actors began to move their assets into more liquid instruments and the financial market came to be dominated by short-term repurchase

agreements. Individuals and financial institutions profited on these instruments because the repurchase price arranged at the start of the transaction generally was less than inflation (and subsequent monetary correction) during the same period. The share of these nonmonetary financial instruments grew from 38 percent of total financial instruments in 1969 to 66 percent in 1977. This shift caused problems for the sector and ultimately led the central bank to inject liquidity into the banking system and promote bank mergers and acquisitions (Andrezo and Lima 1999, 144–46).

By the end of the seventies the twin problems of rising inflation and increasing fiscal deficits were fully apparent. To keep the economy expanding, the government offered credit lines to the real sector and high-yield bonds to financial investors. Both of these activities resulted in growing public sector deficits. The second oil crisis in 1979 and an already mounting external debt stimulated the government to meet its financing needs in the domestic market. According to Andrezo and Lima, "Internal financing, along with the indexation mechanisms prevalent in the economy, triggered an inflationary process as well as strong [upward] pressure on interest rates" (1999, 147).

Domestic financial institutions continued to be willing buyers of government debt—the volume of which rose dramatically during the early nineties. Banks became "administrators of investment 'funds'" rather than intermediators of credit.

As a result of these factors, inflation began to rise ever more rapidly. Chart 3 shows the evolution of consumer price inflation starting in the early eighties. Inflation rose steadily in the early part of the decade, averaging a monthly increase of just over 8 percent from 1981 to 1985. By the second half of the eighties, however, consumer price increases accelerated to average almost 20 percent per month from 1986 to 1990. Chart 3 also shows that this trend worsened in the nineties before the introduction of the *Real* Plan. Monthly consumer price increases averaged 27 percent between 1990 and June 1994, when the new currency was introduced and inflation began a rapid decelerating trend.

Foreign Bank Involvement. In terms of foreign participation in the banking sector, Brazil was generally closed to new foreign entrants during the 1970s. Nevertheless, the importance of foreign banks increased sharply as the government borrowed from international creditors. Brazilian monetary authorities also began to allow domestic firms, including banks, to borrow directly and indirectly from foreign creditors. The central bank's Resolution 63 allowed banks to withdraw long-term funds from foreign banks and relend those same funds in the domestic market for shorter periods of time. The ratio of foreign bank loans to domestic bank loans grew threefold, from 13.8 percent in 1970 to 40.2 in 1981 (Gleizer 1995, 231). These flows increased the importance of foreign banks and agencies already present in the country. The share of total assets held by foreign banks grew from 1.7 percent in 1964 to 12.6 percent in 1980 (Abreu and Verner 1997, 116).

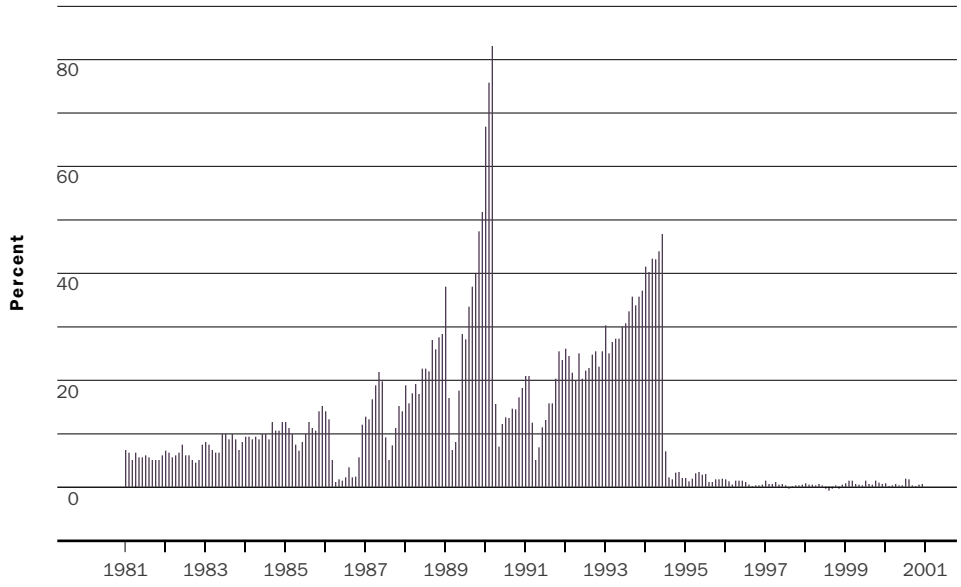
The influence of foreign banks in Brazil changed as international liquidity evaporated in the early eighties. At this point the government was issuing domestic debt in order to pay the interest on the external debt and had virtually ceased its massive public investment programs. These less favorable conditions cost the military government the support it had previously enjoyed from the business community. The military returned power to civilian rule in 1985 during a period of economic decline (Frieden 1991).

Liberalization Efforts. During the late eighties, civilian policymakers began to realize that import substitution industrialization was no longer a viable model for Brazil. Even so, initial efforts to change the policy orientation during the presidential administration of José Sarney in the late 1980s did not formally take hold until 1990 when President Fernando Collor took office. At that point both the pace and scope of commercial sector reforms accelerated sharply. Although Collor had campaigned on a populist platform, he introduced a rapid timetable of tariff reduction that significantly reduced the average tariff from 32.2 percent in 1990 to 14.2 percent in 1994 (McQuerry 1995).

In the financial sector, similarly, the initial liberalization efforts started in 1988 when Brazil freed interest rates on deposits and loans, but efforts proceeded much more slowly than in the trading sector. As discussed below, further efforts to reform the financial sector were rather timid until the *Real* Plan (see the box on page 34), introduced in 1994, began to fundamentally reshape the nation's economic and financial landscape by dramatically lowering the country's chronic inflation.

Any attempt to enact further reform would likely have been futile given that the problems produced by Brazil's chronic and rising inflation eclipsed all economic developments. As previously demonstrated in Chart 3, inflation remained at chronic levels in the

CHART 3
Monthly Consumer Price Inflation (1981–2000)



Source: Instituto Brasileiro de Geografia e Estatística <http://www.ibge.net>

late eighties and first half of the nineties despite repeated efforts to combat price increases.

Furthermore, failed reform ran the risk of triggering a systemic financial crisis, sending the economy into a more rapid cascade of deterioration. Instead, domestic financial institutions continued to be willing buyers of government debt—the volume of which rose dramatically during the early nineties. Yields on this debt rose with Brazil's sovereign risk. Investors increasingly demanded shorter-term paper with fixed yields. As a result, banks became "administrators of investment 'funds'" rather than intermediators of credit (Andrezo and Lima 1999, 202).

Political factors may also have promoted the delay in broader liberalization. The rapid opening of the real economy was widely protested by important segments of the private sector as well as by many politicians and the general public (McQuerry 1995; Kingstone 1999). Other factors may also have clouded the short-term viability of a broader external opening. In March 1990, President Collor angered banks and account holders when he froze bank accounts as a component of his anti-inflation program, and his 1992 resignation and subsequent impeachment ensured that policymakers were more focused on concerns of succession and rebuilding than economic liberalization policies.[2]

The banking sector was not a vocal proponent of liberalization either. Financial institutions had little incentive to reform the system because the high interest rates paid by government bonds ensured a continuing revenue stream even when lending and other financial instruments were not profitable. This situation gave the financial sector considerable clout because authorities could raise funds domestically, where maturities were longer and market access was guaranteed.

During the early 1990s the banks remained highly profitable by playing the float and using customer funds held in the banks as investment capital. These transactions were profitable for the banks because the customers' checking accounts paid a rate less than inflation to the account holders, but the banks were able to apply these same funds in short-term accounts, generally bonds, paying interest rates that far exceeded inflation. The gains on

2. The comparative review of financial opening in Argentina, Brazil, and Mexico by Penido and Prates (2000) characterized Brazil's liberalization efforts in the 1990s as "less intense" than those of the other two countries. Brazil's liberalization also differed in its approach to regulations on the use of foreign currency in the domestic money supply, purchase of domestic bonds by foreign nationals, and access to domestic equity markets. The prohibition on bank accounts with U.S. dollar deposits and relatively few allowances for dollar transactions in the financial system continues to set Brazil's liberalization apart from the next two largest Latin American economies.

The *Real* Plan, or the Program of Economic Stabilization

The July 1, 1994, introduction of the *real*, Brazil's new currency, was the final step in a three-stage process designed to permanently stabilize the national economy and bring an end to the country's chronically high inflation. The three steps were

1. rationalization of government accounts by reducing expenses and increasing federal tax receipts (spiraling government expenditure was considered the primary cause of chronically rising inflation), along with a series of other measures including restructuring public sector banks;
2. creation of a stable standard of value for monetary transactions (called the URV) to supplement inflation as the basis for economic contracts; and
3. dissemination of this standard of value as a new national currency called the *real*.

Source: Brazilian Ministry of Finance

these transactions are often referred to as inflation transfers or inflation revenue. Revenue estimates for the float were around 4 percent of GDP in each of the years between 1990 and 1993. Float income is estimated to have averaged 38.5 percent of the banks' output during the same period (Mendonça de Barros and Almeida 1997, 3–4). Inflation had other benefits for the banks as well. Baer and Nazmi (2000) note that chronic price increases promoted solvency by reducing the real value of debts, and the increase in the money supply injected liquidity into the system, helping borrowers repay their loans.

The types of bonds purchased by the financial sector evolved along with the economic situation. Table 1 demonstrates the changing composition and growth of government bond issues. In 1993, the last full year before the *Real* Plan was implemented, 42.1 percent of bonds were indexed to the inflation rate at the time of maturity. As inflation began to drop dramatically, other instruments were substituted in order to attract buyers for government bonds.

For the financial institutions, one of the more interesting trends has been the return on bonds linked to the overnight interest rate (SELIC). Whereas high inflation had previously stimulated the issuance of these bonds, the stimulus now was the government's growing fiscal deficit. As Table 1 shows, the share of bonds linked to the SELIC rate more than doubled to 37.8 percent of all bonds in the twelve-month period from 1994 through 1995. That share fell sharply in 1996 before picking up again in 1997 as concerns heated up over Brazil's fiscal situation, and problems in developing Asia pressured other emerging market economies. By year-end 1998, just before the January 1999 currency devaluation, the share of bonds linked to the overnight interest rate had risen to nearly 70 percent. Thus, financial institutions have had a strong incentive to participate in the financial markets and have reaped generous profits even after inflation was stabilized.[3]

A notable consequence of low inflation in Brazil has been the growth in public debt issuance. No longer able to curb deficits by printing money, the government sold bonds to meet revenue shortfalls. Debt issuance grew more than 1,000 percent in 1994—the year the *Real* Plan was instituted. Although the growth rate was not nearly as steep in the following years, debt issuance grew steadily between 1995 and 2000 (see Chart 4.) Clearly the downward trajectory in Brazil's foreign debt had begun well before, in the late eighties, when the country was shut out of international credit markets. As the *Real* Plan was instituted, however, domestic debt grew rapidly from a sum representing around 19 percent of GDP at the end of 1993 to 30 percent at the end of 1997.

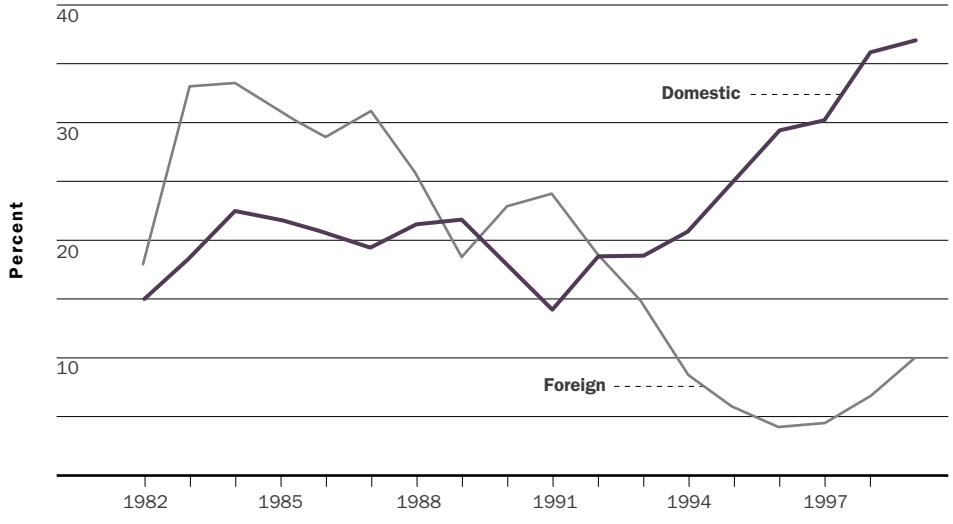
As discussed earlier in this section, banks purchased much of this domestic debt. These high-yield, relatively liquid instruments were good business for the banks. Utilizing the float funds made available during the period between custody and settlement of customer transactions, banks became dependent on these investments. In the five-year period from 1990 through 1994, profits on these inflation-related transactions averaged 35 percent of total bank revenues, reaching as much as 42 percent of total revenues in 1992, a year of particularly high inflation (Baer and Nazmi 2000).

TABLE 1
Government Bond Issues by Type of Indexation (End-of-Year Percentage of All Bonds)

	Inflation Rate	Exchange Rate (Postfixed)	SELIC Interest Rate (Pre- and Postfixed)	Nonindexed (Prefixed)	Balance (In Millions of *Reais*)	Annual Growth Rate of Government Bond Issues (Percent)
1993	42.1	17.3	3.8	26.4	4,988	NA
1994	12.5	8.3	16.0	40.2	61,782	1,138.6
1995	5.3	5.3	37.8	42.7	108,486	75.6
1996	1.8	9.4	18.6	61.0	176,211	62.4
1997	0.3	15.4	34.8	40.9	255,509	45.0
1998	0.3	21.0	69.1	3.5	323,860	26.8
1999	0.3	24.2	61.1	9.2	414,901	28.1
2000	1.6	21.7	52.4	15.3	516,114	24.4

Note: The yield on prefixed bonds is calculated at issuance; the yield on postfixed bonds is calculated at maturity.
Source: Banco Central *Boletim* (various)

CHART 4
Public Sector Debt (As a Percent of GDP)



Source: Banco Central, Dívida Líquida e Necessidade de Financiamento do Setor Público (August 1999) and 1993–99 data from Banco Central *Relatório* 1999 <http://www.bcb.gov.br>

Bank Reform Efforts

Although the factors described above stalled the possibility of banking sector reform, the *Real* Plan had established the preconditions for further financial liberalization. The prohibition of monetary indexation and continued low inflation effectively gave the banks the foundation for renewed economic activity and credit provision. These developments should have positioned the banks to move away from mutual fund management back to their traditional credit intermediation function.

The impact of stabilization (for example, the taming of inflation) and the end of wholesale profiteering on inflation can be seen in the decline of the banking sector's contribution to domestic output in Brazil. During the early nineties, the banking sector was responsible for a significant share of economic activity in Brazil. Table 2 demonstrates this importance for

3. Financial institutions were so heavily hedged in the period leading up to the devaluation that the sector reported record profits in 1999 (EIU 2000a).

TABLE 2
Brazilian Bank Output (As a Percentage of GDP)

	Private Banks	Public Banks	Total for All Financial Institutions
1990	4.6	8.1	12.8
1991	4.3	6.2	10.5
1992	5.9	6.2	12.1
1993	8.5	5.9	15.6
1994	6.9	4.6	12.4
1995	3.6	3.2	6.9

Source: Mendonça de Barros and Almeida (1997)

both private and public institutions relative to GDP throughout the early nineties and shows the abrupt decline in 1995. After averaging a 12.7 percent share of GDP in the five-year period from 1990 through 1994, the share of domestic output produced by all financial institutions plummeted by nearly half, to 6.9 percent, after the *Real* Plan was implemented. The figure has remained in the range of 6 percent of GDP since that time.

The Brazilian government's policies to liberalize the banking sector through privatization and industry restructuring have been carried out largely via two central bank programs and by careful management of the increase in foreign banks entering the sector.[4] The first central bank program involved privately owned banks and was referred to as PROER, or the Program to Support the Restructuring and Strengthening of the National Financial System. The second program targeted reduction and reform of the public-owned banking sector and was called PROES, or the Program of Incentives for the Reduction of States' Participation in Banking Activities.

PROER

President Cardoso enacted PROER by decree in November 1995 in response to Brazil's new low-inflation economic environment and its dramatic implications for the financial sector. While interest rates and the returns banks could earn on financial instruments would fluctuate over the next few years under the *Real* Plan, a general trend downward for both interest rates and inflation was necessary if the *Real* Plan were to be successful. Because financial institutions could no longer maintain profitability that was largely based on inflation-generated gains, the medium-term impact of these trends on the banking sector would be very detrimental unless a profound restructuring were carried out.

The least stable of the banks were already beginning to fail. The central bank took control of over twenty-one banks between the start of the *Real* Plan and the institution of PROER. One of the banks taken over by the central bank was Banco Econômico, which at that time was the country's eighth-largest institution and the fourteenth-largest bank in Latin America. News reports stated Econômico had more than U.S.$1 billion in negative net assets and a reserve shortfall of more than U.S.$3 billion when it was taken over in August 1995. Lacking a federal deposit insurance fund at that time, private banks made an emergency loan to Econômico so that it could guarantee its deposits (Robinson 1995).

The public sector banks, which make up a large segment of Brazil's banking system, were also already showing severe problems. The banks owned by the states of São Paulo and Rio de Janeiro, the two largest state-owned banks, had been under the control of the central bank since the *Real* Plan began. News accounts cited cash flow shortfalls in the billions of *reais* in each of these institutions.

In addition to the problems already evident in the country's banks, the international scenario surrounding the decision to establish a restructuring program was not favorable for Brazil. Mexico's economy was in shambles after the December 1994 devaluation and its banking sector had begun to experience a devastating crisis. At the time there was intense speculation about how badly Mexico's crisis would affect Argentina and Brazil.

This scenario likely influenced the Brazilian Central Bank in determining the PROER guidelines. One government report stated the purpose of the program as no less than preserving "the solvency of the National Financial system by eliminating those institutions that posed a risk to the system" (Banco Central 1997, 50). Thus, even though Brazil had not entered into a systemic banking crisis at that point, it was, arguably, on the cusp of one.[5]

PROER aimed to help private banks clean up their balance sheets and to reduce the number of

institutions through mergers and acquisitions. Specifically, the program involved a special central bank credit line to banks in need of liquidity and/or funds for restructuring. As a condition of these loans, the banks pledged collateral (for example, real estate or Brady bonds) valued at 120 percent of the loan. The measures also gave the central bank more control over mergers by requiring that institutions seeking to acquire troubled banks get central bank approval, obtain majority shareholder approval for the purchase of another bank, retire all merger costs within five years, and assume the liabilities of the institution being acquired. In return, eligible banks could receive lines of credit from the central bank to fund bank mergers and acquisitions. A related measure promoted mergers over the establishment of new banks by increasing reserve requirements to 32 percent of total capital for new banks but allowing merged banks to maintain only 8 percent of capital in reserve (Christie 1995).

A series of complementary measures were also decreed in late 1995. These included fiscal incentives for banks to acquire other financial institutions, the establishment of a deposit insurance fund (the Fundo de Garantia de Créditos [FGC]) guaranteeing up to R$20,000 per depositor and disincentives for establishing new banks (for example, increased capital requirements). Separately, new central bank regulations aimed to promote accountability and avoid bailouts by insuring that shareholders of institutions that were sold or transferred were still liable for any previous wrongdoing.

Perhaps the most significant of these new measures was the law giving the central bank authorization to restructure financial institutions that were not meeting system requirements or were demonstrating financial problems. While a form of this law had existed previously and the central bank was authorized to place banks under one of three forms of "special regime" (a temporary system of special administration, intervention, or extrajudicial liquidation), these measures lacked a preventative character. Now the central bank was empowered to prescribe preventative remedies such as increased capitalization, transfer of stockholder control, or mergers and acquisitions for faltering banks, and certain assets of failing banks could now be confiscated (Banco Central 2001b).

These instruments have shrunk the number of institutions in the financial system as a whole and the number of banks.[6] Central bank records show that a total of 135 financial institutions (all types) were intervened in or taken over between November 1995, when PROER began, and year-end 2000. Among these institutions, thirty-three (24 percent) were banks. Overall, sixty-seven (almost half) of the 135 financial institutions were closed. Among the banks, twelve (36 percent) of the thirty-three institutions were closed. The financial institutions that were not closed were either sold or remain in a state of liquidation or presale restructuring (Banco Central 2001d, 2001e).

Financial institutions had little incentive to reform the system because the high interest rates paid by government bonds ensured a continuing revenue stream even when lending and other financial instruments were not profitable.

The number of banks in operation has also fallen during this period. At the end of 1995 there were a total of 233 commercial and multiple banks in operation in Brazil, but the number had fallen to 191 by year-end 2000 (Banco Central 1997, 2001f).

PROES

The Brazilian government expanded its restructuring efforts to include banks owned by state governments in the second half of 1996. By this time the program to restructure private banks had been initiated and the first wave of state banks had been taken over or intervened with by the central bank. Banks belonging to the states of São Paulo (Banespa), Rio de Janeiro (Banerj), Rio Grande do Norte, and Alagoas had been placed under central bank direction at year-end 1994. Three other state-owned banks joined this group by February 1995

4. This section does not discuss the series of prudential regulations put in place during this same period by the central bank. While these reforms are extremely important for sound functioning and growth of the banking sector, the focus here is on the two restructuring programs. See Herculano (1999) for a review of Brazil's progress toward implementing the Basel Agreement on Banking Supervision.
5. Alves, Carvalho, and Studart (2001) note that it is not clear that Brazil was entering a banking crisis of systemic proportions because there was not mass capital flight or a significant drop in the overall level of deposits. Nevertheless, they argue, the question of whether Brazil was about to enter a banking crisis is ultimately unanswerable because the restructuring programs may have prevented an exodus of deposits and capital that otherwise would have ensued as more banks failed without government programs in place.
6. These data include both public and private sector–owned banks.

(Banco Central 2001c). Reports of the alleged problems within some public sector banks were of alarming proportion. Banespa, which was later taken over by federal authorities, was reported to have had a balance-sheet deficit of U.S.$23 billion when the central bank first intervened—a substantially larger amount than the U.S.$10 billion hole in the Bank of Credit and Commerce International (Gall 1996).

As mentioned in the previous section, grave problems in public sector banks became evident soon after the *Real* Plan ended dramatic price increases and stabilized the inflation outlook. In the eighties politically motivated lending and economic volatility had generated problems for some public sector banks, but the nature of the problems was now more severe. Ness (2000) notes that the public banks had always struggled with the conflict between their nature as a business and the political and economic goals assigned to them by government policy.

PROER aimed to help private banks clean up their balance sheets and to reduce the number of institutions through mergers and acquisitions. Specifically, the program involved a special central bank credit line.

In general, state governments had abused their banks as deficit finance vehicles. Many public sector banks had also contracted foreign loans to finance local projects and had issued bonds to meet their financing needs, entailing high debt-servicing costs in local and foreign currency. Previously, excess domestic currency spending had been camouflaged by inflation, government capitalization injections, and inflation-related revenue garnered by these institutions. After the *Real* Plan stabilized the economy, these practices were no longer viable. Further, public sector banks were less adaptable to economic change because they were unable to take advantage of technological advancements and their customer base was limited to cash-strapped public sector entities. Thus, the scope of problems in public sector banks was now quite severe.

The goal of restructuring state banks was to stop using the banks to clean up imprudent fiscal policies and to minimize the size of the public sector involvement in banking. Public banks were even more dependent on float income and inflation transfers than their private sector counterparts, taking in an estimated 63 percent of the inflation income for the whole banking sector; this dependence made the end of high inflation an even harsher awakening for these institutions. Mendonça de Barros and Almeida argue that the loss of inflation income hurt the public banks more than the private banks given that that public banks had been in decline well before the *Real* Plan was initiated and were unable to introduce competitive gains (1997, 9).

In cleaning up state banks the government hoped to improve the fiscal performance of the entire public sector. According to the central bank, PROES "was designed to hold back states' presence in banking activity as a means to curb credit extension to states and municipalities" (Banco Central 2000a, 1). This step was necessary not only to reduce the public sector presence in banking but also because the liabilities of state and municipal banks were, ultimately, sovereign liabilities. Accordingly, state- and municipal-owned financial institutions were prohibited from making new loans to their governments.

Brazilian authorities motivated the states to give up their banks by financing 100 percent of debts owned by these banks at very reasonable interest rates and terms of repayment. In order to get these terms, the banks agreed not to issue bonds until 2010. Additionally, the states could chose from five options for the future disposition of the institutions: "restructure balance sheets of the banks, transfer ownership control to the Federal government, sell to the private sector, transform banks into nonfinancial development agencies, or cease banks' operations" (Banco Central 2000a, 1). In exchanging their impaired assets for central government bonds, the banks' state owners rolled the costs of these bonds into their existing debts to the federal government.

PROES was successful in reducing the presence of state banks in the financial system both in terms of balance sheets and in the number of institutions in operation. At year-end 1995, just before the program began, banks owned by states and municipalities comprised 18 percent of system assets and liabilities. The presence of these banks was reduced to around 8 percent of both system assets and liabilities by the end of 1997. At year-end 1999, the share was further reduced to around 5 percent of both system assets and liabilities (IMF 2001, 173).

By early 1998 all forty-five state-owned financial institutions had been reviewed with the following outcomes: ten banks were liquidated, seven banks had been or were scheduled to be cleaned up and privatized by the states, six banks had been or were scheduled to be cleaned up and privatized by the federal government, five banks underwent restructuring and renewed normal operations, and fourteen banks were transformed into state development agencies. The remaining three banks did not take

advantage of PROES and restructured on their own (Banco Central 2000a, 3).

Political wrangling and juridical disputes repeatedly delayed the privatization of Banespa, the largest of the state-owned banks. The institution's sheer size and checkered history ensured that its privatization received considerable attention by bank analysts and the news media. Although Banespa had been plagued by mismanagement and abused for political purposes, it was nevertheless a giant bank with an asset base of nearly U.S.$15 billion and a 573-branch network in the country's most affluent state. These attributes made the acquisition attractive to both foreign and domestic firms. A controlling share of Banespa was sold to the Spanish banking conglomerate Santander in November 2000 for R$7.05 billion (U.S.$3.59 billion), an amount 281 percent above the minimum bid (Dow Jones 2000).

The huge premium and the increased presence of a major international bank in Brazil in many ways vindicated the federal government's efforts to restructure Banespa into a salable asset. Nevertheless, there were high costs for the government as it waged a complicated and combative five-year struggle to restructure the bank. One unofficial report estimated that the federal government's restructuring of Banespa cost around R$55 billion, more than seven times what it brought at auction (*Jornal do Commercio* 2000).

Finally, it is important to note that financial institutions owned by the federal government were not included in PROES—only state-owned banks. While federal banks suffer many of the same difficulties as state-owned banks, these institutions have an advantage: they can rely on the central government for necessary funding shortfalls. Indeed, the Banco do Brasil, which is the largest federal bank as well as the nation's largest bank, was recapitalized in 1996 (Ness 2000). Further capitalizations will be costly, however, requiring the federal government to take these funds from other areas or to issue additional debt.

To address concerns about the future of this sector, the Brazilian Central Bank commissioned an external study. The report's main conclusions were that federal banks are an important segment of the banking system and that whatever course is chosen for them will affect the entire sector. At the end of 1999 federal banks held 38 percent of system assets, down only slightly from 40 percent in 1995. The study also pointed out the urgency in beginning to restructure this sector by identifying "a series of deficiencies in the structure and operation of the federal financial institutions, which suggest that they are not efficiently fulfilling the role for which they exist." If these deficiencies are not addressed, they may cause the banks "to lose R$1.3 billion per year in the 2003–05 period." The report did not recommend privatization for these institutions but did suggest that their "commercial" role should no longer be carried out by the state (Booz-Allen and Hamilton—FIPE 2000).

The Role of Foreign Capital

This article has offered various claims to support the argument that Brazil's adoption of banking sector liberalization has been more pragmatic in orientation than it was ideological. The successful implementation of the *Real* Plan meant that the existing banking system, with its abundance of banks more engaged in financial investments than traditional banking activities, was no longer viable. The new consensus reached was that the banking system must modernize along with the real economy. Problematic banks must be removed in order to reduce the potential for systemic crises. Both the PROER and PROES programs shared this fundamental characteristic.

The goal of restructuring public sector banks was to stop using the banks to clean up imprudent fiscal policies and to minimize the size of the public sector involvement in banking.

The increased foreign bank presence testifies to the banking reform's pragmatic nature. While the government certainly solicited domestic private capital for new investment in the banking sector, domestic capital was in a somewhat uncertain state in that during the last half of the nineties it was undergoing a series of adjustments to adapt to the country's new economic reality. Domestic capital did purchase several of the privatized banks and is likely to play a critical role in further changes to banking sector composition.

From the perspective of systemic risk reduction, however, domestic institutions have two important limitations. First, foreign banks generally utilize more advanced technology than do domestic banks in developing countries. When foreign banking capital enters emerging market economies, domestic banks tend to respond to these demands by introducing the same techniques. If foreign banks do not invest in Brazil, then domestic banks have reduced incentives to modernize. The top handful of private, domestic banks in Brazil already have many of these advantages, but the remainder do not. The second

and more salient limitation of the use of only domestic capital is that the Brazilian Central Bank continues to serve as the lender of last resort for national banks. Foreign banks, on the other hand, receive this service from their respective home country regulators, thus reducing Brazilian domestic liabilities while simultaneously improving system soundness.

Despite the pragmatic necessity of introducing greater foreign capital into the Brazilian financial system, the role of foreign capital in Brazil's policy has been both confusing and intriguing. The confusion centers on the fact that the country's policy seems to be simultaneously for and against greater foreign participation. Overall, foreign capital has long been an important part of the Brazilian economy, even during the military regime. Prior to 1971, foreign banks were allowed to enter Brazil without restrictions, but limits were placed on foreign capital participation from 1971 to 1988. Even so, new foreign capital entered Brazil during this period within these limits (Arraes 2000).

The role of foreign capital in Brazil's policy has been both confusing and intriguing. The confusion centers on the fact that the country's policy seems to be simultaneously for and against greater foreign participation.

Legal changes enshrined in the 1988 constitution seemingly resolved any discussion on foreign banks; lawmakers included a temporary act (Article 52) prohibiting new foreign banks from starting until new, comprehensive financial sector legislation could be prepared. However, this same temporary act contradicted that ban by allowing foreign capital to enter the system through "authorizations resulting from international agreements" (*CFRB* 1988).

In 1996, soon after PROER was initiated, the administration of President Cardoso provided some clarification to its own policy intent by affirming that greater foreign participation in the financial system was in the nation's best interests because it would allow for the utilization of foreign savings, the introduction of new technologies, and increased efficiency (Banco Central 1997). Several times over the next few years President Cardoso used the "international agreements" clause of the constitution to allow new and greater foreign banking operations in Brazil.

Although the constitutional prohibition on foreign capital is a hallmark indicator that Brazil's financial system lacks a fundamental element of liberalization, the international agreement clause in the 1988 constitution has also proved to be a powerful tool to influence the direction of the financial system. Implemented as a guiding hand, this policy allows the central bank to encourage foreign banks to purchase public bank assets instead of using other avenues of entry such as chartering a new bank or acquiring a private bank. Another instance of this guidance was the closing of the retail banking market to expansion by foreign banks and to the entrance of new foreign institutions until all the state-owned banks could be sold (EIU 2000b).

As Table 3 shows, assets held by foreign-controlled banks in Brazil remain at low levels compared to those in other developing countries. Although the share of foreign-controlled banks in Brazil's banking system doubled to 17 percent in the five-year period after the restructuring programs were implemented, this share is less than half the levels in Argentina (49 percent), Chile (54 percent), and Venezuela (42 percent). In this survey, only Korea, Malaysia, Thailand, and Turkey have a lower percentage of foreign-controlled assets (Mathieson and Schinasi 2000).

The continued large role played by public sector banks in Brazil will limit growth of foreign bank participation. In mid-2000, 49 percent of assets in the top fifty banks in Brazil were held by public sector banks (federal and state-owned). Brazilian private entities controlled 22 percent of the remaining system with the other 29 percent held by banks with foreign control or foreign participation (Banco Central 2000b).

Political constituencies also influenced the content and scope of policy. Interest groups, made powerful by past policies, will naturally seek to resist reforms detrimental to their well-being, even if their actions postpone policy change only temporarily. The development of both the private and public banking sector in Brazil was characterized by what Makler calls financial federalism and entailed "encouraging the development and shepherding of sub-national public banks and sub-national private financial conglomerates in exchange for support to achieve national and regional development as well as to strongly establish the country in international markets" (2000, 4).

Thus, if it is to be successful, banking sector liberalization in Brazil must simultaneously seek to dismantle these constituencies and replace them with viable alternative engines of financial sector development. This need may have been one of the motivations behind the decision to reform the private banking sector before starting the public sector reform program even though the state banking sector may generally have been in worse shape than the private banking sector.

TABLE 3
Assets Held by Foreign-Controlled Banks in Brazil (Percentage of Total Assets)

	1994	1999
Czech Republic	5.8	49.3
Hungary	19.8	56.6
Poland	2.1	52.8
Turkey	2.7	1.7
Argentina	17.9	48.6
Brazil	8.4	16.8
Chile	16.3	53.6
Colombia	6.2	17.8
Mexico	1.0	18.8
Peru	6.7	33.4
Venezuela	0.3	41.9
Korea	0.8	4.3
Malaysia	6.8	11.5
Thailand	0.5	5.6

Note: Foreign control is defined as owning 50 percent of total equity. Data are end-of-period.

Source: Mathieson and Schinasi (2000)

The previous sections showed how inflation and the government's need to finance its deficit benefited private banks in Brazil. The analysis by Armijo (1996) demonstrates the way in which inflation-generated revenue promoted a pro-inflation constituency in the financial sector. While Brazilian policymakers likely did not seek to prolong inflation in order to benefit the financial sector, politicians did not have to respond to mass preferences during the period of military tutelage. When the political system fully returned to elected leaders in 1990, mass preferences became much more important. Given that inflation undermines the precarious economic condition of poor and lower-income groups, politicians in Brazil were obliged to increase their own commitments to a low-inflation economy. The fact that banking authorities lacked the institutional means to carry out full-blown banking reform when problems first arose is one indication of the influence exercised by elite groups such as bank owners.

In many regards, Brazil's banking sector liberalization appears to be the outcome of a delicate and sometimes shifting balance between three competing factors: the need to continue promoting national developmental needs within the constraints of fewer government resources, the limitations of existing legal barriers on foreign capital entry into the financial system, and the mitigation of the demands of new and old political constituencies.

Costs and Benefits

A complete evaluation of bank reform policies must also include an economic cost-benefit assessment. While this task is outside the scope of this article, it is clear that the structure of the PROER and PROES programs entailed different levels of cost outlay and long-term liabilities. Under the restructuring program for the private banks, the government incurred direct liabilities through cash loans to financial institutions. These loans must be repaid with interest. In the case of a bank's defaulting on its loan, the outstanding balance (that is, the potential loss) would be offset by what the government could get for the banks' assets pledged as collateral. At the end of 1999 the Brazilian Central Bank reported R$15.7 billion, or approximately U.S.$7.8 billion, in liabilities from PROER (*Gazeta Mercantil* 2000).

The PROES program, on the other hand, did not generally include loans and cash outlays to the state banks because it featured debt-for-bond swaps. The banks exchanged their old, nonperforming state bonds for performing federal bonds. Thus, the federal government did not incur the direct fiscal liabilities that it did with PROER; however, it does have to pay interest on the bonds to the states.

As of August 2000 the face value of bonds already issued was R$55 billion (nearly 6 percent of 1999 GDP). When interest income is considered, the value is R$92 billion. Central bank data show that the bulk (53 percent) of these bond swaps were issued to Banespa, the largest of the state banks (IMF 2001, 167, 169). The takeovers of Banespa and the six other banks by the federal government did involve direct fiscal outlays because the central bank funded the restructuring costs necessary to make the banks attractive to private buyers.

Banking sector reforms also promoted other policy objectives such as attracting greater international investment to Brazil. The *Real* Plan's success in stabilizing the economy brought new credibility to economic policy and made Brazil a much more attractive destination for foreign investment. The country's privatization program, which had begun in the early 1990s, gained new impetus after the *Real* Plan was instituted, in part because of increased international interest. A notable portion of these inflows was for the purchase of federal or state-owned institutions. At year-end 2000, privatization receipts resulting from the sale of financial institutions totaled close to U.S.$4 billion, representing 14 percent of total federal privatization receipts excluding transferred debts (BNDES 2001). The six privatizations of banks owned and sold directly by the states brought in approximately U.S.$1.5 billion (IMF 2001, 172).

The financial services industry has also fared well as a recipient of foreign direct investment, taking in U.S.$10.8 billion in nonprivatization funds between 1995 and 1999. Financial services' share of foreign direct investment represented 9.3 percent of all such investment during this period and totaled 14 percent of investment channeled to the services sector (Banco Central 2001a).

Another important contribution of the Brazilian government's bank reform policies is that the absence of a systemic banking crisis there has allowed the government to continue focusing on the task of improving fiscal accounts and other economic fundamentals, rather than digging out from a financial system collapse. Other Latin American countries have not enjoyed such a good situation. Mexico suffered a harsh banking crisis after the 1994 peso devaluation.[7] Argentina, Chile, and Uruguay experienced crises in the early eighties. In the nineties Argentina again underwent a profound crisis and restructuring in the banking sector, along with Colombia and Venezuela. Had Brazil suffered a full-blown banking crisis, the gains achieved by the *Real* Plan and economic stability would have been jeopardized. Nevertheless, these reforms were not sufficient to offset structural problems in the real economy or to prevent the January 1999 devaluation.

Finalizing banking sector reforms will be difficult in the absence of a new financial system law that specifies the ground rules and provides a sound legal foundation for the country's financial system.

Conclusion

Ultimately, Brazil's banking reform is rather hard to characterize. The absence of an economic crisis has encouraged gradualism and fashioned a reform that, in many regards, is narrow in scope and slower than in other countries. At the same time, Brazil's reform may also be labeled somewhat radical considering that the new enabling legislation for the financial sector has not yet been written and that the constitution formally limits greater participation by foreign capital in the banking sector.

These contradictions affirm that the government's policy for the banking sector has not yet been fully defined even though reforms have been under way since late 1995. Indeed, further reform will likely be necessary in both the public and private banking sectors. Finalizing any of these reforms will be difficult in the absence of a new financial system law that specifies the ground rules and provides a sound legal foundation for the country's financial system. The reforms implemented in recent years have begun to change Brazil's economic fundamentals and the prospects for the banking system. However, continued fiscal deficits will likely force the government to issue more high-yield bonds, and the presence of international volatility could pressure the central bank to keep interest rates high. Unfortunately, such conditions would shelter banks operating in Brazil from the need to return to the basic functions of supplying credit and could prolong the interregnum between stabilization and revitalization.

7. See McQuerry (1999) for a discussion of Mexican banking sector reform.

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