Economic Review

Federal Reserve Bank of San Francisco

Spring 1991 Number 2

Table of Contents

The Federal Reserve Bank of San Francisco's Economic Review is published quarterly by the Bank's Research Department under the supervision of Jack H. Beebe, Senior Vice President and Director of Research. The publication is edited by Judith Goff. Design, production, and distribution are handled by the Public Information Department, with the assistance of Karen Flamme and William Rosenthal.

For free copies of this and other Federal Reserve publicatons, write or phone the Public Information Department, Federal Reserve Bank of San Francisco, P.O. Box 7702, San Francisco, California 94120. Phone (415) 974-2163.

Real Business Cycles: A Selective Survey

Chan Huh and Bharat Trehan

Economist and Senior Economist, Federal Reserve Bank of San Francisco.

The authors would like to thank the members of the editorial committee, Fred Furlong, Ramon Moreno, and Brian Motley, and also John Judd, Carl Walsh, and participants at an in-house FRBSF seminar for helpful comments.

It is now more than ten years since the publication of Kydland and Prescott's first paper on real business cycles (RBC). RBC theories rationalize fluctuations in key real macro variables as the natural outcome of the competitive economy where individuals make optimal, intertemporal resource allocation decisions in response to stochastic shifts in the production technology. We use a simple model to bring out the salient features of this methodology and present a selective survey of work in this area over the last decade.

It is now more than ten years since the publication of Kydland and Prescott's first paper on real business cycles.[1] Their early work has stimulated an impressive body of research. This paper presents a selective survey of the developments in this field over this period.

There can be different ways of describing the distinguishing tenets of real business cycle (RBC) theories. For instance, Stockman (1988, p. 24) says, "the purpose of real business cycle (RBC) models is to explain aggregate fluctuations in business cycles without reference to monetary policy." Perhaps more fundamentally, it is the following central implication of RBC theories that has attracted attention: Fluctuations in aggregate output, as well as employment, are not a manifestation of coordination failure in some markets, but a natural outcome of the competitive economy where rational individuals make optimal, intertemporal resource allocation decisions in response to stochastic shifts in the production function.

Another aspect of these models is the fact that they are dynamic, general equilibrium models of the economy, and they generate empirical predictions for a wide array of macroeconomic variables. This is in contrast to most earlier analyses, which focused upon describing the behavior of a subset of the economy. Thus, these models aim to fulfill Lucas's (1977) requirement for understanding business cycles: "One exhibits understanding of business cycles by constructing a *model* in the most literal sense: a fully articulated artificial economy which behaves through time so as to imitate closely the time series behavior of actual economics" [sic] (p. 11).

In a sense, RBC models are the descendants of the models of Lucas (1975) and Barro (1976). Elements that are common to these models include the role of intertemporal substitution, the emphasis on individual optimization, as well as the requirement that markets clear—in the sense that no unexploited gains from trade are permitted. These elements distinguish both kinds of models from the traditional Keynesian theories of the business cycle.

However, RBC models diverge sharply from Lucas-Barro type models when it comes to the sources of macro-

economic fluctuations. Whereas the earlier models focused on the role of monetary shocks in causing business cycles, RBC models assign the primary role to shocks to production technology. It is this combination of assumptions about the economy's structure (i.e., optimizing individuals, perfect competition, and clearing markets) and the source of shocks (primarily, shocks to technology) that suggests that macroeconomic fluctuations represent optimal responses, and—in the absence of externalities—also makes it difficult to see how stabilization policy can lead to improvements in welfare.

RBC models also differ from the business cycle models of Lucas and Barro in the production technology they assume. Specifically, these models employ the production structure contained in the Solow growth model. However, the fact that these models allow endogenous saving and labor supply decisions places fewer restrictions upon the dynamic behavior of key macroeconomic variables (such as income, investment, etc.) than traditional growth models do, and therefore allows us to study business-cycle-like movements in this artificial economy.

This paper is organized as follows. Section I lays out a simple, intertemporal model to illustrate the key elements of an RBC model. This model is then solved and the solutions used to derive relationships between different variables. The next section discusses how the predictions from an artificial RBC economy are compared to the data and how well these models perform. Section III surveys research aimed at incorporating money into these models. Section IV reviews some of the criticisms made against these models, while the last section offers an appraisal and some concluding comments.

I. A Simple Intertemporal Model

We will analyze a simple two-period model, where many agents with identical preferences and endowments reside in the economy. This makes the economy-wide equilibrium outcome exactly the same as that for the individual, and allows us to analyze the behavior of the economy in terms of the behavior of a representative agent. Assume that each individual's preferences can be described by

$$U(c_t, l_t) = \frac{(c_t l_t^A)^{1-\gamma}}{1-\gamma},$$

where c_i and l_i denote consumption and leisure in period i.[2] For simplicity we assume that $\gamma = 1$, so that the utility function becomes

$$U(c_t, l_t) = \log c_t + A \log l_t, \tag{1}$$

where $A > 0$. Each individual makes allocation decisions in periods one and two to maximize the two-period objective function,

$$U(c_1, l_1) + \beta\, U(c_2, l_2). \tag{1}'$$

where β is the rate at which individuals discount tomorrow's utility. For simplicity, we set $\beta = 1$ below.

We assume that each individual begins period 1 with an endowment of k_1 units of capital. Each individual has to choose how much to consume and invest (c_1, i_1), and how much time to spend in leisure or work (l_1, n_1). These decisions will depend on the prices of leisure (that is, the wage rate) and rental capital, determined in the factor market and taken as given by individuals in the economy. Equations (2) and (3) embody these decisions and the relevant constraints on each set of decisions:

$$c_1 + i_1 = w_1 n_1 + r_1 k_1 \tag{2}$$

$$l_1 + n_1 = 1. \tag{3}$$

Here w_1 is the wage rate and r_1 is the capital rental rate. Equation (2) states that the sum of the individual's consumption and investment (or saving) must equal the sum of her income from labor and capital. Equation (3) simply normalizes total hours to equal 1.

The individual does not invest in capital formation in period 2. However, she still has to make the leisure-labor choice. Equations (4) and (5) describe these decisions for period two:

$$c_2 = w_2 n_2 + r_2 k_2 \tag{4}$$

$$l_2 + n_2 = 1. \tag{5}$$

The evolution of the individual's capital stock from period 1 to 2 is given by

$$k_2 = (1 - \delta) k_1 + i_1, \tag{6}$$

where δ denotes the depreciation rate for one period. For simplicity, we assume that capital is used up each period, so δ is set to one. Consequently, $i_1 = k_2$ in our model.

Consumers make allocation decisions to maximize (1)' subject to the constraints (2)-(6). This will give rise to the following set of equations that describe the necessary conditions for the consumer's optimum:

$$
\begin{aligned}
\frac{\partial u_1}{\partial c_1} - \lambda_1 &= 0 \\
\frac{\partial u_1}{\partial l_1} - w_1\lambda_1 &= 0 \\
-\lambda_1 + r_2\lambda_2 &= 0 \\
\frac{\partial u_2}{\partial c_2} - \lambda_2 &= 0 \\
\frac{\partial u_2}{\partial l_2} - w_2\lambda_2 &= 0
\end{aligned} \tag{7}
$$

Here λ_1, λ_2 are Lagrange multipliers associated with constraints (2) and (4), respectively, and measure the shadow price of consumption in the two periods.

Assume that there are as many firms as individuals. Each firm maximizes one-period profit, given by

$$\Pi_i = Y_i - w_i N_i - r_i K_i, \tag{8}$$

where Y denotes the firm's output, while N and K respectively denote the labor and capital employed by the firm. Firms are assumed to employ input factors in competitive factor markets, so that factor prices (measured here in terms of output) are taken as given. These firms employ an identical production technology given by the constant elasticity of substitution (CES) function

$$Y = [\alpha_1 N^{-\rho} + \alpha_2 (Kz)^{-\rho}]^{-\frac{1}{\rho}}$$

where the good Y can either be consumed or invested. Here α_1 and α_2 are the respective shares of labor and capital, and ρ is the elasticity of substitution between the two. The z_is denote capital specific technology shocks. For simplicity again, we assume that $\alpha_1 = \alpha_2 = -\rho = 1$, so that the production function becomes

$$Y_i = f(N_i, K_i, z_i) = N_i + K_i z_i.^3 \tag{9}$$

We further assume that there is no uncertainty in this economy, so that z_1 and z_2 are known when agents make decisions at the beginning of period 1.[4]

Given this structure for the economy, our aim is to derive a system of equations that expresses the endogenous variables as functions of the exogenous technology shocks and predetermined capital stock variables that describe the state of the economy. Solving the first order conditions (equation (7)) will give rise to individual decision rules that relate individual consumption-saving and leisure-labor decisions to the set of variables that are taken to be exogenous to an individual consumer, such as the wage and capital rental rates for both periods and aggregate capital stocks in each period.

For the next stage we exploit the structure of the model economy. First, the constant returns to scale technology and perfect competition assumptions imply that factor prices will be set equal to marginal products. Thus, in our simple model, we will obtain $w_i = 1$ and $r_i = z_i$, for $i = 1, 2$.

These conditions, together with the first order conditions above (equation (7)), imply certain specific relationships between the decision variables (that is, c_1, n_1, i_1, etc). Thus, we obtain

$$c_2 = r_2 c_1 \tag{10a}$$

$$l_i = A c_i, \quad \text{for } i = 1, 2. \tag{10b}$$

The first equation shows the equilibrium tradeoff between consumption today and tomorrow. It states that in equilibrium the marginal utility of \$1 of consumption today must equal the marginal utility of $\$r_2$ of consumption tomorrow. Similarly, (10b) presents the equilibrium tradeoff between consumption and leisure. This tradeoff is determined by the parameter A, which represents the utility derived from leisure relative to that derived from consumption. The equation shows that at the optimum the individual equates the marginal utility of consumption with the marginal utility of leisure.

Then, we impose the market clearing conditions. Specifically, in equilibrium the demands for labor and capital will equal the respective supplies (i.e., $N = n$ and $K = k$), and total output will be exhausted (i.e., $y = c + k$). As a result, we obtain a system of equations that describes the evolution of the equilibrium values over time:

$$
\begin{aligned}
n_1 &= D_1\{2 + A(1 - k_1 z_1 - z_2^{-1})\} \\
c_1 &= D_1(D_2 + z_2^{-1}) \\
i_1 &= k_2 = \frac{1}{2}(D_2 - z_2^{-1}) \\
n_2 &= D_1\{2 + A(1 - z_2 D_2)\} \\
c_2 &= D_1(1 + z_2 D_2),
\end{aligned} \tag{11}
$$

where $D_1 = 1/2(1 + A)$ and $D_2 = (1 + k_1 z_1)$. We now use our model and these results to discuss some of the key issues in the RBC literature.

Intertemporal Choices

The intertemporal nature of the decision is immediately clear in (11). The equilibrium outcome of the first period is directly dependent on the state of the economy in the

second period, and vice versa. The reason for these intertemporal linkages is easily seen from (10a). Because the individual equates the marginal utility of consumption in both time periods, any change in consumption (or in consumption possibilities) in one period will also affect consumption in the second. For similar reasons, any change in leisure in one period will also lead to a change in leisure in the next period.

It is easiest to understand the adjustments taking place by examining how individuals react to the two technology shocks in the model. Consider first the response to a change in z_1. From (11) we have

$$(12) \qquad \begin{aligned} \frac{\partial n_1}{\partial z_1} &= -D_1 A k_1 < 0 \\ \frac{\partial n_2}{\partial z_1} &= -D_1 A k_1 z_2 < 0. \end{aligned}$$

Recall that the z_is affect the productivity of capital (and in equilibrium equal the real interest rate). Further, since the productivity of capital is independent of labor supply, a higher z_1 is equivalent to getting a larger endowment of capital in the first period. In other words, an increase in z_1 has a pure wealth effect. Theory tells us that individuals should react by reducing labor supply in both periods. (12) shows that a large realization of z_1 unambiguously lowers n_1. It will also lower n_2 as long as z_2 is positive, a requirement that does not seem too stringent when it is recalled that z_2 $(=r_2)$ is the gross rate of return on investing in the first period.

Higher wealth should also imply an increase in consumption. In our model, (10a) shows that any change in the equilibrium level of leisure (and hence labor supply) must be accompanied by a change in consumption. This can be confirmed from (11) as well

$$\begin{aligned} \frac{\partial c_1}{\partial z_1} &= D_1 k_1 > 0 \\ \frac{\partial c_2}{\partial z_1} &= D_1 k_1 z_2 > 0. \end{aligned}$$

The effect of an increase in z_2, however, is quite different from that of an increase in z_1. Again from (11)

$$\begin{aligned} \frac{\partial n_1}{\partial z_2} &= \frac{A D_1}{z_2^2} > 0 \\ \frac{\partial n_2}{\partial z_2} &= -A D_1 D_2 < 0. \end{aligned}$$

Thus, a large z_2 unambiguously lowers n_2 because of the wealth effect. However, it has the opposite effect on n_1. Note that this change in n_1 occurs without any change in the wage rate. This is because an increase in the productivity of tomorrow's capital stock makes it desirable to have a larger capital stock tomorrow. One way to increase tomorrow's capital stock is to increase work effort and produce more today, so that more can be invested.

The other way is to reduce consumption today, since the rewards to deferring consumption have gone up. Specifically,

$$\begin{aligned} \frac{\partial c_1}{\partial z_2} &= -\frac{D_1}{z_2} < 0 \\ \frac{\partial c_2}{\partial z_2} &= D_1 D_2 > 0 \end{aligned}$$

Thus, an increase in the productivity of tomorrow's capital stock leads to increased investment today; this higher investment is obtained by reducing consumption and by increasing work effort.

Thus, changes in intertemporal opportunities cause individuals to alter both consumption and leisure. These intertemporal considerations remain central as the time horizon is extended from our simple two-period framework to the infinite horizon models typically used in RBC analysis.

Fluctuations in Output

When the solutions for n_1, n_2, and i_1 (shown in (11)) are substituted into (8), we can write equilibrium outputs of periods one and two (Y_1, Y_2) as functions of the state variables.[5] Differentiating these expressions leads to

$$\begin{aligned} \frac{\partial Y_1}{\partial z_1} &= (2 + A) D_1 k_1 \\ \frac{\partial Y_2}{\partial z_1} &= D_1 k_1 z_2 \end{aligned}$$

and

$$\begin{aligned} \frac{\partial Y_1}{\partial z_2} &= \frac{A}{(2+A) z_2^2} \\ \frac{\partial Y_2}{\partial z_2} &= D_1 D_2 \end{aligned}$$

The equations show that output in the two periods reacts differently to each shock, that is to say, $\partial Y_1/\partial z_i \neq \partial Y_2/\partial z_i$, for $i = 1, 2$. So, output in our model economy will fluctuate over the two periods, where the particular shape is determined by the realizations of the exogenous technology shocks in both periods. Notice that the differential response of output over the two periods is perfectly compatible with the fully informed, optimizing behavior of agents in the economy. In the context of our model,

attempts to offset this response (that is, attempts to "stabilize" output) will have adverse welfare consequences. That is because the fluctuations in output are the result of individuals' utility maximizing decisions about consumption and leisure over time, and attempts to alter these decisions will only force individuals to make choices that were initially rejected as being less desirable.

Consumption and Investment Volatility

Since no investment takes place in the second period, we will examine the consumption-investment (savings) decision of the first period to see what our model says about the relative volatility of consumption and investment. From (11) we obtain

$$\eta_1^c \equiv \frac{\partial c_1/\partial z_1}{c_1} = \frac{k_1}{1+k_1z_1+1/z_2}$$

and

$$\eta_1^i \equiv \frac{\partial i_1/\partial z_1}{i_1} = \frac{k_1}{1+k_1z_1-1/z_2}$$

so that

$$\frac{\eta_1^i}{\eta_1^c} = \frac{z_2(1+k_1z_1)+1}{z_2(1+k_1z_1)-1} > 1.$$

Carrying out the same exercise with respect to z_2 also leads to:

$$\frac{\eta_2^i}{\eta_2^c} = \frac{z_2(1+k_1z_1)+1}{z_2(1+k_1z_1)-1} > 1.$$

These semi-elasticities measure how much individuals modify their optimal consumption-saving allocations in response to a productivity shock either today or in the future. These results show that investment will be more responsive to external shocks than consumption in this economy, as long as z_2 is no smaller than 1. (This restriction implies that in the worst states of the world the decision to invest is equivalent to a decision to hold nonproductive inventories, since firms always get back what they invest.) The investment series will continue to be more volatile than the consumption series over time when the time horizon is extended in our economy.

The fundamental reason that consumption is less volatile than investment can be found in the basic properties of the utility function that describes preferences in our model economy. The specification of the utility function (1) implies that a typical person in the model economy does not regard consumption in different periods (periods one and two) as perfect substitutes. In other words, the individual wants to consume in both periods. If this were not the case, a small change in the relative advantage to consuming in any period would lead the individual to switch all consumption to that period.[6] One response to this desire to smooth consumption would be to smooth production as well. However, the returns to production, and to the ownership of capital, can vary widely over time, so investment will tend to be more volatile.

The mechanics of this argument are best understood in terms of the model discussed above. Consider, first, an increase in z_1. Recall that this implies an increase in wealth. The individual's response is to work less and consume more in both periods. However, the direct effect of working less in the second period would be to reduce second period output and, therefore, second period consumption. Consequently, in order to smooth consumption the individual must raise investment in period 1 by more than the change in consumption.

An increase in z_2 represents an increase in the rate of return on capital in the second period. As discussed above, individuals react to this increase by raising labor supply today and lowering consumption. So, period 1 output goes up while consumption declines, that is to say, investment rises by more than the fall in consumption.

Our finding that investment is more volatile than consumption is one of the widely recognized key stylized facts of the U.S. and other economies, and, as we discuss below, has been replicated by many different RBC models.

II. Matching the Model with the Data

The Methodology

As shown above, the pattern of output in our simple model depends upon the technology shocks in each of the two periods. In a more sophisticated multi-period model, typically used in such work, one can observe distinct cyclical fluctuations whose general characteristics will depend on the structure of the technology shock process, which is the primary source of exogenous impulses. A model builder can then obtain a set of descriptive statistics on artificial time series generated by simulating this model. These statistics can then be used to examine the explanatory power of a model, not only in terms of the qualitative implications, but also in terms of quantitative similarity to the actual time series data.

In practice, this methodology is implemented in the following way. First, one chooses explicit specifications for

the preferences of consumers, the aggregate production technology, and an exogenous impulse generating mechanism. For example, the researcher may decide that the Cobb-Douglas function is a good representation of the production technology or that the stochastic process for technology shocks is well described as a first order autoregression. Second, the artificial economy is calibrated, that is to say, the researcher chooses specific parameter values for the functional forms she has selected. For instance, if the researcher were to employ the CRRA utility function described above, she would have to choose values for γ and A. Similarly, the values for the parameters of the production function (α_1 and α_2 in our example above) also have to be estimated. Typically, some of these values are drawn from various micro and macro studies; for example, the parameters measuring the degree of risk aversion, as well as the shares of labor and capital in the aggregate production function are obtained in this way. Values for other parameters are obtained by imposing the condition that the model's steady state implications are similar to long-run observations for the U.S. economy. This includes, for example, the average proportion of time devoted to leisure and to work, the inter-temporal discount factor (β in our model), etc.

Next, the model economy is solved for an equilibrium, and decision rules for the representative individual are obtained. These rules specify individual behavior as functions of state variables (such as the capital stock carried over from the last period) and the exogenous shocks. For our simple model, equation (11) presents the relevant decision rules. The capital stock does not show up in (11) because of our assumption of 100 percent depreciation. Before going further, it also is worth pointing out that only a certain limited class of specifications for preferences and technology allow one to obtain a closed form, or an analytical solution. Consequently, some type of approximation procedure is usually adopted in practice.[7]

Armed with these decision rules, we are now ready to face the critical test: how well does the model economy mimic the real one? Answering this question involves using the model economy to generate artificial data. Since the model is driven by random shocks, this involves repeated draws from the probability distribution specified for the technology shock process. This artificially generated data is then compared to data for the U.S. economy.

Prior to making such a comparison, the data need to be transformed to make them stationary. One way to do so is to use the method employed by Kydland and Prescott (1982), and to apply a filter proposed by Hodrick and Prescott (1980) to both the actual and artificial data. The usual practice then is to summarize the detrended data in terms of its second moments (such as the standard deviations and correlation coefficients), and to compare these statistics on the artificial economy with the corresponding statistics for the U.S. economy.

The Comparison

Table 1 presents one such example, reproduced from Kydland and Prescott (1982).[8] Notice that the standard deviation of output in the model economy is exactly the same as in the U.S. economy. This is by construction. Specifically, as part of the calibration process, the size of the technology shock in the model economy is chosen to obtain this result. This does not restrict the other variables in the model economy to behave in the same way as they do in the U.S. economy, and a comparison of these variances and covariances provides a way of judging the model's adequacy. This is because the relative behavior of different variables also is a function of the model's structure—its propagation mechanism—and does not depend only upon the kind of exogenous shock process that is employed. Later, we will discuss how altering the nature of the technology shock process alters the behavior of the model.

As Kydland and Prescott point out, the model captures the relative size of the fluctuations in output, consumption, and investment. Thus, investment is substantially more volatile than income in both the U.S. and the model economies, while consumption is less volatile. Recall that our simple model also leads to the result that investment is more volatile than consumption. In addition, the Kydland-Prescott model also captures the strong, positive correlation between these variables and output.

Table 1

Variable	Actual Data (Sample: 1950:1-1979:2)		Model Economy	
	Standard Deviation	Correlation with output	Standard Deviation	Correlation with output
Output	1.8	1.0	1.8 (.23)	1.0
Consumption	1.3	.74	.63 (.09)	.94 (.01)
Investment	5.1	.71	6.45 (.62)	.80 (.04)
Labor Hours	2.0	.85	1.05 (.13)	.93 (.01)

Source: Kydland and Prescott (1982).

Note: Standard errors are in parentheses.

Obviously, the model does not provide a "perfect fit." For example, both consumption and labor hours are only half as volatile in the model economy as they are in the U.S. economy. Of the two, attention has focused upon "fixing" the problem with labor hours. Kydland and Prescott attempted to raise the variability of labor hours in their model economy by increasing the substitutability of leisure in different periods. The results of this attempt are already incorporated in Table 1; obviously, their attempt was not completely successful.

A number of subsequent papers also have focused on this problem. Kydland (1984) assumes that there were two different kinds of workers—differentiated on the basis of work skills—and shows that this led to greater variability in labor hours than the homogeneous labor case. Using a suggestion by Rogerson, Hansen (1985) shows that indivisibility of labor could be the reason for the relatively high variability of labor hours. Allowing for indivisible labor, Hansen shows that in his model economy the standard deviation of labor hours was roughly 80 percent of that in the data for the U.S. economy (compared to the ratio of 50 percent shown in Table 1). Cho and Rogerson (1988) allow for heterogenous labor (or household production) and show that in their model economy total hours are roughly 10 percent more variable than in the U.S. economy (over the 1955-1984 period).

While these attempts have been focused on making the model economy match the "stylized facts," other economists have directed their efforts towards a closer examination of the stylized facts themselves. Singleton (1988) argues that since traditionally defined seasonal, cyclical, and secular components of time series have common determinants, prefiltering the data leads to a violation of the restrictions imposed by the theory. Consequently, the results are likely to be functions of the method used to prefilter the data. Using a bivariate Vector Autoregression of real wages and hours worked, he shows that Granger causality tests as well as variance decompositions are sensitive both to whether the data is seasonally adjusted and to the treatment of the secular component. He also points out that the filter used by Kydland and Prescott leads to results similar to those obtained after the data is first differenced.

King, Plosser, and Rebelo (1988, p. 225; hereafter KPR) also point out that the "stylized facts" about the U.S. economy are sensitive to how the data is detrended. Since ". . . the basic neoclassical model has implications for untransformed macroeconomic data and not some arbitrary or prespecified transformation or component that is defined outside the context of the model," they argue that the procedure employed to detrend the data should be consistent with the theoretical model. KPR work with a model in which deterministic labor-augmenting technological change is the engine of growth, and in which technological change itself takes place according to a log linear trend. Consequently, they study deviations of the log levels of output, consumption, and investment from a common linear trend. Labor hours are not detrended since they show no trend.

When post-war U.S. output (for the 1948-1986 sample period) is detrended this way the standard deviation of labor hours is only half as much as that of output, in contrast to the nearly equal standard deviations obtained after the Hodrick-Prescott filter is used (see Table 1). Thus, the evidence on the relative variability of labor hours seems sensitive to the detrending procedure employed.[9]

The Role of the Technology Shock Specification

The specification of the technology shock process is obviously a central issue. KPR examine how the behavior of the model economy changes in response to changes in the technology shock process. They find that if the technology shock is not serially correlated there is no serial correlation in output, investment, or labor hours, while consumption, wages, and the real interest rate continue to be serially correlated. Thus, fluctuations in output appear to reflect fluctuations in the technology shock process. In addition, the degree of persistence of the technology shock affects the relative volatility of different variables. For instance, more persistent technology shocks reduce the variability of labor hours. Highly persistent shocks imply that the return to working in adjacent (or nearby) periods is roughly the same, so the intertemporal substitution of labor becomes less desirable.

Do technology shocks in fact follow the kind of process required by RBC models to mimic key features of the U.S. economy? The problem here is that we do not directly observe the process governing the evolution of technology. To get around this problem, Prescott (1986, p. 25) suggests, "One method of measuring technological change is to follow Solow (1957) and define it as the changes in output less the sum of the changes in labor's input times labor share and the changes in capital input times capital share. Measuring variables in logs, this is the percentage change in the technology parameter of the Cobb-Douglas production function." After examining data on the U.S. economy for the 1955-1984 period he concludes that the process governing the change in technology is close to a random walk with drift, and so is consistent with the technology shock process assumed in RBC models.[10]

Accepting the Solow residuals as an appropriate measure of technological shocks to the U.S. economy gives us an additional dimension for judging the performance of the RBC model. Recall that Kydland and Prescott (1982) chose the size of the technology shock to match the standard deviation of output. If the measured Solow residuals are used as exogenous technological shocks instead, the model's prediction of the standard deviation of real output can be compared to that of the U.S. economy. Kydland and Prescott (1989) do exactly that, and conclude that about 70 percent of U.S. post-war cyclical fluctuations are induced by variations in the Solow technology parameter.[11] A similar strategy is followed by Plosser (1989), who inputs the measured Solow residual for the U.S. economy (over the 1954-1985 period) into a RBC model. In contrast to the Kydland and Prescott method of looking at the second moments of the data, this procedure leads to simulated time series for the major economic variables (such as output, consumption, etc.) that can be compared directly to data for the U.S. economy. Plosser finds that the simulated data are close to the actual data, with the correlations between the two ranging from .52 to .87 for different series. However, these papers do not provide a formal means of judging how close the predicted values are compared to the actual values. We will return to these issues in Section IV.

III. What Does Money Do?[12]

The RBC models that we have surveyed above have shown that it is possible to have economies display business cycle-like behavior *without* reference to money. This is in marked contrast to more traditional analyses, such as Friedman and Schwartz (1982), Lucas (1975) and Barro (1976), which assign an important role to monetary disturbances. Indeed, some have argued that this is the distinguishing feature of RBC models (as we point out in the introduction).

It is also possible to assert that some form of monetary neutrality is assumed implicitly in RBC analysis. However, to regard monetary neutrality as the only defining tenet of RBC theories would be similar to claiming that most papers in public finance are studies of monetary neutrality because they fail to include money in the models. It seems more likely that the omission of money or financial market variables reflects the fact that early contributors were more concerned with explaining the non-monetary characteristics of business cycles. For instance, KPR (1988, p. 196) stress that it is necessary first to understand the effects of real disturbances, and that, "Without an understanding of these real fluctuations it is difficult *a priori* to assign an important role to money."[13]

Indeed, more recent research in this field focuses on the issues related to monetary aspects of the aggregate economy. Since they are "fully articulated" economies, it is necessary to motivate the use of money in these models by explicitly specifying some kind of transactions technology. Below, we discuss the two alternative mechanisms that have commonly been used in these analyses: the cash-in-advance constraint and the shopping-time technology specification (or a household production technology). A series of related questions can be asked once money is introduced into an RBC model. How successful are these models in explaining the observed correlations among output, money, and other real and nominal variables? What is the nature of the causal link between fluctuations in money and output? Alternatively, does the inclusion of money improve our ability to explain business cycles?

One way of introducing money in an RBC economy is to model it as an input into the transactions technology. King and Plosser (1984) and Kydland (1989) adopt a shopping-time technology to model the transactions role of money. Specifically, they assume that the time required to carry out transactions varies inversely with the amount of money held. Huh (1990) adopts a household production technology which requires the use of both physical output and money to generate actual consumption for consumers.[14]

King and Plosser (1984) focused on explaining the procyclical correlation between output and the broad monetary aggregates (such as M1) that has been observed in the U.S. economy. They introduce separate competitive firms (banks) that produce transactions services. These services are demanded by both households (because of the shopping time technology) and firms (as an input to the production process). Thus, banks will increase the supply of transactions services in response to a favorable technology shock to the final-good-producing firms to meet the increased demand of both the firms and consumers. Consumer demand for transactions services goes up because the opportunity cost of leisure time, as well as the value of time taken up by shopping activities, has gone up due to an increase in the real wage rate. Thus, the King-Plosser model predicts the observed positive correlation between output and inside money. However, it is important to note that the causal relationship between the two is the reverse of what is traditionally assumed—an increase in output leads to an increase in the money stock, and not vice versa.

The price level is determined in the market for government issued currency, which is demanded by households as a substitute for transactions services supplied by financial intermediaries.

The King-Plosser paper emphasized establishing a plausible theoretical construct that gave rise to reverse causation, and the quantitative analysis characteristic of RBC analysis was not carried out. To carry out such an analysis one needs to calibrate the transactions technology explicitly based on empirical studies of individual or household behavior with respect to money holdings and purchasing patterns. This way of modeling provides a practical route that can potentially capture and measure the role of money as a medium of exchange in a real economy. This also will impose empirical discipline on studies of the monetary aspect of an economy, similar to that found in other RBC analyses.[15]

Kydland (1989) examines the implications of allowing the possibility of a tradeoff between leisure and money as envisioned in a shopping time technology. One interesting finding is that the price level of the model economy turns out to be half as variable as the CPI of the U.S. economy, even with a constant money stock assumption. These price level fluctuations in the model economy are due to shifts in the demand for real balances which, in turn, vary entirely due to the desire of agents in the economy to substitute leisure (or labor) over time. The price level also exhibits a negative contemporaneous correlation with output in this economy, a feature that both Cooley and Hansen (1989) and Kydland and Prescott (1990) also find in post-war U.S. data. However, Kydland finds that introducing money in this way does not change the behavior of either output or labor supply in the model economy.

Huh (1990) obtains a more comprehensive accounting of the pattern of comovements among output, money stock, and price level observed in the U.S. time series data. Huh adopts a household production specification of demand for money, which requires the use of both physical output and money as input factors in generating actual consumption. The money supply of the model economy each period is determined by an explicit monetary reaction function, which depends upon both lagged real shocks and past values of money growth. Given this specification, the model economy exhibits a spurious positive comovement between money and output that approximates the positive correlation observed in U.S. time series data on the two variables. Variations in the steady state rate of inflation turn out to have real effects in this economy.[16] However, changes in the money supply do not seem to be an important source of business cycle movements.

Huh partially exploits the added opportunity of imposing empirical discipline that was discussed earlier. For example, the paper uses information about the relative variability of a broader measure of monetary aggregates (M1) over a narrowly measured one (monetary base) in calibrating the money supply function. But no comparable procedure was implemented with regard to the transaction technology calibration.

The other specification that has been employed in these models is the cash-in-advance (or liquidity) constraint, which motivates the introduction of money by simply requiring the use of money in making transactions. Various economic implications of the cash-in-advance constraint have been extensively studied in monetary economics (for example, see Lucas (1980), Lucas and Stokey (1987), Stockman (1981)). Cooley and Hansen (1989) apply this liquidity constraint to the RBC economy of Hansen (1985).

In the Cooley-Hansen economy, goods can be divided into two groups: cash goods and noncash goods, depending on whether the purchase of a good requires the use of cash (e.g., consumption) or not (e.g., leisure). Money is nonneutral because anticipated changes in money affect the relative price of consumption (cash good) and leisure (noncash good). Cooley and Hansen found the steady state welfare cost of inflation to be nontrivial in their economy. However, variations in the money supply do not have much impact on the cyclical behavior of the real variables in their model either.[17] The authors speculate that money may have a larger role to play in a model with restrictions on available information similar to those in Lucas (1972).[18]

Kydland (1989) carries out such an exercise. To measure the informational impact in isolation, Kydland adopts a version of the model economy of Lucas (1972) which is populated by spatially separated agents. The information structure assumed by Kydland implies that agents must extract information about the real wage from observations on the nominal wage. Monetary shocks alter the price level, thereby complicating the agent's signal extraction problem. However, it turns out that variations in the growth rate of money do not lead to significant cyclical movements in this model either.[19]

Overall, these (ongoing) efforts to extend standard RBC research to allow a role for money have produced interesting results. These studies provide a positive answer to the question of whether there exist plausible specifications that can explain (in the sense of Lucas (1977)) a set of key observations on nominal quantities and prices. However, the answer to the question of whether these specifications of money are an exhaustive and sufficiently robust mapping of the role of money in the "real" economy seems less

clear. Thus far, for example, no studies based on the RBC premises have shed light on the effects of open market operations involving different types of instruments of government indebtedness.[20] Another potential source of nonneutral money is some form of a nominal contractual arrangement.[21] Consequently, it seems inappropriate to interpret the results of these studies as demonstrating that money has no role to play in causing business cycles.

IV. What the Critics Say

The developments in RBC theory surveyed above represent innovations both in terms of technique and in ways of thinking about business cycles. However, that does not imply that RBC theory is free from shortcomings. In this section we review some of the criticisms leveled against this approach. We begin by reviewing what critics have to say in three broad areas. First, economists have expressed concern about a key propagation mechanism in these models, namely, the intertemporal substitution of leisure. Second, they have criticized the theory's reliance upon technology shocks. And third, they have also questioned the method by which parameter estimates have been obtained, that is to say, they have questioned the technique of "calibration." We conclude the section by summarizing some additional criticisms of the theory.

As discussed above, this approach relies upon intertemporal substitution of leisure to generate business cycles. This reliance has been criticized on several grounds. For instance, Walsh (1986) points out that while labor supply is procyclical, most of the cyclical variation in employment is accounted for by changes in the employment rate, rather than by changes in the labor force as the theory would predict. Since recessions are periods of low return, the theory also predicts that the quit rate should be countercyclical, whereas the data show that the quit rate is procyclical.

In addition to concerns about the mechanism generating business cycles, questions have also been raised about the nature and role of the technology shocks. For instance, Summers (1986) wonders where the technology shocks are, and whether recessions should be defined as periods of technological regress. A similar sentiment is expressed by Mankiw (1989, p. 85): "The existence of large fluctuations in the available technology is a crucial but unjustified assumption of real business cycle theory."

Over the postwar period, probably the most prominent aggregate shocks have been the changes in the relative price of oil. Since oil is a major input, variations in its relative price are likely to have a measurable impact on economy-wide output. However, in a recent study, Kim and Loungani (unpublished, p. 18) find that ". . . the inclusion of energy price shocks leads to only a modest reduction in the RBC model's reliance on unobserved technology shocks."

It is also possible that the economy-wide technology shocks represent the aggregation of a large number of shocks to different industries. However, this notion is questioned by McCallum (1989, p. 29), who states that if the term *technology shock* is ". . . . taken literally to refer to shifts in the state-of-knowledge technological relationship between inputs and outputs, then it would seem highly unlikely that there could exist any substantial *aggregate* variability." This is because the economy contains a large number of different sectors employing different technologies, and shocks to these technologies should be more or less independent. Since the economy-wide technology shock would be an average of these industry-specific shocks, it would evolve more smoothly than what RBC models seem to require.

Prescott's use of the Solow residual to measure the size of the technology shock has also been criticized. Recall that the Solow residual is obtained as a residual from a (Cobb-Douglas) production function using labor and capital as inputs. This procedure implies that errors in the measurement of labor and capital will show up as variations in the estimated Solow residual (since the errors in measuring output are likely to be uncorrelated with the errors in measuring labor and capital). Consider, for example, what happens when there are variations in the rate of capital utilization. Since the measured Solow residual is based upon an assumption of 100 percent capacity utilization, any change in the rate of capacity utilization will be measured as a technology shock.[22]

Variations in "the rate of utilization" for the labor input are likely to have similar effects. Eichenbaum (1990) points out that allowing for labor hoarding in an RBC model drastically reduces the role of technology shocks. Thus, naive Solow residual accounting overestimates the variance of the technology shocks.

McCallum (1989) also points out that the Solow residual will overestimate the variance of the technology shock in the presence of adjustment costs. (Adjustment costs can be one reason for labor hoarding.) As evidence, he points to a study by Jorgenson and Griliches in which the elimination

of aggregation errors and a correction for variations in labor and capital utilization reduces the role played by the Solow residual (in explaining output growth) to only 7 percent of the initial estimate.

A number of others have also expressed similar reservations about the use of the Solow residual to measure technology shocks. According to Hall (1989), the Solow residual is correlated with oil prices, military spending, and even the political party of the president. Similarly, Evans (1990) shows that the Solow residual is correlated with alternative measures of the money supply. These correlations contradict the assumption that the Solow residual only measures shifts in the production function.

If the Solow residual is not a good measure of technology shocks, what are we left with? RBC proponents have not done a good job of coming up with alternatives, leaving critics to wonder how the theory can be verified.

The next major criticism of RBC models has to do with the issue of statistical inference. The basic problem is that the calibration techniques discussed above do not take account of the uncertainty that exists regarding the true value of the parameters. Thus, Manuelli and Sargent (1988, p. 531) express concern about the use of out-of-sample evidence to estimate parameters since it precludes the use of a formal probability model to make judgments about the results. They further ask "Does it matter *how* the extraneous (out of sample) parameter estimates have been made? Were these estimates obtained using a theoretical structure consistent with the general equilibrium structure Kydland-Prescott maintain? Were the extraneous estimates obtained in ways that would be statistically consistent in view of the cross-equation and cross-frequency restrictions imposed by the Kydland and Prescott model?"

In a similar vein, Eichenbaum (1990, p. 9) states ". . . calibration exercises do not provide any information on how loudly the data speak on any given question." He takes issue with Kydland and Prescott's contention that technology shocks account for 70 percent of the business cycle variation in post-war U.S. output. On the basis of his attempt to incorporate parameter uncertainty into measurements of the role of technology shocks, he concludes that ". . . we ought to be very comfortable believing that the model explains *anywhere* between 5% and 200% of the variance in per capita U.S. output." In other words, the role of technology shocks is very imprecisely estimated.

A number of other criticisms have also been made. For example, some economists (Summers (1986), among others) find a pervasive use of the "representative agent" construct in RBC theories objectionable. In addition, the model has only been tested on postwar U.S. data so far. Critics have pointed out the need to test the model using alternative samples. Rogoff (1986), for example, has suggested estimating the model for different countries.

Ingram and Leeper (1990) argue that the use of RBC models to examine policy issues may be subject to a version of the Lucas critique.[23] This criticism is applicable to models that use parameter values used in calibrating early RBC models which ignored the effects of policy (e.g., Kydland and Prescott 1982). Ingram and Leeper show that ignoring the effects of monetary policy in a world in which policy has real effects implies that some of the estimated parameters will be reduced form coefficients. Policy analyses based on the assumption that these are deep, policy invariant parameters will, therefore, lead to incorrect inferences.

V. An Appraisal

Clearly, RBC models are not without their critics. Nevertheless, this line of inquiry has made important contributions to economic analysis. RBC models represent a significant innovation in economic modeling, since they were the first operational models based upon microeconomic foundations. As such, they provide a coherent, logically consistent way of thinking about the macroeconomy. At one level, these models provide a useful counterpoint to the view that in the absence of fiscal and monetary policy shocks, real output would grow at a steady 3 percent annual rate (or whatever the sample average growth rate would happen to be).

One attraction of these models is that they provide a relatively straightforward way of testing theories against data. However, existing RBC models are highly stylized and do not have the same econometric detail as the large scale Keynesian models often used for policy purposes.

So what can these models tell us about how to conduct policy? Kydland and Prescott suggest that we need to learn more about business cycles before making policy recommendations. For instance, in Kydland and Prescott (1988, p. 358) they state, "Our analysis should not be interpreted to mean that fluctuations are optimal and that there is no role for stabilization policy. Our view is that public finance considerations are not the principal factor driving the business cycle and that abstracting from them at this stage is warranted. Only when we have considerable confidence in a theory of business fluctuations would the application

of public finance theory to the question of stabilization be warranted."

Their conclusion is based on a model that does not explicitly incorporate either public spending or money. What can we say on the basis of models that do? As discussed above, changing either the growth rate of money or the size of the monetary shocks in these models does not have a significant effect on the cyclical behavior of the real variables. On the surface, this seems to suggest that monetary policy is not very important. However, existing models are not yet rich enough to support such a conclusion. For instance, these models allow only a limited role for money and do not allow for other nominal assets. Thus, the available evidence does not seem sufficient (or robust enough) to convince a risk-averse policymaker either to adopt or to abandon a specific course of action.

NOTES

1. Their first paper on this topic ("A Competitive Theory of Fluctuations . . . . ") was published in 1980, though Kydland and Prescott (1982) is more frequently cited.

2. This function belongs to the constant relative risk aversion (CRRA) class. See Blanchard and Fischer (1989) for a discussion.

3. A simpler production function does impose costs. For instance, our specification implies a constant marginal product of labor and consequently a constant wage rate.

4. For our purposes the important point is that the z_i's shift the marginal product of capital.

5. In our specification, Y_1 is not equal to Y_2 even in the absence of shocks. However, this difference is not central to our discussion, since our focus is on the *change* in output in response to the technology shocks.

6. The elasticity of intertemporal substitution is a fundamental determinant of the volatility of consumption. For example, if the utility function is linear in consumption, the elasticity of the intertemporal substitution of consumption becomes infinitely large. Since individuals do not care about the period they consume in, consumption becomes extremely volatile. To demonstrate this heuristically, suppose that the two-period utility function is as follows:

$$u(c_1, c_2) = [c_1^{-\rho} + c_2^{-\rho}]^{-\frac{1}{\rho}},$$

where c_i denotes consumption in period i for $i = 1, 2$. The elasticity of substitution between c_1 and c_2 is given by $1/(1 + \rho)$. The utility function becomes linear when ρ is -1. Note that the elasticity of substitution goes to infinity as ρ approaches -1.

7. See Kydland and Prescott(1982), and King, Plosser and Rebelo (1988) for two distinct solution procedures. A comparison of alternative solution procedures is contained in the *Journal of Business and Economic Statistics*, January 1990.

8. King and Plosser (1989) employ a different technique to carry out tests of RBC models.

9. KPR also cite other work by King and Rebelo that demonstrates that applying a low frequency filter (such as first differences) to the data from a theoretical economy raises the correlation between output and labor input.

10. Also see Kydland and Prescott (1988).

11. Their model is more general than the one discussed above, since it allows labor input to change both in terms of hours per worker and the number of employed workers.

12. As mentioned above, there are many extensions of the basic Kydland-Prescott model that we do not cover in our survey. For instance, Stockman (1988, 1990) deals with open economy issues. Christiano and Eichenbaum (1988) examine the effects of shocks to government spending in an RBC model. Christiano (1988) introduces inventories.

13. A somewhat different view is expressed by Eichenbaum and Singleton (1986, p. 92):

"In our view, proponents of real business cycle theories are not claiming that monetary policy cannot or has never had a significant impact on the fluctuation of real output, investment, or consumption. Rather we subscribe to the second interpretation of RBC analyses as investigations of real allocations under the assumption that, to a good approximation, monetary policy shocks have played an insignificant role in determining the behavior of real variables."

14. These techniques of introducing money are closely related to the money-in-utility-function (MIUF) approach. The MIUF approach is criticized by some monetary theorists as implicit theorizing because of its reliance on the underlying model and its assumptions with implications that might be contradictory to those of the final model (for a critical discussion, see Kareken and Wallace (1980)).

15. However, there is a justifiable concern about implementing this technique for a monetary economy. According to this methodology, one has to get estimates of the deep parameters governing preferences and technology that are invariant with respect to any type of monetary policy shifts and interventions. It might be especially difficult to obtain or isolate such information about the parameter values of the underlying transaction technology from data.

16. In both the Huh economy and the Cooley-Hansen economy (discussed below) changes in the steady state inflation rate have effects that are the opposite of the "Tobin effect." The Tobin effect implies a positive correlation between the steady state inflation rate and the capital stock. It arises as a result of portfolio substitution: an increase in the rate of inflation, for instance, lowers the rate of return on money and causes individuals to substitute into physical capital. By contrast, in a cash-in-advance model, an increase in inflation makes activities that require the use of money (purchases of consumption goods) less attractive relative to other activities (leisure), because of the decrease in the purchasing power of money holdings due to inflation. For more discussion see Stockman (1981) and Lucas (1987).

17. It is important to realize that a cash-in-advance constraint imposes some significant restrictions on the model structure. The first is the exogeneity of the length of the period defined in the economy, which was first pointed out by Harris (1980). Cash balance holding in a cash-in-advance economy is analogous to a hot potato, where the temperature of the potato measures the rate of inflation in the economy. The higher the inflation (i.e., the hotter the potato), the faster one wants to dispose of it. In this economy, the length of each period is defined as the time for which money is held, and, therefore, the velocity of money is defined to be one. Consequently, the length of the time period might change as the purchasing power of cash holdings varies due to changes in monetary policy, that is, as the economy moves between high and low inflation.

The next restriction is not unrelated to the first. The exogenous grouping of goods in terms of cash versus

noncash goods is too restrictive. As the prevailing inflation rate changes, the scope of transactions involving cash versus noncash (credit or barter) is very likely to shift.

18. These restrictions lead to confusion about aggregate and relative price changes, and therefore cause money to have real effects.

19. Monetary misperception has been regarded as a potentially important source of monetary non-neutrality not only by the economists in the Lucas-Barro tradition, but also by some current practitioners of RBC theories (see the earlier discussion of the Cooley-Hansen paper). Thus, the test by Kydland has added significance. However, in an attempt to isolate the effect of money through informational confusion, a stringent neutrality is imposed on the model economy. In the model economy, individuals are paid in fiat currency (nominal wage), but it is unclear how transactions of goods are consummated or what happens to the individual money holdings in his "islands" economy. Consequently, interpreting the noise component of the observed nominal wage as a money or aggregate price shock seems arbitrary.

20. Imrohoroglu and Prescott (1990) is intended to examine some of these issues.

21. For example, Stadler (1990) obtains a strong non-neutrality result by incorporating a temporarily fixed nominal wage contract feature in an otherwise real model. We regard the assumed fixity too extreme and implausible, but it is one demonstration that such complications may alter the usual "effectively neutral money" results.

22. Greenwood, Hercowitz, and Huffman (1988) analyze an RBC model in which the rate of capital utilization is endogenous.

23. See Lucas (1976).

REFERENCES

Barro, Robert J. 1976. "Rational Expectations and the Role of Monetary Policy." *Journal of Monetary Economics* 2, pp. 1-32.

_____. 1977. "Unanticipated Money Growth and Unemployment in the United States." *American Economic Review* 67, pp. 105-115.

Blanchard, Olivier J., and Stanley Fischer. 1989. *Lectures on Macroeconomics*. Cambridge, Massachusetts: The MIT Press.

Burns, Arthur, and Wesley Mitchell. 1946. *Measuring Business Cycles*. New York: National Bureau of Economic Research.

Cho, Jang-Ok, and Richard Rogerson. 1988. "Family Labor Supply and Aggregate Fluctuations." *Journal of Monetary Economics* pp. 233-245.

Christiano, Lawrence. 1988. "Why Does Inventory Investment Fluctuate So Much?" *Journal of Monetary Economics* 21, pp. 247-280.

_____, and Martin Eichenbaum. 1988. "Is Theory Really Ahead of Measurement? Current Real Business Cycle Theories and Aggregate Labor Market Fluctuations." NBER Working Paper No. 2700 (September).

Cooley, Thomas, and Gary Hansen. 1989. "The Inflation Tax in a Real Business Cycle Model." *American Economic Review* (September) pp. 733-748.

Eichenbaum, Martin. 1990. "Real Business Cycle Theory: Wisdom or Whimsy?" NBER Working Paper No. 3432 (September).

Eichenbaum, Martin, and Kenneth Singleton. 1986. "Do Equilibrium Real Business Cycle Theories Explain Post-War U.S. Business Cycles?" In *Macroeconomic Annual* Vol. I, ed. Stanley Fischer. Cambridge: MIT Press.

Evans, Charles L. 1990. "Productivity Shocks and Real Business Cycles." Unpublished manuscript. University of South Carolina.

Friedman, Milton, and Anna J. Schwartz. 1982. *Monetary Trends in the United States and the United Kingdom*. Chicago: University of Chicago Press.

Greenwood, Jeremy, Zvi Hercowitz, and Gregory Huffman. 1988. "Investment, Capacity Utilization, and the Real Business Cycle." *American Economic Review* 78, pp. 402-417.

Hansen, Gary. 1985. "Indivisible Labor and the Business Cycle." *Journal of Monetary Economics* 16, pp. 309-327.

Hall, Robert E. 1989. "Invariance Properties of Solow's Productivity Residual." NBER Working Paper No. 3034 (July).

Harris, Milton. 1980. "Discussion," In *Models of Monetary Economies*, ed. J.H. Kareken and N. Wallace, pp. 157-159. Federal Reserve Bank of Minneapolis.

Hodrick, R. J., and E. C. Prescott. 1980. "Post-War U.S. Business Cycles: An Empirical Investigation." Working Paper. Carnegie-Mellon University.

Huh, Chan G. 1990. "Output, Money and Price Correlations in a Real Business Cycle Model." Working Paper 90-02. Federal Reserve Bank of San Francisco.

Imrohoroglu, Ayse, and Edward S. Prescott. 1990. "The Cost of Inflation." Mimeo (November). Federal Reserve Bank of Minneapolis.

Ingram, Beth, and Eric M. Leeper. 1990. "*Post* Econometric Policy Evaluation: A Critique." International Finance Discussion Paper No. 393 (December). Board of Governors of the Federal Reserve System.

Jorgenson, D.W., and Z. Griliches. 1967. "The Explanation of Productivity Change." *Review of Economic Studies* pp. 249-283.

Kareken, John H., and Neil Wallace. 1980. "Introduction." In *Models of Monetary Economies*, eds. J.H. Kareken and N. Wallace, pp. 1-9. Federal Reserve Bank of Minneapolis.

Kim, In-Moo, and Prakash Loungani. 1990. "The Role of Energy in Real Business Cycle Models." Unpublished paper. Federal Reserve Bank of Chicago.

King, Robert, and Charles Plosser. 1984. "Money, Credit, and Prices in a Real Business Cycle Economy." *American Economic Review* 74, pp.363-380.

King, Robert, and Charles Plosser. 1989. "Real Business Cycles and the Test of Adelmans." NBER Working Paper No. 3160.

_____, and Sergio Rebelo. 1988. "Production, Growth and Business Cycles: I. The Basic Neoclassical Model; II. New Directions." *Journal of Monetary Economics* 21, pp. 195-232 and 309-341.

Kydland, Finn E. 1984. "Labor Force Heterogeneity and the Business Cycle." In *Carnegie Rochester Conference Series* 21, pp. 173-208. Amsterdam: North Holland.

_____. 1989. "The Role of Money in a Business Cycle Model." Discussion Paper 23. Federal Reserve Bank of Minneapolis.

_____, and Edward C. Prescott. 1980. "A Competitive Theory of Fluctuations and the Feasibility and Desirability of Stabilization Policy." In *Rational Expectations and Economic Policy*, ed. Stanley Fischer. Chicago: University of Chicago Press.

_____, and _____. 1982. "Time to Build and Aggregate Fluctuations." *Econometrica* 50, pp. 1345-1370.

_____, and _____. 1988. "The Workweek of Capital and Its Cyclical Implications." *Journal of Monetary Economics* 21, pp. 343-360.

_____, and _____. 1989. "Hours and Employment Variation in Business Cycle Theory." Discussion Paper 17 (August). Institute for Empirical Macroeconomics, Federal Reserve Bank of Minneapolis .

_____, and _____. 1990. "Business Cycles: Real Facts and a Monetary Myth." Federal Reserve Bank of Minneapolis *Quarterly Review* (Spring) pp. 3-18.

Long, John, and Charles Plosser. 1983. "Real Business Cycles." *Journal of Political Economy* 91, pp. 1345-1370.

Lucas, Robert E., Jr. 1972. "Expectations and the Neutrality of Money." *Journal of Economic Theory* 4, pp. 103-124.

_____. 1975. "An Equilibrium Model of the Business Cycle." *Journal of Political Economy* 83, pp. 1113-1144.

_____. 1976. "Econometric Policy Evaluation: A Critique." In *The Phillips Curve and Labor Markets*, ed. K. Brunner and A. H. Meltzer. *Carnegie-Rochester Conference Series on Public Policy*, Vol. 1. Amsterdam: North Holland, 1976.

_____. 1977. "Understanding Business Cycles." In *Carnegie-Rochester* Conference Series 5, pp. 7-29. Amsterdam: North Holland.

_____. 1980. "Equilibrium in a Pure Currency Economy." *Economic Inquiry* 18, pp. 203-220.

_____. 1987. *Models of Business Cycles*. New York: Basil Blackwell.

_____, and Nancy Stokey. 1987. "Money and Interest in a Cash-in-Advance Economy." *Econometrica* 55, pp. 491-514.

Mankiw, N. Gregory. 1989. "Real Business Cycles: A New Keynesian Perspective." *Journal of Economic Perspectives* (Summer) pp. 79-90.

Manuelli, Rodolfo, and Thomas J. Sargent. 1988. "Models of Business Cycles: A Review Essay." *Journal of Monetary Economics* 22, pp. 523-542.

McCallum, Bennett T. 1989. "Real Business Cycles." In *Modern Business Cycle Theory*, ed. R.J. Barro. Cambridge: Harvard University Press.

Plosser, Charles I. 1989. "Understanding Real Business Cycles." *Journal of Economic Perspectives* 3, pp. 51-79.

Prescott, Edward C. 1986. "Theory Ahead of Business Cycle Measurement." *Carnegie Rochester Conference Series*, Vol. 25, pp. 11-44.

Rogerson, Richard D. 1988. "Indivisible Labor, Lotteries and Equilibrium." *Journal of Monetary Economics* 21, pp. 3-16.

Rogoff, Kenneth. 1986. "Theory Ahead of Business Cycle Measurement: A Comment on Prescott." *Carnegie Rochester Conference Series*, Vol. 25, 1986, pp. 45-47.

Singleton, Kenneth J. 1988. "Econometric Issues in the Analysis of Equilibrium Business Cycle Models." *Journal of Monetary Economics* 21, pp. 361-386.

Solow, Robert M. 1956. "A Contribution to the Theory of Economic Growth." *Quarterly Journal of Economics* 70, pp. 65-94.

Stadler, George W. 1990. "Business Cycle Models with Endogenous Technology." *American Economic Review* 80, pp. 763-778.

Stockman, Alan C. 1981. "Anticipated Inflation and the Capital Stock in a Cash-in-Advance Economy." *Journal of Monetary Economics* 8, pp. 387-393.

_____. 1988. "Real Business Cycle Theory: A Guide, an Evaluation and New Directions." Federal Reserve Bank of Cleveland *Economic Review* (Quarter 4) pp. 24-47.

_____. 1990. "International Transmission and Real Business Cycle Models." *American Economic Review*, Papers and Proceedings (May) pp. 134-138.

Summers, Lawrence. 1986. "Some Skeptical Observations on Real Business Cycle Theory." Federal Reserve Bank of Minneapolis *Quarterly Review* (Fall) pp. 23-27.

Walsh, Carl E. 1986. "New Views of the Business Cycle: Has the Past Emphasis on Money Been Misplaced?" Federal Reserve Bank of Philadelphia *Business Review* (Jan/Feb) pp. 3-14.

Japanese Capital Flows in the 1980s

Reuven Glick

Research Officer, Federal Reserve Bank of San Francisco.

Editorial Committee members were Sun Bae Kim, Jonathan Neuberger, and Gary Zimmerman. Research assistance by Mary-Linda Chan is gratefully acknowledged.

Concern about the extent to which Japanese investors will continue to invest abroad has prompted attention to understanding the determinants of Japanese capital outflows. This paper discusses Japanese capital outflow trends and their determinants during the 1980s. It highlights the roles of excess Japanese savings, U.S. government budget developments, and Japanese financial market liberalization. It concludes that the massive Japanese capital outflows during most of the 1980s are likely to decline in the future.

During the 1980s Japan became the world's largest capital exporter. From a mere $10 billion in 1981, its net long-term capital outflows rose to a peak of $137 billion in 1987, before declining to the still substantial level of $89 billion in 1989. As the world's largest capital exporter, Japanese investors have been leading acquirers of U.S. securities and other types of debt, with net long-term capital outflows to the U.S. amounting to $54 billion in 1989.

Many policymakers, especially in the United States, have been concerned about the extent to which Japanese investors will continue to invest abroad, in general, and in dollar assets, in particular. If Japanese portfolios become too saturated with holdings of dollar assets, it is argued, Japanese investors will curtail their demand for U.S. assets and/or require larger risk premiums for continuing to hold these assets. Such behavior would adversely affect U.S. financial markets by inducing higher U.S. interest rates and a lower value of the dollar.

Understanding past and current determinants of Japanese capital outflows is important for evaluating the prospects for future outflows. The logic of macroeconomic accounting implies that Japan's capital outflows are the counterpart of its current account surpluses during the past decade. A country's current account is, in essence, the macroeconomic balance between national savings and investment. To the extent that a country runs a current account surplus by exporting (selling) more goods and services than it imports (buys), it must lend the difference to foreigners. It does so by investing and acquiring an equal amount of net claims on foreigners through its capital account. Correspondingly, a country that imports (buys) more than it exports (sells) must borrow the difference by issuing liabilities to foreigners. Thus U.S. capital inflows are the counterpart of U.S. current account deficits.

Most discussion of Japan's capacity and willingness to finance U.S. current account deficits has focused on trade in goods and services and factors that influence Japanese net exports and U.S. net imports of goods and services, such as relative price levels and income levels.[1] The logic of macroeconomic accounting, however, implies that capital flows are also important. It suggests that relative savings and investment levels and interest rates, factors

that more directly influence Japanese net demand for foreign assets, are important as well.

From this perspective, the accumulation of U.S. assets by Japanese investors need not be viewed as purely residual and involuntary behavior necessary to finance the ongoing excesses of U.S. imports of goods and services over exports. Rather the increase in capital outflows from Japan may at least in part have arisen for other independent reasons.

This article discusses recent trends and features of Japan's net capital outflows during the 1980s and the major factors that brought about their increase. It highlights the roles of both macroeconomic and microeconomic factors, particularly those independent factors that have directly influenced Japan's capital account transactions.

On the macro level, underlying the rapid Japanese accumulation of overseas assets during the 1980s has been the emergence of a large excess of domestic saving over domestic investment in Japan. Rising budget deficits and a corresponding demand for capital in the United States have played an important role as well. On the microeconomic level, the process of financial market liberalization in Japan permitted greater competition among individual financial institutions and allowed more Japanese investors to engage in international capital transactions.

The paper is organized as follows. Section I looks at the trend and composition of Japanese international capital account transactions. Section II discusses the role of macroeconomic factors for the rise in net Japanese outflows. Section III examines the role of microeconomic and institutional factors. Section IV discusses the outlook for the magnitude of future Japanese capital outflows.

I. Japanese International Transaction Trends

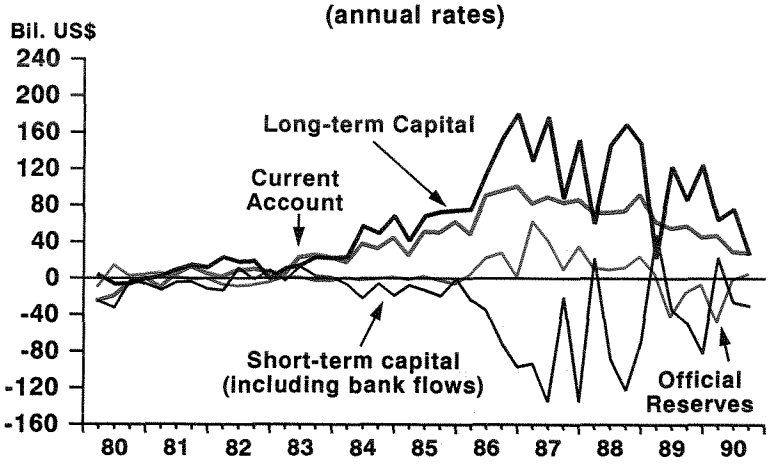
Current and Capital Account Overview

Table 1 presents figures for broad categories of Japan's international transaction flows for the period 1980-90.[2] As the figures indicate, Japan has experienced sustained current account surpluses since 1981. These surpluses have increased rapidly, rising from $5 billion in 1981 to a peak of $87 billion in 1987, roughly 4 percent of Japan's GNP. Since then the current account surpluses have declined.

The rapid rise in Japan's current account surplus since 1981 has had its counterpart in a greatly increased net outflow of capital, particularly in net long-term investments.[3] (Net long-term investments are defined as gross outflows of capital invested in foreign assets *minus* gross inflows of capital invested in Japanese liabilities, all with maturities of more than one year.) Net long-term capital account outflows rose from $10 billion in 1981 to $137 billion in 1987, before falling to $89 billion in 1989.[4] The partial data available for 1990 indicate that this decline in capital outflows is continuing.[5]

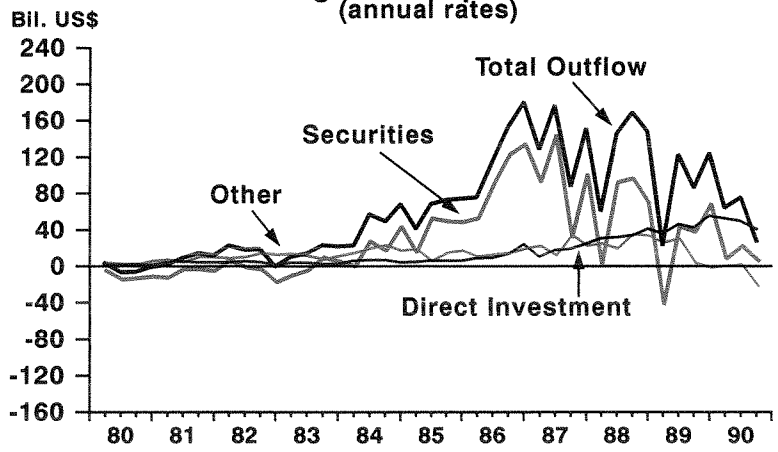
As shown in Chart 1, since 1981, Japanese net long-term investments have been consistently greater than the current account surpluses. Beginning in 1986, the magnitude by which long-term investment outflows exceeded the current account surpluses has been particularly large. This suggests that Japanese capital outflows reflect factors motivating a greater demand for foreign assets, in contrast to the

Chart 1
Japanese Net International Transactions
(annual rates)



Note: Positive values indicate current account surplus or net capital outflows.

Chart 2
Net Long-term Capital Outflows
(annual rates)



Note: 'Other' includes trade credit and loans.

view that Japanese investors have acquired foreign assets involuntarily merely to finance unbalanced trade in goods and services.

The net long-term capital outflows arising from the purchase of foreign securities by Japanese investors have generally been accompanied by net short-term capital inflows. (See Table 1.) Between 1986 and 1988 the short-term capital inflows were especially high. These capital inflows have been particularly associated with short-term foreign borrowing by Japanese banks.

Net movements in Japan's official reserve assets have reflected the foreign exchange intervention policies of Japanese monetary authorities. Prior to 1985 these movements were negligible. Between 1985 and 1988 Japanese monetary authorities generally accumulated foreign exchange reserves, particularly in 1987 ($39.2 billion) as a result of efforts to slow the appreciation of the yen. Thus in these years monetary authorities, in addition to private investors, helped finance Japan's current account surpluses. In 1989 this pattern reversed. Net reserve outflows amounting to $12.8 billion accompanied efforts to dampen the weakening of the value of the yen. Reserve outflows continued in 1990.

Composition of Long-Term Capital Flows

The changes in Japan's net long-term capital outflows during the 1980s primarily reflect movements in net securities outflows. (See Chart 2.) Japan's net direct investment outflows have increased steadily in recent years, but

Table 1
Japanese International Transactions
(Billions of dollars)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990*
Current Account Balance	−10.7	4.8	6.9	20.8	35.0	49.2	85.8	87.0	79.6	57.2	37.0
Long-term Capital, net	2.3	−9.7	−15.0	−17.7	−49.7	−64.5	−131.5	−136.5	−130.9	−89.2	−56.1
Short-term Capital, net	16.3	8.7	−1.5	−3.5	13.3	9.9	56.9	95.7	64.0	29.4	11.2
Bank-related	13.1	6.4	0.0	−3.6	17.6	10.8	58.5	71.8	44.5	8.6	9.8
Other	3.1	2.3	−1.6	0.0	−4.3	−0.9	−1.6	23.9	19.5	20.8	1.3
Official Reserves, net	−4.9	−3.2	5.1	−1.2	−1.8	−0.2	−15.7	−39.2	−16.2	12.8	12.8
Official Non-Reserves, net	0.2	−1.1	−0.2	−0.4	−0.5	1.7	2.0	−3.0	0.7	11.9	0.7
Errors & Omissions	3.1	0.5	4.7	2.1	3.7	4.0	2.5	−3.9	2.8	−22.0	−15.4

*Figures for 1990 are annualized from data for the first three quarters of the year.

Note: Positive entries indicate net capital inflows or current account surplus.

Source: Bank of Japan, *Balance of Payments Monthly* No. 291, Oct 1990.

still account for only about 20 percent of total net long-term capital outflows.[6]

On the outflow side, *gross* long-term foreign securities purchases rose from $3.8 billion in 1980 to $102.0 billion in 1986, fell off somewhat in 1987 and 1988, before rising again in 1989 to $113.3 billion. (See Chart 3.) Foreign securities investment averaged 72 percent of long-term capital outflows in 1986 and 1987, but fell to 59 percent in 1988 and 1989. Roughly 80 to 90 percent of Japanese *gross* foreign securities purchases have been in bonds, but a trend towards more stock purchases has recently emerged.[7]

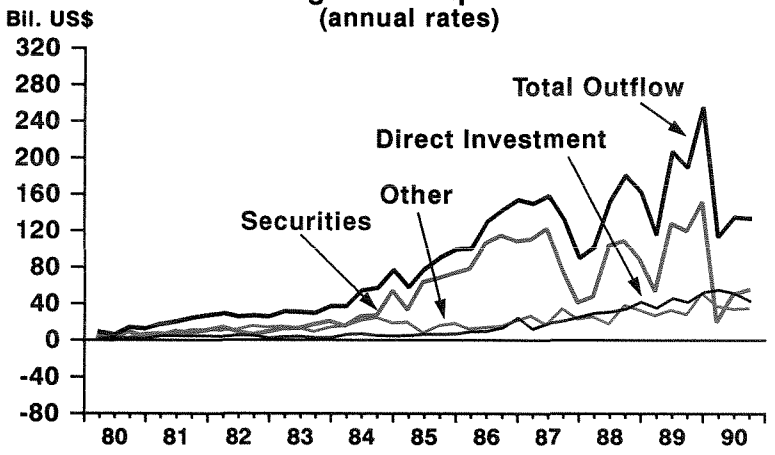
On the inflow side, purchases of Japanese securities have generally accounted for more than 90 percent of *gross* long-term capital inflows. (See Chart 4.) These securities inflows remained relatively constant from 1980 to 1985, averaging $13 billion per year. Since 1986 they have fluctuated more significantly, primarily in association with movements in Japan's stock market, and rose dramatically to $89 billion in 1989.[8]

Institutional Investors

As Table 2 indicates, most of Japan's foreign securities outflows are attributable to Japanese bank and nonbank financial institutions. Their purchases of foreign securities typically account for 60 to 70 percent of gross Japanese long-term securities purchases. The remainder is attributable to nonfinancial firms and individuals, for which detailed data are not available, and is calculated as a residual.

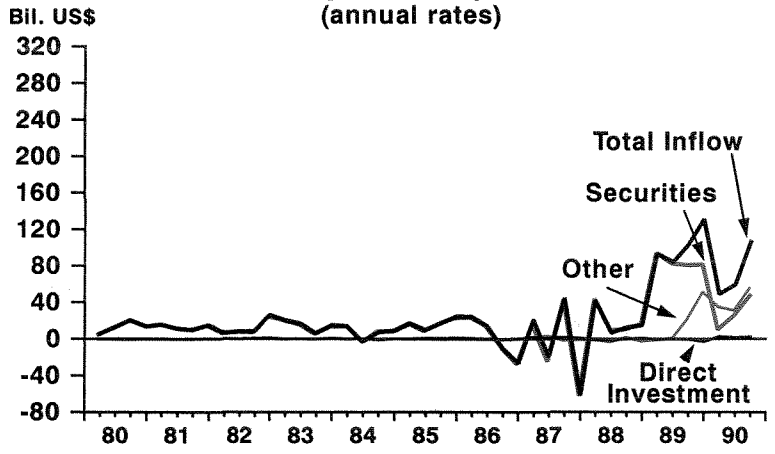
Chart 5 presents the ratios of foreign securities holdings to total assets for different types of financial institutions. With the major exception of securities investment trusts,

Chart 3
Gross Long-term Capital Outflows
(annual rates)



Note: 'Other' includes trade credit and loans.

Chart 4
Gross Long-term Capital Inflows
(annual rates)



Note: 'Other' includes trade credit and loans.

this ratio generally increased for all types of institutions throughout the past decade. This suggests that factors affecting the foreign investment behavior of Japanese financial institutions have been important determinants of Japanese outflows during the 1980s.

Despite the common trend of increase in the ratio of foreign securities to total assets, there are differences in the magnitude of the ratio of foreign securities to total assets among investors. In particular, as may be observed from Chart 5, the ratio is high for insurance firms, trust accounts, and investment trusts. The ratio for Japanese banks is relatively low. This suggests that factors affecting the allocation of funds among Japanese investors and their ability to invest abroad has played a role in the composition of Japanese capital outflows.

Geographic Composition of Securities Outflows

Where have Japanese investments been going? There are no comprehensive direct statistics on the currency composition of Japanese foreign securities investments, but indirect evidence is available.

Table 3 breaks down Japanese foreign securities investments, including both stocks and bonds, by the country in which they are acquired.[9] As the table indicates, although the United States continues to attract a high percentage of Japanese investment, the ratio peaked in 1985 at 56 percent and has since been declining, with a discernible sharp drop in 1989.[10]

However, a sizable proportion of overseas investments is in Luxembourg and the U.K., centers of Eurobond trading, particularly in Eurodollar securities. In fact, almost all of the investment in Luxembourg is in dollar-denominated Eurobonds. The total share of securities in the U.S.and Luxembourg, a rough proxy for dollar-denominated investments, peaked at 78 percent in 1985, but has slowly declined to 66 percent in 1989.[11]

Available data on the currency composition of foreign securities investments by institutional investors supports the general inference from the aggregate data that dollar-denominated assets dominate overseas Japanese investments. Deguchi (1987), for example, reports data on the composition of foreign investment by Japanese life insurance companies. He finds that at the end of 1986 these firms held 57 percent of their foreign investment in dollar-denominated securities.

The discussion in this section has identified several

Table 2

Securities Capital Outflows by Type of Investor

(Billions of dollars)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990*
Institutional, Total	5.5	6.5	7.6	10.9	19.8	36.5	70.2	47.6	43.6	84.5	55.6
Banks	0.8	1.8	2.9	2.6	7.4	13.8	15.0	7.8	3.5	23.5	25.1
Life Insurance Companies	0.5	2.0	3.1	4.3	3.8	3.9	15.0	21.0	21.4	29.6	12.8
Securities Investment Trust Companies	0.6	0.4	−0.2	0.3	2.5	3.3	13.5	1.6	5.0	0.3	−11.5
Other Trust Accounts	0.1	0.7	0.9	1.6	2.1	8.5	16.3	11.5	2.3	15.5	5.0
Other Insurance	0.9	0.2	0.4	1.0	1.0	0.9	2.1	2.6	2.3	4.5	3.9
Postal Life Insurance	0.0	0.0	0.0	0.8	1.5	1.6	3.1	3.5	2.1	1.7	1.9
Co-operatives	2.7	1.3	0.4	0.3	1.4	4.5	5.2	−0.3	7.0	9.4	18.3
Non-Institutional	−1.7	2.3	2.1	5.1	11.0	23.3	31.8	40.1	43.3	28.8	−13.9
Total Securities Capital Outflow	3.8	8.8	9.7	16.0	30.8	59.8	102.0	87.8	86.9	113.3	41.7

*Figures for 1990 are annualized from data for the first three quarters of the year

Note: Flow figures for institutional investors were calculated by dividing the change in year-end foreign security holdings valued in yen by the year-average dollar-yen rate. Noninstitutional figures were calculated as the residual from total securities capital outflow. Negative entries indicate sales exceed purchases.

Source: Institutional foreign securities investment data from Bank of Japan, *Economic Statistics Monthly;* exchange rate data from IMF, *International Financial Statistics;* total securities capital outflow data from Bank of Japan, *Balance of Payments Monthly.*

Chart 5
Foreign Securities as a Percent of Total Assets by Institution

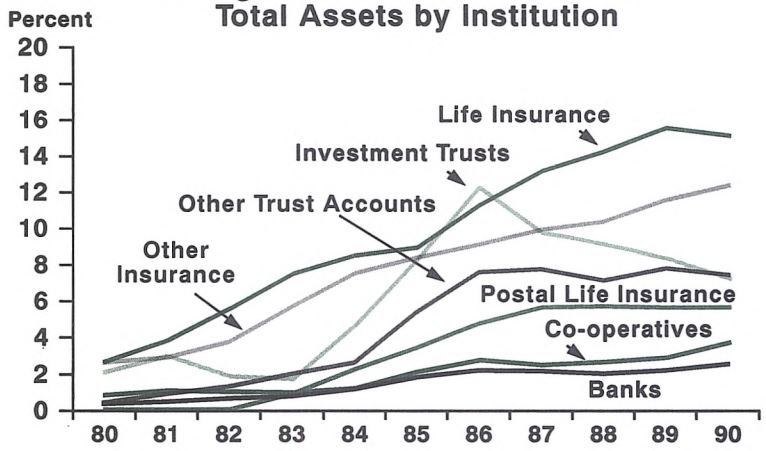


Table 3

Geographical Distribution of Japanese Securities Capital Outflows

(Billions of dollars, percent in parentheses)

	1981	1982	1983	1984	1985	1986	1987	1988	1989
U.S.	1.5	0.4	5.0	11.4	31.3	49.6	37.4	36.2	26.5
	(25.5)	(6.8)	(38.3)	(42.4)	(56.4)	(49.1)	(41.3)	(40.7)	(23.3)
Luxembourg	1.4	1.7	3.2	6.2	11.7	24.3	27.2	25.4	48.1
	(23.4)	(26.6)	(24.4)	(23.3)	(21.1)	(24.1)	(30.0)	(28.6)	(42.3)
U.K.	1.4	2.0	2.2	3.8	6.2	12.8	8.7	10.7	11.1
	(22.6)	(32.8)	(17.0)	(14.1)	(11.2)	(12.7)	(9.6)	(12.0)	(9.8)
West Germany	0.6	−0.1	0.2	−0.0	0.4	3.2	5.6	6.0	4.5
	(9.7)	(−1.5)	(1.3)	(−0.1)	(0.8)	(3.2)	(6.2)	(6.8)	(4.0)
Netherlands	0.2	−0.1	0.0	0.0	−0.1	0.1	0.5	0.8	0.3
	(2.7)	(−1.7)	(0.4)	(0.2)	(−0.1)	(0.1)	(0.6)	(0.9)	(0.2)
France	−0.0	0.1	0.1	0.0	0.0	0.4	1.0	0.6	3.9
	(−0.1)	(1.4)	(0.5)	(0.1)	(0.1)	(0.4)	(1.2)	(0.6)	(3.4)
Switzerland	0.0	0.0	0.2	0.9	0.5	0.1	0.4	0.9	1.2
	(0.5)	(0.7)	(1.4)	(3.5)	(1.0)	(0.1)	(0.4)	(1.0)	(1.1)
Australia	0.1	1.8	0.7	1.6	1.0	−0.3	2.4	1.8	1.5
	(1.9)	(28.4)	(5.5)	(5.9)	(1.7)	(−0.3)	(2.7)	(2.0)	(1.4)
Canada	0.8	0.1	1.1	2.1	2.2	6.6	2.5	1.4	4.8
	(12.4)	(1.5)	(8.0)	(7.7)	(4.1)	(6.6)	(2.8)	(1.5)	(4.2)
Others	0.1	0.3	0.4	0.8	2.1	4.2	4.8	5.1	11.8
	(1.5)	(4.9)	(3.2)	(3.1)	(3.8)	(4.2)	(5.3)	(5.8)	(10.3)
Total	6.1	6.2	13.2	26.8	55.4	101.0	90.6	88.9	113.7
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

Note: Excludes yen-denominated foreign bonds; includes foreign exchange-denominated bonds issued in Tokyo. Negative entries indicate sales exceed purchases.

Source: Ministry of Finance, *International Finance Bureau Yearbook,* (Kokusai Kin'yu Kyoku Nenpo).

major features of Japanese capital outflows. First, net long-term outflows have exceeded current account surpluses, particularly since 1986. Most of these outflows are associated with foreign securities purchases. Second, net short-term capital inflows have been significant, especially those associated with Japanese banks. Third, most Japanese institutional investors have significantly raised the ratio of their foreign securities to asset holdings. Lastly, most of these capital flows have been into dollar-denominated assets.

II. Macroeconomic Determinants of Capital Outflows

The growth and composition of Japanese capital flows during the 1980s may be explained by a number of factors. The macroeconomic factors, discussed in this section, include the emergence of excess domestic savings in Japan and growing U.S. government budget deficits, as well as changing exchange rate expectations and risk perceptions. The microeconomic factors, which include the effects of Japanese financial liberalization, are discussed in the following section.

Excess Japanese Savings

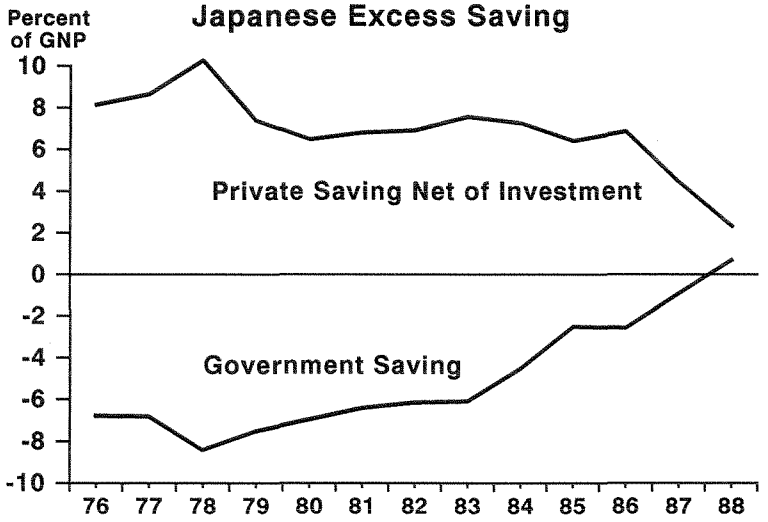
From national income account relationships, a country's net capital outflows equal its excess domestic savings. To the extent that a country saves more than it invests domestically, it must lend the difference to foreigners. It does so by exporting (selling) more goods and services than it imports (buys), running a current account surplus, and correspondingly investing and acquiring an equal amount of claims on foreigners through its capital account.

The domestic savings balance can be broken into a private saving balance and a government saving balance. Thus net capital outflows, and correspondingly the current account surplus can be expressed as the sum of the excess of private savings over private investment and of government tax receipts over government expenditures.

Chart 6 shows the patterns of private saving net of investment and government saving in Japan. Between 1980 and 1986, Japan's surplus of private saving over investment averaged nearly 7 percent of GNP. Although Japan's private savings rate has remained relatively high, compared to other industrial countries during this period the private savings rate actually fell.[12] However, declining domestic investment generally offset the drop, leaving private saving net of investment relatively unchanged.

The decline in investment through the mid-1980s can be attributed to the reduced domestic prospects for investment arising from a deceleration in Japan's long-run growth rate that began in the 1950s, and continued through the 1960s and 1970s. Kasman (1987), for example, estimates that Japan's potential real growth fell from 9 percent over the period 1967-1973 to 4.5 percent over 1976-1986. Other reasons that may have contributed to the drop in investment include higher real interest rates, diminishing returns to investment, and the rising price of urban land which caused residential construction to fall.

Chart 6
Japanese Excess Saving



The reasons for the decline in savings also included slower growth as well as the ongoing aging of Japan's population. Japan's birth rate has fallen significantly in recent years. In 1989, Japan's fertility rate fell to a post-war low; the average Japanese woman of child-bearing age had 1.57 children, down from 1.77 children in 1979 and 4.54 in 1949, well below the estimated 2.1 rate needed to prevent the population from eventually declining.[13] The resulting slower growth in the number of labor force participants who save relative to the number of people entering retirement who dissave has lowered the overall level of private saving.

With private excess savings relatively flat or falling for much of the 1980s, most of the increase in Japan's net capital outflows has been associated with an increase in government saving (that is, government receipts minus expenditures). Mainly because of reduced spending, the Japanese government budget deficit has declined steadily, since 1978, when it amounted to more than 8 percent of GNP. It fell throughout the 1980s and turned into a small surplus in 1988. This improvement in the government budget balance reduced the public sector's demand for domestic saving. Thus the shift in the flow of Japanese government saving, combined with relatively high domestic private saving and investment, resulted in excess Japanese savings, in effect providing the resources for foreign investment.

Since 1987, however, economic growth in Japan has boomed. Domestic investment rose to meet more favorable opportunities. As a result, the gap between private saving and investment fell sharply to 2 percent of GNP in 1988. (Later figures are not yet available.) The fall in the magnitude of Japan's current account surpluses and capital outflows that began in 1988 can be associated with this decline in excess savings.

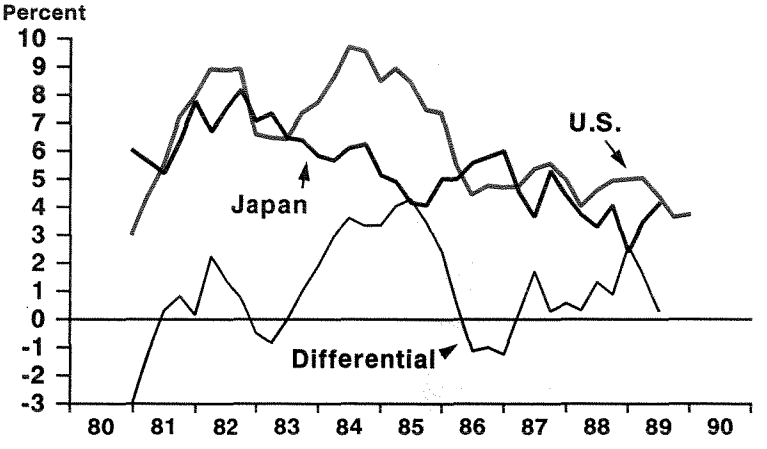
Financing U.S. Budget Deficits

In a global context, Japan's capital outflows are net capital inflows for the rest of the world. In the U.S., Japan's largest external debtor, rising budget deficits from 1980 to 1985 and corresponding demand for capital in the U.S. were also major factors in generating Japanese foreign investment.[14] The U.S. budget deficit, which averaged less than 2 percent of GNP in the 1970s, climbed to 5 percent of GNP following the 1981-83 tax cuts and defense buildup. This in turn pushed up U.S. real interest rates and attracted capital from abroad, which induced the appreciation of the dollar against the yen.[15]

The relationship between Japan and U.S. economic activity is evident in trends followed by real long-term interest rates during the 1980s. Chart 7 shows that U.S. real interest rates (adjusted for expected inflation, as proxied by the year-ahead actual change in prices) rose sharply in 1981 and remained well above Japanese rates over the first half of the decade.

The relatively higher return on U.S. financial assets boosted ex ante demand for U.S. assets from abroad. Declining Japanese government borrowing, combined with relatively loose monetary policy and falling interest rates reduced the supply and attraction of Japanese domestic investment outlets. This series of developments is consistent with the movement of net capital outflows from Japan

Chart 7
Japanese and U.S. Real Interest Rates



to the U.S. as well as the appreciation of the dollar that occurred from 1980 to 1985.

After 1985, however, the relative interest rate levels do not appear to explain Japan's pattern of capital flows as well. As observed earlier, Japan's net long-term capital outflows jumped substantially in 1986 to levels well above its current account surpluses. Short-term capital inflows rose sharply as well. It is precisely at this point in time, however, that U.S. budget deficits began to decline, U.S. interest rates fell, and the dollar began to drop. Other factors must therefore have been at work.

Other Macroeconomic Factors

Exchange rate expectations are another component of the overall rate of return expected by Japanese international portfolio investors and therefore of the relative demand for dollar and yen assets. That Japanese investors continued to desire to hold dollar-denominated foreign assets after 1985 even though the U.S.-Japan interest rate differential declined and the dollar depreciated can be explained by the possibility that expectations of future dollar depreciations were declining. In this instance, the smaller expected decline in the future value of the dollar against the yen would compensate somewhat for the lower relative interest return to holding dollar assets. Indeed, available survey evidence indicates that the expected one-year-ahead depreciation of the dollar against the yen averaged almost 11 percent over the period June 1981 to December 1985, and declined to 6 percent in October 1986 and to almost zero by February 1988.[16]

However, the results of more sophisticated empirical analyses produce mixed results about the sensitivity of Japanese foreign capital demand to exchange rate-adjusted interest differentials. Kawai and Okumura (1988) found Japanese capital outflows depended positively on the exchange rate-adjusted (nominal) interest rate differential between the U.S. and Japan during the period 1982-1983, but not during 1984-1987. Kawai (1989) found stronger evidence that Japanese stock demand for foreign financial assets depended significantly on the interest differential over the entire period 1982-1987. Ueda (1990), however, found that the interest differential explained only a small portion of changes in the foreign securities component of Japanese investment portfolios.

Another possible macroeconomic factor at work includes changes in perceived risk to holding foreign assets. Specifically, the continued accumulation of dollar assets by Japanese investors, by leading to an undesirably large share of dollar assets in their portfolios, may lead them to curtail their demand or to compel larger risk premiums for continuing to hold these assets. The econometric work cited above, using various proxies for risk, has found some evidence that since 1985 Japanese investors have responded more significantly to exchange risk.

There were, in fact, several episodes during which Japanese purchases of U.S. assets declined sharply. In late 1986 and early 1987, for example, anecdotal evidence suggests that Japanese private investors appeared to reduce their holdings of dollar assets markedly in response to high perceived dollar exchange risk. This decline in Japanese private investments was offset in part by an increase in Japanese official intervention. By 1988, however, Japanese private foreign investments resumed at earlier high levels.

While macroeconomic factors, including interest rate differentials, expected exchange rate depreciation, and perceived risk have, to varying degrees, explained aspects of Japan's pattern of capital outflows during the 1980s, these factors do not appear to explain all aspects of Japan's capital transactions. In particular, they do not fully explain the sharp rise in Japanese capital outflows and the emergence of short-term capital inflows beginning in 1986. Nor do they explain the behavior of institutional investors. To explain these features, we turn to microeconomic and institutional factors.

III. Microeconomic Determinants of Capital Outflows

Another major factor underlying the sharp rise in capital outflows in Japan during the 1980s has been the ongoing process of financial market liberalization. There were two aspects of this liberalization process: domestic deregulation steps that led to greater competition for funds among Japanese financial institutions, and the lowering of barriers to the integration of Japanese financial markets with world financial markets.

Domestic interest rate liberalization and the development of open securities markets in Japan beginning in the late 1970s induced depositors to shift their funds from low interest, fixed rate deposits to relatively high-interest, floating rate funds. The deregulation process was accelerated following a May 1984 U.S.-Japan agreement outlining specific actions for the Japanese government to liberalize further its domestic capital market by deregulating interest rates on large denomination deposits.[17]

The continuing liberalization of domestic capital markets increased competition among Japanese financial institutions for funds and accounts. As a result, Japanese

investors' demand increased for more opportunities to obtain higher returns and diversify their portfolios both domestically and internationally. Commercial banks, and other institutions dealing in financial instruments still subject to interest rates restrictions, suffered in their ability to raise funds domestically relative to other intermediaries, such as insurance companies and pension funds, which were able to offer unregulated financial instruments.

The relaxation in the early 1980s of previously stringent government controls on capital flows encouraged Japanese foreign investment. The revision of capital control regulations with the enactment of the Foreign Exchange and Foreign Trade Control Law in December 1980 generally eliminated restrictions on individuals and nonfinancial corporations, but ceiling restrictions on overseas investments by most Japanese financial institutions still remained.[18]

For example, investment trusts typically faced few or no regulatory restrictions on foreign investments.[19] On the other hand, life insurance and other insurance companies were permitted to hold a maximum of 10 percent of their assets in foreign securities (including yen-denominated foreign securities).[20] Most other financial institutions were prohibited from investing abroad. As a result, foreign securities investment by institutional investors was very limited.[21] For example, at the end of 1980 life insurance firms held only 2.7 percent of their total assets in foreign currency assets.

These restrictions were lifted gradually in the early 1980s. Pension trusts were allowed to hold foreign securities up to 10 percent of their assets in 1981. The Postal Life Insurance System (Kampo) was permitted to invest in foreign bonds up to 10 percent of its assets in 1983.[22] In 1984 holdings on foreign securities by certain trust funds were relaxed.

However, high U.S. real interest rates and remaining restrictions on institutional investors' behavior still pent up demand among institutional investors for foreign assets. In 1986, Japan's Ministry of Finance moved to increase the ceilings sharply and greatly expanded the opportunities for financial institutions to invest abroad. The limits on holdings of foreign securities by life insurance companies and pension trusts were raised from 10 to 25 percent of total assets in March 1986 and to 30 percent in August 1986. The ceiling for the Postal Insurance System was raised from 10 percent to 20 percent in the same year. Also in 1986 loan trusts were allowed to invest up to 1 percent in February and later (in June), up to 3 percent of assets in foreign currency bonds.[23]

As the authorities raised the percentage of institutional assets that could be invested, their foreign investment has soared. This trend suggests that much of the rapid growth in Japan's foreign asset holdings during the 1980s, particularly after 1986, in part represents a stock adjustment towards desired levels that for regulatory and other reasons were not previously attainable.

The propensities of insurance firms and trust accounts to invest abroad have been relatively high for several reasons. In particular, they have accumulated large amounts of funds to invest as the aging of the population has increased the demand for insurance and pensions. The elimination of most tax preferences on bank savings accounts in 1989 also induced a rapid shift of funds available to life insurance companies and trust funds. Consequently, over the last ten years there has been an upward trend in the ratio of assets in these institutions relative to the total assets of all Japanese financial institutions.

In addition, these institutions have long investment horizons and a strong preference for assets that bear high interest as a result of accounting rules that have generally limited policy payouts by life insurance companies, in particular, to coupon and dividend earnings from investments.[24] For most of the 1980s Japan's low inflation and accompanying low interest rates made it difficult to obtain high current returns by investing in domestic yen-denominated bonds. Moreover, most of the return on domestic equities came in the form of capital appreciation rather than dividends. This made investment in foreign currency securities with high coupons and dividend yields attractive for policy payoffs.[25] The desire to generate income from interest payments spurred investment in relatively high-interest foreign bonds and high-dividend foreign stocks, particularly in the U.S. for most of the 1980s, but also in Canada, Australia, and the U.K.[26]

Because of limits on allowable long-term foreign exchange exposure, Japanese bank purchases of foreign currency denominated securities have been relatively small in comparison to their total assets. At the same time continuing restrictions on deposit interest rates in Japan reduced the competitiveness of Japanese banks and their ability to raise funds domestically. Consequently, the growth of domestic demand deposits lagged behind loan demand. To supplement their domestic deposits, Japanese banks used borrowings from offshore branches in London and the U.S. It is estimated that in 1987 one half to two-thirds of the funds borrowed abroad by Japanese banks in the U.S. were reloaned to parent banks in Japan (Terrell 1990). This accords with the pattern of significantly high short-term capital inflows to Japan pointed out in Section I.

However, beginning in 1988, continued liberalization of

deposit interest rates payable in the domestic Japanese market increased the share of bank deposits with unregulated rates from less than 20 percent to almost 50 percent in 1989. As a result, foreign borrowing by Japanese banks has diminished significantly.[27]

IV. Future Japanese Capital Outflows

The rise in Japanese capital outflows during most of the 1980s is attributable to a combination of excess domestic savings, U.S. budget developments, and Japanese financial liberalization. The capacity and willingness of Japanese investors to invest more in foreign assets, particularly in the U.S., depends on how prevalent these factors will be in the future. Since 1988 there is evidence of significant decline in Japan's current account surpluses and capital outflows. This decline can be largely attributed to the dramatic rise in domestic investment between 1987 and 1989, combined with a continued fall in savings. However, extrapolating into the future is difficult.

Over the long run, the magnitude of Japan's excess domestic savings will depend significantly on demographic factors affecting Japan's savings rate, on investment trends, and on future Japanese government budget policies. Japan's birth rate is currently among the lowest in the world. It is estimated that over the next 30 years Japan's labor force could decline by as much as 10 million and that the proportion of the population over 65 years old will rise from its current level of 11.5 percent to above 20 percent.[28] The aging of the population is expected to reduce further the level of Japan's saving as the older dissaving population dominates the younger savers. This decline in saving in the long run will tend to reduce Japan's capital outflows.

Future investment and government policy actions are harder to project. Higher interest rates in Japan since 1989 have begun to dampen investment. The dramatic stock market decline in the first half of 1990 presumably is also having an adverse effect. Recent legislation intended to expand future Japanese fiscal spending should tend to reduce capital outflows. On balance, the excess of domestic saving over investment and new Japanese foreign investment should diminish during the 1990s.

The continued liberalization of Japan's financial markets will probably be a less significant factor for capital outflows in the future. The deregulation of Japan's domestic financial markets is continuing. However, barriers to international capital flows are virtually gone. In particular, ceilings on foreign securities holdings of Japanese institutions are no longer binding.

It is difficult, however, to evaluate how much future increase may occur in the desired portfolio share of foreign investments by Japanese investors. Some idea can be obtained by comparing Japanese portfolio share figures with corresponding figures in other countries. It is estimated that 6.5 percent of Japan's total securities were invested abroad in 1988, up from 4 percent in 1983. Even so, Japanese investors remain less diversified than investors in a number of other countries. For example, investors in the U.K. and Germany held 22 and 15 percent, respectively, of their securities abroad. U.S. investors held only 2 percent of their total securities holdings abroad, but this may be attributed to the greater diversification benefits provided by the U.S. economy.[29] This evidence suggests Japanese investors may want to diversify further into foreign assets in the future.

Other available evidence compares the shares of foreign investment in the total assets of private pension funds for 1980 and 1986 in several countries. This evidence indicates that the international diversification of pension funds has proceeded rapidly in the 1980s. In 1986, the U.K. had the highest share (20 percent) followed by Australia (15 percent); Japan held 10 percent. However, all other countries, including Canada, Switzerland, Germany, the U.S., and France, had lower shares than Japan. On the basis of this evidence, it is difficult to expect a continued rapid rise in the share of foreign investment by Japanese institutional investors in coming years. (See Fukao and Okina (1989)). Even without any further increases in the portfolio share of these investments, the magnitude of foreign securities purchases by Japanese institutional and noninstitutional investors is likely to remain high in the near future, as long as these institutions continue to receive new funds for investment.

In the near term, most Japanese investments should continue to be in dollar-denominated assets because of the relative thinness of other markets. Thus the desire of Japanese investors to acquire additional dollar-denominated assets at current yen exchange rates and interest differentials should not be underestimated. Nevertheless, Japanese purchases of U.S. securities likely will grow more slowly in the medium and long term as Japanese investors adjust their portfolios to include more European currency-denominated assets in light of developments in Europe, including the reunification of Germany and ongoing European Community financial reforms. Consequently, the U.S. will face greater global competition for funds than in the past. Accordingly, the terms of external finance for the United States may not be as favorable as in recent years.

NOTES

1. See, for example, Reinhardt (1986).

2. Figures for 1990 are for the first three quarters of the year and are expressed at an annual rate.

3. Japanese international transaction statistics follow a nationality definition of residency. Thus, for example, bonds issued outside Japan by Japanese residents are recorded as capital inflows. In contrast, U.S. international transaction statistics follow a geographic definition of residency. Consequently, they do not define bonds issued outside the U.S. by U.S. residents as capital inflows.

4. In 1986 and 1987 net long-term capital outflows averaged more than 6 percent of GNP.

5. There is some past evidence of a seasonal increase in demand for foreign assets by Japanese investors. Hence the annualized figures for 1990 based on data for the first three quarters of the year may underestimate the figures for the full year.

6. Japan's capital flow figures have become more difficult to interpret as more foreign securities investment takes place through the foreign subsidiaries of Japanese financial institutions, such as life insurance firms and trust banks. These flows are often reported either as direct investment flows or as loans from parent firms in Japan, rather than as securities investment flows. It is estimated that roughly one-half of all transactions by trust banks and one-third of all transactions by life insurance companies are conducted directly with overseas securities companies (Okumura, 1988). Thus some of the rise in gross direct investment and loan outflows from Japan (included in the "Other" category in Charts 2 and 3) in recent years may be due in part to these transactions.

7. A small portion of long-term foreign securities purchases are for bonds issued publicly in Japan by nonresidents, primarily denominated in yen (samurai bonds).

8. In 1988 and 1989, purchases of Japanese bonds also rose sharply, primarily due to a rise in the issuance of external bonds, i.e., yen-denominated or foreign currency-denominated bonds issued outside of Japan by residents.

9. It should be noted that these overseas investment figures from the Ministry of Finance exclude yen-denominated foreign bonds issued by nonresidents in Japan (samurais), but include foreign-currency denominated bonds issued by nonresidents in Tokyo (shogun bonds); the former are included in the Bank of Japan capital outflow statistics contained in earlier charts.

10. A major factor for the surge of investments in the U.S. in 1985 was the abolition in June 1984 of the 30 percent withholding tax on U.S. bonds held by foreign investors.

11. Much of the Eurodollar securities purchased by Japanese investors are in fact issues by Japanese firms. Investment in Eurodollar bonds was particularly facilitated by the liberalization in April 1984 of the conditions under which foreign-currency denominated bonds could be issued by Japanese residents. This allowed Japanese firms to issue them as swap bonds, that is bonds combined with long-term forward currency contracts. The Eurodollar bonds thus issued have been largely purchased by Japanese institutional investors.

Between 1987 and mid-1989 Japanese firms issued nearly $100 million in Eurodollar warrant bonds, which gave investors the right to buy the issuing firm's stock at a set price during a specified period. During the Tokyo stock market boom, warrant bonds provided Japanese firms a relatively inexpensive way to raise money, since investors were willing to accept lower interest payments in exchange for the right to buy stock below market prices.

Most of these warrant issues were in fact repatriated and reported as foreign bond and equity purchases by Japanese investors. Adjusting net foreign securities purchases for warrant repatriation reduces estimates of Japanese investment abroad by $5 to $10 billion each quarter in 1989. See Napier (1989).

12. Net household saving in Japan fell from a peak of 23 percent of disposable income in 1976 to 18 percent in 1980, 16 percent in 1985, and 15 percent in 1989. In 1989 the household saving rate was 12 percent in Germany and France, 6 percent in the U.S., and 5 percent in the U.K. (OECD *Economic Outlook*, June 1990, Table R 12, p. 192.) It should be noted that aggregate private savings include corporate retained earnings in addition to household savings.

13. The corresponding figure in 1989 was 1.87 for the U.S. and 1.28 for West Germany. (*U.S. News and World Report*, December 24, 1990 and *Economist*, January 26, 1991).

14. Glick (1988), using a two-country model of saving and investment behavior, estimates that the rising U.S. budget deficits explained roughly half of the increase in Japan's current account surplus between 1981 and 1986.

15. An alternative explanation sometimes given for the increase in U.S. real interest rates in the early 1980s is that U.S. investment demand increased in response to the more favorable treatment of business fixed investment in the 1981 tax bill. However, the supporting evidence for this view is doubtful. See Frankel (1988).

16. The survey evidence comes from the *Economist*-affiliated *Financial Report*. See Frankel (1988). That the dollar actually depreciated continuously against the yen from its peak in February 1985 through the beginning of 1988 resulted in significant foreign exchange losses for Japanese investors in U.S. assets.

17. The terms of the agreement were released in a document called the "Report of the Joint Working Group on Yen/Dollar Exchange Rate Issues."

18. Evidence of the role of the existence of residual controls on capital outflows from Japan is provided by the existence of a negative differential between the 3-month Gensaki interest rate that could be earned in Tokyo and the 3-month Euroyen interest rate that could be earned offshore in London. See Frankel (1984).

19. One set of funds, Domestic and Foreign Security Funds (Naigaisai) can invest both at home and abroad without any ceilings at all on foreign securities holdings. Other funds are limited to having no more than 50 percent of their total assets in foreign investments. Tokkin funds, in particular, face no restrictions on investing in high-yielding foreign bonds.

20. Foreign currency-denominated domestic bonds and foreign currency deposits were not subject to this limit. Between 1982 and 1986 limitations also applied to allowable increases in the purchase of foreign bonds as a percent of the increase in total assets; these limits were dropped in 1986. At the same time, limits on other foreign currency assets, such as deposits, real estate, and foreign currency denominated domestic bonds issued by Japanese firms (sushi bonds) became subject to the same limits in relation to total assets.

21. One response to the 10 percent limit on the assets of insurance and pension funds that could be invested abroad was investment in foreign currency-denominated bonds issued by Japanese firms abroad (sushi bonds). Such issues were treated as domestic issues in Japan and hence were not subject to the ceilings on foreign investment.

22. This limit did not include yen-denominated foreign bonds in the case of pension trusts. Capital outflow restrictions on the Postal Insurance system and the Postal Savings System are set by the Ministry of Posts and Telecommunications, not by the Ministry of Finance.

23. Investment in either domestic or foreign stocks is not allowed by loan trusts. The foreign investment ceiling for loan trusts was raised to 5 percent in 1989.

24. Capital gains from stock and bond purchases, could not be used for policy payments, but they could be used to offset foreign exchange losses.

25. One way around the restriction on capital gains was through foreign subsidiaries since profits repatriated through subsidiaries are considered income instead of capital gains. As a result, a number of Japanese life insurance firms have established foreign subsidiaries.

26. Because of their relatively low interest rates for most of the 1980s, DM and Swiss franc assets make up a negligible share of foreign securities holdings.

The capital gains restriction has led to charges that Japanese companies have at times played havoc with certain U.S. stocks that pay high dividends, such as utility companies. Japanese firms have often bought and sold foreign stocks simply to obtain the dividend payment, even if it meant taking a capital loss. The companies buy the stock just in time to claim the dividend and then sell it at a capital loss. Because more than one company has been able to claim the dividend on a single share of an American company on the same day, trading in such stocks was often remarkably heavy on the days in question.

27. To some extent short-term borrowing by Japanese institutions may also be associated with strategies to hedge foreign-exchange exposure of long-term foreign asset positions. The decline in foreign borrowing since 1988 may reflect greater use of off-balance sheet hedging strategies involving, for example, forward contracts.

28. *U.S. News and World Report,* December 24, 1990.

29. J.P. Morgan, *World Financial Markets*, November 22, 1989, "Government Bonds and Global Diversification."

REFERENCES

Deguchi, H. 1987. "Changing Life Insurance Companies" [Ookina Henbo o Togeru Seiho Kin'yuu Gyomu]. In *Changing Life Insurance: A Vision for the 21st Century (Henbosuru Seimei Hoken: Nijuu Isseiki eno Vision)*, ed. K. Seki. Tokyo: Kinzai.

Frankel, Jeffrey. 1984. *The Yen-Dollar Agreement: Liberalizing Japanese Capital Markets*. Washington, D.C: Institute for International Economics.

Frankel, Jeffrey. 1988. "Factors Determining the Flow of Capital from Japan to the United States." Working Paper No. 8872 (April). University of California, Berkeley.

Fukao, Mitsuhiro, and Kunio Okina. 1989. "Internationalization of Financial Markets and Balance of Payments Imbalances: A Japanese Perspective." *Carnegie-Rochester Conference Series on Public Policy* 30, pp. 167-220.

Glick, Reuven. 1988. "Saving-Investment Determinants of Japan's External Balance." Federal Reserve Bank of San Francisco *Economic Review* (Summer) pp.3-14.

Kasman, Bruce. 1987. "Japan's Growth Performance over the Last Decade," Federal Reserve Bank of New York *Quarterly Review* (Summer).

Kawai, Masahiro. 1989. "Japan's Demand for Long-term External Financial Assets in the 1980s." Institute of Social Science Occasional Papers (March). University of Tokyo. Forthcoming in the *Annals of the Institute of Social Science*.

_____, and Okumura, Hirohiko. 1988. "Japan's Portfolio Investment in Foreign Securities." Research Paper No. 9 (January). Japan Center of International Finance.

Napier, Ron. 1989. "Japanese Long-term Capital Outflow Declines in 1989." Mimeo (August 16). Japanese Stock Research, Market Analysis, Salomon Bros.

Okumura, Hirohiko. 1988. "International Money Flows and Capital Exports Through Portfolio Investment in Tokyo Financial Markets." Paper presented to U.S.-Japan Consultative Group on International Monetary Affairs, December 1-2, Washington, D.C.

Reinhardt, Vincent. 1986. "Macroeconomic Influences on the U.S.-Japan Trade Imbalance." Federal Reserve Bank of New York *Quarterly Review* (Spring) pp. 6-11.

Terrell, Henry. 1990. "Statement before the Task Force on the International Competitiveness of U.S. Financial Institutions." U.S. House of Representatives, Committee on Banking Finance and Urban Affairs (August 2).

Ueda, Kazuo. 1990. "Japanese Capital Outflows." *Journal of Banking and Finance* pp. 1079-1101.

Interstate Banking and Competition: Evidence from the Behavior of Stock Returns

Elizabeth S. Laderman and Randall J. Pozdena

Economist, and Vice President, Banking and Regional Studies, respectively. The authors have benefited from the comments of the editorial committee, Frederick Furlong, Sun Bae Kim, and Mark Levonian. We also would like to thank Deborah Martin for her skilled, enthusiastic, and dedicated research assistance.

In this paper, we empirically examine the response of bank holding company stock returns over the period 1964 to 1989 to changes interstate banking laws. We find that returns respond negatively and significantly to an increase in the number of eligible source states from which acquiring banking firms can enter the bank holding company's headquarters state. In addition, the negative effects are stronger in the absence of reciprocity requirements and weaker in the presence of a market that already is relatively competitive. We conclude that interstate banking tends to enhance potential and/or actual competition in state banking markets, particularly those formerly restricted.

Since the late 1970s, many states have enacted interstate banking legislation. These laws permit bank holding companies headquartered in selected other states to operate bank subsidiaries in their state. Recently, bills have been introduced in Congress to liberalize interstate banking laws to permit banks to operate their own branches across state lines.[1]

Proponents of such legislation argue that complete elimination of interstate banking restrictions would generate some significant benefits, including a more efficiently configured banking industry, and would invigorate competition in the commercial banking market. Opponents are concerned that interstate branching would lead to excessive concentration and ultimately to a less competitive banking market.

In this paper, we examine the effect of liberalization of interstate banking by studying individual bank stock returns over the period 1964 to 1989. The patchwork liberalization of interstate banking laws over this period had the effect of varying the number of states from which bank holding companies could enter various state markets. We find that individual bank stock returns reacted negatively to these legislative changes, consistent with the hypothesis that interstate banking increases potential and/or actual competition. For banks in general, this negative effect on returns appears to be stronger than any positive effects that would stem from potential economies of scale or scope or from the benefits of asset diversification.

The remainder of the paper is divided into five sections. In Section I, we discuss the legal background of interstate banking laws. In Section II, the theory regarding the potential effects of interstate banking is presented and we present the findings of previous researchers. Section III discusses the methodological approach that we employ, and the data used. We present the empirical findings in Section IV, followed by a discussion of policy implications in Section V.

I. The Legal Background of Interstate Banking

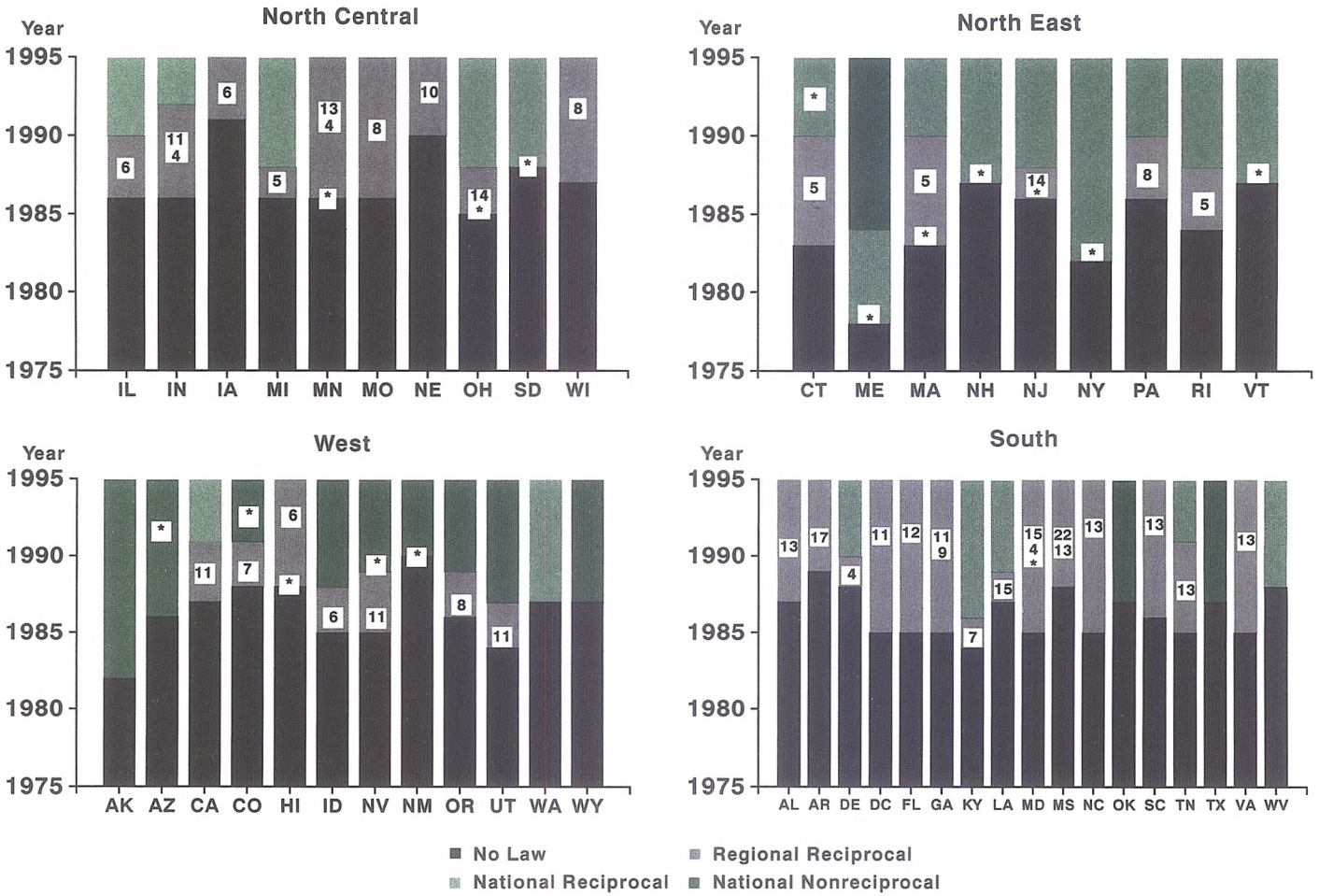
Interstate banking restrictions originate in laws passed earlier this century. The McFadden Act, originally passed in 1927 and amended in 1933, effectively prohibited interstate branching by giving the states, not the federal government, the power to decide whether any bank could establish branch offices within their borders. The McFadden Act has been interpreted to say that if state law is silent on the issue of interstate branching, then out-of-state banks are prohibited from establishing branches in-state.

The McFadden Act left open the possibility of a bank holding company having separately chartered bank subsidiaries in more than one state. This mechanism of interstate banking was foreclosed, however, by the Douglas Amendment to the 1956 Bank Holding Company Act. The Douglas Amendment prohibited bank holding companies from acquiring or establishing banks outside their home office state unless the laws of the state in which the bank was to be acquired or established explicitly provided for such entry. In effect, therefore, state law presently determines the extent of interstate banking.

Recent Liberalization

Beginning in the late 1970s, states have passed interstate banking laws that explicitly provide for the entry of out-of-state bank holding companies.[2] The mechanisms permitted by these changes in law involve outside ownership of in-state bank subsidiaries. It is important to note that these laws do not permit out-of-state banks to set up or acquire in-state branches. There are three main distinctions to be made among interstate banking laws. The first

Chart 1
Effective Dates for Interstate Banking Laws



*Law Implemented Allowing De Novo Entry
Numbers represent the number of eligible source states for regional reciprocal laws.
(GA, IN, MD, MN, and MS changed their laws to increase the number of eligible states.)

pertains to the geographic extent of the zone from which out-of-state bank holding companies may enter. Under "regional compacts," entry is permitted only from states in a surrounding region, with the boundaries of the region determined by the state passing the law. On the other hand, national interstate banking laws designate the entire country as the eligible region.

The second distinction pertains to whether the interstate banking law requires "reciprocity." All of the existing regional compacts and some of the national laws limit entry to those states in the eligible region that permit bank holding companies from the "host" state to enter *their* state.[3]

The third distinction pertains to the permissible means of entry. Some states permit entry via establishment of a new (*de novo*) bank subsidiary, while others require that entry be via acquisition or merger with an existing institution. It appears that all states that permit *de novo* entry also permit entry via acquisition.[4]

Many states have changed their original interstate banking laws. The effective dates for the different types of interstate banking laws for each state are shown in Chart 1.[5] In Chart 1, interstate banking laws are presented by region. Because many of the laws are regional reciprocal laws, this makes it easier to estimate the number of *actual* eligible source states as opposed to potential source states. As seen in Chart 1, changes have all been in the direction of liberalizing the restrictions on entry. For example, a state may move from a regional reciprocal law to a national reciprocal or national nonreciprocal law, or from a national reciprocal law to a national nonreciprocal law.

Chart 1 also shows the number of eligible "source states."[6] As seen in Chart 1, some states have enlarged considerably the number of potential source states in their regional compact over time.

Currently only Utah, Nevada, Rhode Island and Virginia permit interstate branching.[7] As stated in the introduction, though, legislation has been introduced in both the House and the Senate to repeal the McFadden Act, which would allow U.S. banks to branch nationwide irrespective of state law. The effect of such legislation, should it be adopted, is an open question. One purpose of this paper is to examine the experience of states with various types of interstate banking laws in order to infer the effects of interstate branching.

II. Theory and Previous Research

Because the empirical research in this paper concentrates on an examination of bank holding company stock returns, which depend on profitability, our discussion centers around the effect of interstate banking on bank profits. However, underlying the profitability effects are effects on bank costs and competition and accompanying effects on the consumer of bank services. By examining bank profitability, we hope to infer the relative importance of these potential cost and competition effects.

Theory suggests that interstate banking may either raise or lower bank profits. For example, interstate banking may raise profits by lowering costs, either through scale or scope effects or through diversification effects. First, to the extent that interstate banking restrictions are binding, banks may be forced to operate at a suboptimal scale or to offer a suboptimally limited range of services. Relaxation of the restrictions, therefore, might permit banking organizations to operate at a more efficient scale and with a more efficient scope. As a result, banks would have lower operating costs and, in the short run at least, higher profits. In the long run, though, we could expect at least some of these profit gains to be competed away, as consumers face more favorable prices.

A second effect of interstate banking on costs may arise from the diversification of bank portfolios. To the extent that bank portfolio risk is nonsystematic and that returns on any new assets are not perfectly positively correlated with the return on the existing portfolio, the expansion of business opportunities introduces the possibility of reducing risk by diversifying. If bankruptcy costs are at least partially borne by the bank, and if diversification is costless, then diversification raises expected profits and may eventually benefit consumers, too.[8]

Geographic diversification may not be without costs, however. The management of loan assets requires administrative input, monitoring of the borrower, and implementation of covenants and terms. Depending upon the costliness of these activities, the pure diversification advantages could be offset by the costs of administering and monitoring such varied and far-flung loans. Thus, like the scale economy effects, the effective impact of diversification advantages of interstate banking is ultimately an empirical issue.

Interstate banking may affect profitability through its effect on costs, as just discussed, or through its effect on competition. Theoretically, interstate banking could either strengthen competition, and lower profits, or weaken competition, and raise profits. On the one hand, interstate banking could lower profits by increasing the threat of competitive entry in regional banking markets. For example, incumbent banks may enjoy above normal profits if they can set "limit" prices that are above the competitive

level but low enough to deter entry. Entry will be deterred if there are significant learning economies, set-up costs, or other barriers that make entry into the region at or below the limit price unprofitable.[9]

By permitting entry from a larger pool of existing bank holding companies, the relaxation of interstate banking restrictions increases the probability that one of the pool will have low enough costs or a large enough store of wealth to enable the bank to enter and undercut the incumbents. Anticipating this, incumbents may lower limit prices in response to interstate banking liberalization, and thus experience lower profits. If they do not, the market may expect that actual entry will increase. Either way, the expected value of future profits will decline, to the benefit of consumers.

On the other hand, the mergers and acquisitions facilitated by interstate banking or branching could lead to a reduction in the number of banks in the nation and, thereby, decreased competitiveness and increased profitability. While this effect is possible, it relies on the assumption that the relevant geographic market is the nation as a whole. It seems likely, however, that the relevant market, for consumer or retail banking services, at least, is smaller than the nation.[10] Thus, even if interstate provisions decrease the number of banking firms in the whole country, they do not necessarily decrease (and may increase) the number of banking firms in competition for a region's consumers. Some banking products, of course, likely have effective markets larger than a region; business lending, for example, is probably not locally confined. For such services, it is possible that interstate banking would not increase competition, although foreign competition likely provides a safety valve against undue concentration of power.

We have discussed several hypotheses regarding the effects of interstate banking, but there are only two possible effects, if any, on profits—they will either go up or down. In our empirical work, we will study the effect of interstate banking on bank profitability and returns. If we observe that profits go up, it may be because interstate banking decreases costs, or decreases competition, or both. In this case, the effect on consumers would be ambiguous. However, if profits fall, this will suggest an increase in potential or actual competition, which would unambiguously benefit consumers.

A number of previous studies have attempted to evaluate the effects of interstate banking. In general, this prior research has focused on the portfolio or stock price performance of banks involved in mergers or acquisitions, or the comparative performance of interstate and noninterstate banking firms. We will now review some of this past work.

Cost Effects: Economies of Scale and Scope

Born, Eisenbeis, and Harris (1988) examined bank acquisition announcements. Using a standard market model of stock returns, these authors looked at whether the announcement of an agreement to acquire an out-of-state bank causes "abnormal returns" for the acquiring bank holding company.[11] They find no effect, and state that this suggests either that there are no benefits to interstate banking, or that the benefits are distributed to the shareholders of the acquired firm, as is the case in general, industrial mergers.[12]

Goldberg and Hanweck (1988) look directly for economies-of-scope advantages in interstate banking. These authors found that grandfathered interstate banking firms did not enjoy any long-run competitive advantage, in terms of market share or profitability, over similar sized noninterstate banking firms. Goldberg and Hanweck conclude that interstate banking firms, although they have the opportunity to engage in a wider range of activities, are not in general more efficient than comparable noninterstate banking firms.[13]

This finding is consistent with the conclusions of numerous, more general studies that have found that economies related to scale or scope are relatively small. For example, Berger and Humphrey (1990) used actual average costs for all insured commercial banks in 1984 to estimate the contribution of various factors to differences in average costs. They estimated differences of 25 percent or more in average costs between the highest and lowest cost groups of banks due to inefficient management, and differences of only 5 percent or less due to scale or product mix.

Cost Effects: Diversification

Other studies have examined the effect of diversification on bank performance. Liang and Rhoades (1988), for example, investigated whether increases in the geographic dispersion of bank offices decrease the probability of bank insolvency. Specifically, they examined whether the portfolio effects of asset diversification were outweighed by the effects of an increase in administrative and monitoring costs for the new assets. Liang and Rhoades' empirical results supported the conclusion that geographic dispersion does reduce the probability of bank insolvency.[14] Should insolvency costs be partly borne by banks, this, in turn, would imply that banks diversified interstate would enjoy cost advantages over nondiversified banks. Liang

and Rhoades also report, however, that geographic diversification was costly to administer; while reducing earnings variance, it also reduced average earnings. On net, though, diversification was not found to decrease the market value of the banking firm.

Evidence pertaining to the relationship between the geographic dispersion of bank offices and *actual* bank failures can be found in the work of Hilary Smith (1987). Using data from actual bank closures, Smith finds empirical evidence that intrastate branching restrictions, which limit branching to a confined area, increase the incidence of bank closure. One may reasonably extrapolate from this result to say that interstate banking has the potential to decrease the probability of bank closure.

Effects on Competition

In addition to effects due to economies of scale or scope, or geographic portfolio diversification, interstate banking may have an effect on the level of actual or potential competition. Adkisson and Fraser (1990) examined the effect of interstate banking laws on premiums paid in actual bank mergers, whether or not the merger was across state lines.[15] They hypothesized that interstate banking could have two countervailing effects on bank merger premiums in general. First, they say, interstate banking may increase competition, thereby lowering the market value of previously protected banking firms and lowering merger premiums. Second, they maintain, interstate banking may increase the number of potential bidders for a particular firm, thereby increasing merger premiums.

Adkisson and Fraser find that the second effect dominated the first effect; that is, bank merger premiums were larger in states that permit interstate banking. This does not mean that competitive effects are absent, of course, but only that they may be overpowered by the effects of rivalry among potential bidders for the (self-selected) sample of banks acquired. By focusing on actual mergers, therefore, the Adkisson and Fraser study cannot answer the broader question of what happens to overall levels of competition in bank product markets.

In summary, the available studies suggest that there are at best modest economies of scale and scope effects, but that the diversification effects of interstate banking may be significant.[16] However, it remains an open question whether interstate banking significantly enhances competition. To address this question, it is necessary to study the effects of interstate banking on all banks, not just those selectively involved in merger and acquisition activity.

III. Methodology and Data

The methodology employed in this paper is designed to determine whether relaxation of interstate banking restrictions enhances competition in commercial banking, or, alternatively, degrades competition and/or enhances efficiency. As explained above, these two alternatives would be expected to have opposite effects on bank profitability. Conceptually, we could make this determination by examining bank performance at a portfolio level before and after changes in interstate banking legislation. The prices of bank products and the level of bank profits could be examined for evidence of effects on costs and competition.

Unfortunately, the quality of price and portfolio information on commercial banks is not sufficient to support such a study. Bank product prices are difficult to obtain, and are not easily separated from changes in other, qualitative dimensions of bank products. Similarly, bank balance sheet and income statement data offer only imprecise measures of actual costs, net worth, and earnings because of the use of book value accounting practices in banking. Those data need to be studied in detail each quarter bank by bank, as is done by private bank stock analysts, to derive more accurate estimates of actual bank performance.

Consequently, we have chosen to study the effect of interstate banking on costs and competition by using data on bank stock price behavior. We would expect changes in profits to be capitalized in share prices and thereby show up as changes in returns. This approach implicitly relies upon the analytical assessments of the marketplace, which likely incorporate a greater information set than that available to the researcher. To the extent that stock markets efficiently incorporate this information, therefore, this approach offers greater potential precision than the direct study of prices or portfolio data.

There are important drawbacks to this approach, however. First, the stock price methodology confines our study to the set of banks with traded equity. At present, useful stock price data are available for fewer than 200 banking organizations. These organizations account for over 85 percent of total banking assets or deposits and, hence, the effects on these banks likely are the dominant effects in the banking marketplace generally. However, the self-selected nature of our sample implies that the results of our study are not easily generalized to the over 14,000 smaller institutions we were unable to study, and may be biased by large bank-specific effects.[17] Additionally, the relatively thin sample of banks limits the degree of detail on the regional banking environment that can be em-

ployed, because some smaller regions are not represented by traded banks.

The basic analytical method thus relates individual bank stock returns over time to variables representing the legal environment and general stock market conditions. The following basic system of equations describes the statistical analysis in this paper:

$$(1) \qquad R_{it} = a + bD_{it} + cM_t + e_{it}$$

where

R_{it} = the dividend-adjusted stock return for bank i in quarter t, measured using the closing stock price at the end of the quarter

= $(\text{Price}_{it} - \text{Price}_{it-1} + \text{Dividend}_{it})/\text{Price}_{it-1}$

D_{it} = a vector of variables, including dummy variables, that describe changes in laws in period t

M_t = the general stock market return

e_{it} = a disturbance term

and a, b, and c are estimated coefficients.[18]

Econometric Issues

A number of econometric issues arose in deriving a practical estimation relationship from this specification. First, it was anticipated that the effects of changes in the law would be unlikely to be captured by a simple, contemporaneous dummy variable. It is likely that effects of the laws would be anticipated, and that the full expected effects on competition would take time to materialize. Consequently, leads and lags of the explanatory variables, in addition to contemporaneous levels, were employed in the final specification of (1).[19] To economize on model parameters, a third-degree polynomial structure was imposed on the distribution of lead and lag parameters.[20]

Second, the issue arose of whether to use effective dates or passage dates for the law change variables. One might argue that, in a market with rational expectations, the effects of the implementation of a law would be fully capitalized into stock prices when the law is passed, or even prior to that. On the other hand, we have little confidence that we can determine the appropriate "announcement date," given that many analysts and insiders may have reliable information prior to when the law is actually passed. In contrast, the effective date of the law is precisely determined. Given these considerations, we estimated regressions using both the passage date and the effective date. However, we report detailed regression results for the effective date only.

Third, since the data environment is one of a pooled time-series of cross-sections (i.e., banks), the issue of efficiency of the coefficient estimates arises. The direct estimation of (1) on pooled time-series and cross-section data can result in inefficient (but unbiased) parameter estimates unless the coefficient vectors a, b, and c are constant across banks and over time. Unfortunately, the most general techniques for addressing this problem are not employable here because of our sample size, given our need to employ lagged explanatory variables. However, by introducing dummy variables for each time period and bank in equation (1), the importance of the cross-sectional and time-series parameter variation can be explored in a limited way in our sample.[21]

Fourth, it is unlikely that bank stock prices, or stock prices generally, are in equilibrium over time about a constant mean level. Thus, it is likely that the chance of a particular positive or negative deviation in stock prices has varied across our sample time period, which includes several record bull markets. The lack of stationarity can also be a source of inefficiency in parameter estimates. Most economic time series, however, can be made acceptably stationary by first-differencing. This is the rationale in (1) above for studying returns, rather than stock prices, in the model.

Fifth, unbiased estimation of the parameters on the interstate banking law variables, D, requires that the passage of these laws be statistically exogenous to the stock return variable. Similarly, the bank structure variables, S, also must not be endogenous to bank stock returns. In practice, it is unlikely that significant banking legislation or other structural aspects of banking markets are determined completely independently of the characteristics and condition of a region's banks. Thus, there is the potential for self-selection or simultaneous equations bias to be introduced if the law dummies are treated as exogenous.

In the context of this study, however, it is unlikely that this bias is significant since stock prices are likely to have capitalized any cross-sectional variations in legislative control by the banks; legislative changes likely take place in reaction to broader regional economic and banking conditions, and not quarterly variation in stock returns. Thus, in a statistical sense, the effect of legislative changes on stock returns is likely to dominate the reverse effect.

Finally, in a time series setting, the issue of bias in attrition or entry into the dataset must be considered. That is, banks that leave the sample (by failure or merger) or enter the sample (by virtue of being a new bank or by newly offering shares for public trading), may be different from

other banks. In the context of this study, attrition and entry are hypothesized to be an integral part of the process that will affect stock returns' reaction to interstate banking laws. Hence, no control for sample attrition or entry is attempted.

Data Considerations

An extensive database was assembled to test the effect of interstate banking laws on bank returns. Bank stock returns data were obtained from the Compustat data file. This data file contains share price and returns information for about 150 leading U.S. bank holding companies during the period 1964 to 1989.[22]

The resulting data are comprised of the quarterly observations on 174 bank holding companies.[23] Returns are calculated using the closing stock price at the end of the quarter (adjusted for stock splits) and the common dividend paid per share by the ex-dividend date. The CRSP tapes were used as the source for the overall market returns variable used in the empirical work discussed below. The daily returns on the Standard and Poor's Composite Index were converted to quarterly returns by summing the daily returns in each quarter.

Information on interstate banking laws was assembled from numerous sources, including a table from the *Banking Expansion Reporter*, a fact sheet obtained from the American Bankers Association, and Baer and Gregorash (1986). Specifically, data was assembled on features of the various state laws affecting interstate banking, and the dates of passage and the effective dates of these laws. The laws were classified as to their reciprocity conditions (Reciprocal versus Non-reciprocal), and their entry restrictions (Acquisition versus *De Novo*).[24] In addition, the number of potential and actual "source" states was calculated for each state at every point in time. Much of this information is summarized in Chart 1.

Information also was assembled on one aspect of the structural characteristics of banking markets. Specifically, information on intrastate branching restrictions for the year 1983 was obtained from the *Annual Statistical Digest* of the Federal Reserve Board of Governors.[25]

Anticipated Effects

The theoretical and data considerations resulted in an empirical implementation of (1) in the form of an ordinary least squares regression of bank stock returns on the explanatory variables in Table 1.

The emphasis of the estimation of the effects of the laws is on the variable called Change in States.[26] This measures the increase in the number of potential source states that results from the change in the law. (If there is no increase in the number of source states in this quarter over last quarter, this variable is zero.) If the market expects that interstate banking will have the predominant effect of increasing home state bank competition, an increase in Change in States should result in a reduction in returns to bank equity holders, and a negative sign on this variable. (In Table 1, column 3, this is referred to as the Rent Depleting Model, or RDM.)

Alternatively, liberalization could be perceived as working to the advantage of home banks by permitting them (to the extent they activate other states' reciprocal laws) to enter more states, thereby enhancing profits through diversification effects, or perhaps through scale or scope effects. Likewise, because liberalization would broaden the pool of potential acquirers, it might increase the potential diversification, scale, or scope benefits of merging with home banks. Finally, if competition were to decrease, surviving banks would all see increased rents. Whether such benefits would show up in the stock returns of home banks as acquirers, or as acquirees, this Rent Enhancing Model (REM in Table 1) would predict that the coefficient on the Change in States variable would have a positive sign.[27]

Note that the structure of the model implies that a positive change in the number of source states will have a stronger effect, the greater the change. This is consistent with the hypotheses discussed above regarding the sources of interstate banking's potential effects on costs and/or competition.

The two main variations in interstate banking laws are whether the law requires reciprocity and whether the law permits *de novo* entry. The effects of these variations are studied by interacting dummy variables with the Change in States variable.

The coefficient on the variable that interacts Change in States with the Reciprocal Dummy should reveal the extent to which reciprocity requirements influence the effectiveness of the increase in the number of source states.[28] The reciprocity requirement essentially makes the actual number of source states less than the potential number represented by the Change in States variable. To the extent that the main effect of interstate banking is pro-competitive (the Rent Depleting Model), we expect the sign on this interaction term to be positive. From the viewpoint of a home state bank as an acquisition target, however, reciprocity requirements limit the potential benefit to be gained from being acquired and, therefore, may modify any increase in stock price due to the Change in States variable.

For our purposes, the other main distinction among interstate banking laws is whether they permit *de novo* entry.[29] From the standpoint of the Rent Depleting Model, allowing *de novo* entry would be expected to enhance the pro-competitive effect of liberalization by affording an alternative means of entry beyond direct acquisition. A negative sign then would be expected on the interaction of the De Novo Dummy with the Change in States variable.

In practice, however, the *de novo* feature of interstate banking laws is unusual, and in our data set of traded bank stocks, data on the banks of Ohio, New York, and New Jersey dominate the actual instances of affected banks (although more states permit *de novo* entry). Thus, there is some possibility that the De Novo Dummy will simply capture the effects of particular conditions in these states. For example, intrastate bank competition already is very vigorous in these three states, so that allowing interstate entry may have very little procompetitive effect within the home states, but may, through reciprocal provisions, add to the ability of banks domiciled in these states to expand elsewhere, thereby enhancing their potential profitability and, hence, their expected return. To the extent that this is the case, the interaction of the De Novo Dummy with the Change in States variable would be detecting effects akin to the Rent Enhancing Model, and would be expected to have a positive sign.

We also interact the Change in States variable with a dummy variable indicating whether or not the state has statewide branching.[30] If the state has statewide branching, we can expect the level of competition to be higher than if it has limited branching or unit banking.[31] This would mean that the amount of excess profits that could be competed away with new entry would be less, and, consequently, that any drop in returns would be less. Thus, under the Rent Depleting Model, the interaction of the Statewide Dummy with the Change in States variable would have a positive sign.

Alternatively, under the Rent Enhancing Model, the existence of statewide branching, and, consequently, larger banking organizations pre-interstate banking, may mean fewer benefits to be had from scale or scope effects or diversification effects. Thus, under the Rent Enhancing

Table 1
Explanatory Variables

Variable Name	Description	Expected Effect (RDM = Rent Depleting Model; REM = Rent Enhancing Model)	Form in Regression
Change in States	The change in the number of source states that may enter the original state as the result of the law change.	RDM: Negative REM: Positive	3rd-degree Polynomial Distributed Lag: 3 leads, current, and 3 lags.
Reciprocal Dummy	Equals 1 if the law requires reciprocity and 0 otherwise.	NA	Interacted with other variables.
De Novo Dummy	Equals 1 if entry can be by de novo bank formation, 0 otherwise.	NA	Interacted with other variables.
Statewide Dummy	Equals 1 if statwide branching is permitted in 1983, 0 otherwise.	NA	Interacted with other variables.
State Change X Reciprocal	The Change in States variable multiplied by the Reciprocal Dummy.	RDM: Positive REM: Negative	3rd degree PDL: 3 leads, current, and 3 lags
State Change X De Novo	The Change in States variable multiplied by the De Novo Dummy.	RDM: Negative REM: Positive	3rd degree PDL: 3 leads, current, and 3 lags
State Change X Statewide	The Change in States variable multiplied by the Statewide Dummy.	RDM: Positive REM: Negative	3rd degree PDL: 3 leads, current, and 3 lags
Market Return	The market return, as measured by the Standard and Poor's Composite Index return.	Positive	Entered as a current variable.

Model, the interaction of the Statewide Dummy with the Change in States variable would have a negative sign.

The remaining variable in Table 1 is entered to control for general market conditions which may affect the realized return. The Market Return variable is intended to capture the time serial influence of the general market on bank stock returns. The coefficient on this variable can be interpreted as the "beta" of the bank stocks in our sample. Hence, it is expected that this variable would have a value near positive 1.0.

As shown in Table 1, we do not include the Reciprocal Dummy, the De Novo Dummy, nor the Statewide Dummy in the regression by themselves. Thus, the specification of the regression does not permit these variables to influence the constant term. However, we did estimate a simplified version of the regression with the dummy variables included by themselves, in addition to being included in interaction terms.[32] The results of this regression were consistent in all important respects with those of the main regression that we report below. In general, the coefficients on the dummy variables by themselves were insignificant, and the other coefficients were either insignificant or had the same sign as in the main regression.

IV. Regression Results

The results of the regression described above are reported in Table 2.[33] The coefficients from the full model are presented, along with a Partial Model that employs only the Change in States variable (along with the Market Return variable). The sample mean of the dependent variable is .0357. The regression results reported in Table 2 were obtained using the effective dates of the laws to date changes. The results using the passage dates were similar and will be discussed below.

The results strongly support the notion that the long-run effect of liberalized interstate banking is to enhance banking competition. We turn first to the Partial Model, which contains only the Change in States variable. The coefficients on the various leads and lags suggest that the effect of expansion in the number of source states has little effect on returns three and two periods prior to the implementation date, but, starting in the immediately preceding quarter, significantly depresses the affected banks' stock returns. This finding is consistent with the Rent Depleting Model of the effect of interstate banking.

Summing the coefficients on Change in States over the seven periods in the distributed lag formulation indicates the total effect, over time, of an increase in the number of eligible source states. The sum of these coefficients is strongly significant, and quite large. In effect, at the sample mean, one additional source state reduces affected banks' quarterly stock returns by about 3 percent for each of seven quarters.

The "beta" of stock price returns to the market is very close to one at .99 and is a significant contributor to the variance of bank stock returns.

In the Partial Model, the only parameter describing the law is the Change in States variable. In the Full Model, this variable is interacted with dummies measuring three other variations: reciprocal versus non-reciprocal (the Reciprocal Dummy), the case of allowed *de novo* entry versus prohibited *de novo* entry (the De Novo Dummy), and statewide branching versus restricted branching (the Statewide Dummy).

In the Full Model formulation, the coefficients on the Change in States variable by itself capture the case of a non-reciprocal, non-*de novo* law in a state with restricted branching. Consistent with the Rent Depleting Model, all of these coefficients are negative and significant, and many are strongly significant. Consequently, the sum of the various coefficients is negative and very strongly significant. The evidence suggests that the market reacts quite negatively to an increase in the number of source states.

If the broadening of interstate banking occurs in the context of a reciprocal law, however, the negative effects of an increase in the number of regional source states are not as strong. This is seen in Table 2, where all of the Change in States X Reciprocal coefficients are positive, and all but the third period lag coefficient are significant. The sum also is positive and significant. These results are consistent with the explanation given in the Rent Depleting Model that reciprocity requirements effectively limit potential entry.

The coefficients on the variable interacting Change in States and the De Novo Dummy are positive, yet insignficant, both individually and in their sum. It may be that a *de novo* provision does not significantly influence the effect of interstate banking laws, at least at the effective date. (Below, we will discuss the effect of *de novo* provisions at the passage date for the law.) On the other hand, as discussed above, the banks of only three states dominate the actual instances of banks in our sample in *de novo* states. Therefore, we may not have enough data to accurately isolate the effects of the *de novo* provision from any effects that may be particular to these three states.

Statewide branching appears to mitigate the negative response to an increase in the number of source states. All

of the significant coefficients on the Change in States X Statewide variable are positive, and the sum is positive and significant. These results are consistent with the prediction of the Rent Depleting Model that statewide branching leaves relatively little in the way of excess profits for interstate banking to erode.[34]

Both the Partial Model and the Full Model also were estimated using the dates when the interstate banking laws were passed instead of the dates when the laws went into effect. Throughout the following discussion, the reader should keep in mind that we have relatively little confidence in the accuracy of our passage dates. This does not mean that we do not know the dates when the laws were passed by the state legislatures, but rather, that we do not know the dates when the market began to assimilate the information that interstate banking legislation would be passed.

In most respects, the results obtained using the passage

Table 2

Detailed Regression Results

			Full Model		Partial Model	
	Variable	Lead/ Lag	Coefficient (xE-03)	t-ratio (abs. val.)	Coefficient (xe-03)	t-ratio (abs. val.)
1	Constant	0	18.04	13.58	18.23	13.67
2	Market Return	0	988.39	66.18	993.45	66.45
3	Change in States	+3	−1.27	1.83	.03	.10
4		+2	−2.52	5.19	−.28	1.20
5		+1	−3.50	7.26	−.82	3.49
6		0	−4.26	10.08	−1.39	6.50
7		−1	−4.82	9.61	−1.81	6.83
8		−2	−5.23	10.32	−1.88	7.04
9		−3	−5.52	6.92	−1.42	3.57
10		Sum	−27.11	13.73	−7.56	7.47
11	Change in States X Reciprocal	+3	1.95	2.15		
12		+2	2.63	4.08		
13		+1	3.05	4.79		
14		0	3.15	5.26		
15		−1	2.88	3.78		
16		−2	2.21	2.81		
17		−3	1.08	.85		
18		Sum	16.96	5.92		
19	Change in States X De Novo	+3	.38	.47		
20		+2	.71	1.21		
21		+1	.69	1.19		
22		0	.47	.87		
23		−1	.20	.29		
24		−2	.02	.03		
25		−3	.09	.09		
26		Sum	2.56	1.02		
27	Change in States X Statewide	+3	−.72	.92		
28		+2	−.26	.45		
29		+1	.13	.24		
30		0	.65	1.19		
31		−1	1.48	2.05		
32		−2	2.83	3.76		
33		−3	4.89	4.08		
34		Sum	9.01	3.41		
35	Adjusted R-squared		.32		.31	
36	Number of observations		9706		9706	

dates were consistent with the results obtained with the effective dates. In the Partial Model, all of the significant coefficients on the Change in States variable (the coefficients on the first, second and third period lags) were negative. However, although the sum of the distributed lag coefficients was negative, it was insignificant.

Most important, though, all the Change in States coefficients were negative and significant, as was the sum, in the Full Model with passage dates. In addition, the sum of the coefficients on the Change in States X Reciprocal variable was positive and significant, as before. The sum of the Change in States X De Novo coefficients was positive, as before, but, this time, significant. The sum of the Change in States X Statewide coefficients was positive, as before, but insignificant.

We have found that the market responds, in a qualitatively similar way, to both the passage and the implementation of interstate banking laws. This suggests not only that the passage of such laws constitutes new information, but that their implementation supplies significant *additional* information, information which reinforces the original response. This may be because, when the law is passed, there is considerable uncertainty concerning the environment in which the law will become effective, whereas there is no such uncertainty at the effective date.

In fact, our results suggest that, in some important ways, the response of returns to the laws' implementation is somewhat stronger than their response to the laws' passage, subject to our dating of passage and enactment. For example, in the Partial Model, the sum of the Change in States coefficients is significant when using the effective date but insignificant when using the passage date. In addition, this sum is slightly larger in absolute value and slightly more significant in the Full Model with the effective date (.027, with an absolute t-statistic of 13.73) than in the Full Model with the passage date (.019, with an absolute t-statistic of 12.31). Also, the branching status of the state affects the response at the implementation date, but not the response at the passage date.

Several factors might influence the absolute size and significance of these coefficients. For example, the amount of *new* information that is supplied to the market and the significance of the information for current returns would be important. The significance of a given amount of new information will be less, the more distant in time is any expected change in profits. This is because the present discounted value of a given adjustment in future profits will fall the farther off is the adjustment. This is one possible explanation for the relative size and significance of the coefficients on Change in States in the two versions of the Partial and Full Models.

An alternative explanation may be that we have a more accurate dating for the implementation than for the "passage" of the laws. The inability to pinpoint exactly when new information on interstate banking laws might have first appeared would contribute to the inefficiency of coefficient estimates in the passage date regressions. We have some evidence that this may be the case. We estimated a passage date regression with Change in States interacted with the number of days until implementation of the law included.[35] The capitalized value of future changes should be lower the farther away is implementation, so this interaction term should be positive, given negative coefficients on Change in States. We found that the interaction terms were indeed positive, but insignificant. This lends some support to the notion that we do not have an accurate measure of the passage date.

Despite this concern, the significance of the positive sum of the coefficients on Change in States X De Novo in the passage date estimation of the Full Model deserves some discussion. As mentioned above, it is likely that the states that empirically have incorporated *de novo* features may be those that already are highly competitive. Hence, the effect in those states of expanded interstate banking is more likely to be in the form of diversification advantages to the home state banks as they are now able to enter all of those states whose reciprocal banking laws permit such entry. Apparently this effect shows up at the passage date, and no additional significant effect shows up at the effective date.

V. Conclusion

The empirical work in this paper suggests that interstate banking, particularly when unrestricted by reciprocity requirements, tends significantly to enhance potential and/or actual competition in state banking markets.[36] There is little evidence to support the alternative hypothesis that interstate banking results in significant cost savings due to scale, scope, or diversification effects and/or consolidation that yields less competitive banking conditions. Bank holding company stock returns respond negatively and significantly to an increase in the number of eligible source states from which acquiring bank holding companies can enter. This effect shows up at both the passage date and the effective date of the interstate banking law, suggesting that there is new information that comes to the market once the law is actually implemented. In addition, the negative effects are stronger in the absence of reciprocity requirements and weaker in the presence of a market that is already relatively competitive, as indicated by statewide branching provisions.[37]

Conceivably, of course, the findings in this paper could evolve in the long-run as interstate consolidation proceeds. However, in the time frame of our data, the effects seem to evolve in a direction consistent with more, rather than less, banking competition over time. In addition, although depression of stock returns appears to be the overall effect of increasing the number of source states, there do appear to be conditions under which the returns of individual banks in particular states may benefit from liberalization of interstate banking. Thus, the overall impacts have some state-by-state variations, and stock analysts will have to examine the particular circumstances of further liberalization of state banking laws to discern their effects on individual bank stocks.

Finally, it is important to underscore the limitations of the empirical work presented here. The sample of banks studied here is not necessarily representative of the large number of small banks in the nation. Thus, although it seems that interstate banking increases competition among medium- and large-sized banks, its specific effects on small banks depends upon their competitive relationship with the larger banks in their states. Also, our focus on stock market returns, rather than the actual accounting experience of individual banks, leaves open the possibility that we have captured the market's expectations, but not the reality, about the long-run effects of interstate banking.

NOTES

1. See Trigaux (1990).

2. Maine enacted the first interstate banking law, in 1975. The law did not become effective, though, until 1978. It was a number of years before interstate banking was introduced in any other state; New York was the second, passing a law that became effective in 1982.

3. Oregon is the only state that ever had a regional nonreciprocal interstate banking law. In 1989, a national nonreciprocal law went into effect in Oregon.

4. Some interstate banking laws contain additional provisions such as ceilings on out-of-state control of bank deposits, minimum age requirements for the acquiree, required commitments by the acquirer to community reinvestment, or required capital-to-asset ratios for out-of-state acquirers. Also, some laws prohibit "leapfrogging," the entry by a bank holding company headquartered outside the eligible region, with only a toe-hold subsidiary in a state in the region.

5. As of 1989, Kansas, Montana, and North Dakota had no interstate banking laws, so they are excluded from the chart.

6. In Chart 1, the number of states in the eligible region corresponds to the number of *potential* states, whether or not those states have in fact met the reciprocity requirement.

7. See Zuckerman (1990) for a discussion of Utah's new interstate branching law. Nevada's law is somewhat restrictive in that it allows out-of-state banks to set up *de novo* branches only in counties with a population below 100,000. It is unclear whether the law will be interpreted to allow acquisition or merger with existing branches. (Source: Conversation with the office of the Commissioner, Financial Institutions Division, Nevada Department of Commerce.)

8. Whether a bank would choose to diversify so as to reduce risk would depend on a number of factors, including the risk preferences of shareholders, the risk preferences of bank managers, and the opportunities for shareholders to efficiently diversify their asset portfolios in the securities market. Bank managers' risk preferences are likely to be affected by the nature of bankruptcy costs and the existing system of deposit insurance. (See Boyd and Graham (1986) and Santomero (1984) for further explication of these issues.)

9. For example, regulators impose a barrier to entry by requiring experience in banking as a prerequisite for a new bank charter.

10. See, for example, Keeley and Zimmerman (1985).

11. A market model specifies a particular company's stock returns to be a function of returns on a well-diversified portfolio of stocks and, perhaps, of other factors correlated with aspects of systematic or nondiversifiable risk, such as interest rates. In an "event study," such as that used by Born, Eisenbeis and Harris, the effects of the events on stock returns are isolated by comparing returns around the time of the event with the returns predicted by the market model. The difference is labelled "abnormal returns" and is attributed to the effect of the event under study.

12. See, for example, Jensen and Ruback (1983). The Born, Eisenbeis and Harris finding also is qualitatively consistent with the finding in de Cossio, Trifts and Scanlon (1987). These authors find that bidding firms in bank acquisitions receive significantly higher abnormal returns when they are involved in intrastate as opposed to interstate mergers, while target firms earn significant abnormal returns from both intrastate and interstate mergers.

13. Similarly, Rose and Wolken (1990) found that, in unit banking and limited branching states, affiliation with a bank holding company generally provides no significant long-term competitive advantage (in terms of market share accumulation) for holding company subsidiaries over independent banks.

14. Liang and Rhoades calculate the probability of bank insolvency to be a function of the expected net-income-to-asset ratio, the capital-to-asset ratio, and the standard deviation of net income-to-assets.

15. The "premium" in a merger is the difference between the price per share of stock paid by the acquirer and the price per share just prior to the time that the possibility of a merger first became known to the public. In some cases, the premium is fully capitalized in the market price of the stock, and the acquirer pays a price per share corresponding to the market price. In other cases, the acquirer ends up paying more than the prevailing market price per share. Adkisson and Fraser proxy the base market value of the firm with the book value of the firm, and measure the premium as the ratio of the purchase price to the book value.

16. Despite the evidence cited suggesting the relative unimportance of economies of scale and scope, one might still reasonably maintain that such effects are indeed important. There are two potentially mitigating factors that bank cost studies may not adequately take into account. First, the FDIC's "too big to fail" policy undoubtedly favors large banks over small ones, and this may have the effect of decreasing large banks' cost of funds. Second, banks with large branch networks may be preferable, for reasons of convenience, from the bank customer's point of view. This may be true even though, for a given level of services, such banks may produce services no more efficiently than small banks.

17. As of December 31, 1985, there were 15,072 commercial banks in the United States. (Source: *Annual Statistical Digest*.)

18. A previous researcher, Chong (1989), has studied the effects of the passage of interstate banking laws on bank holding company stock returns. He estimated a two-factor market model, regressing individual daily bank

stock returns on a constant term, the market return, the twist of the yield curve, and interstate banking law announcement date dummies, interacted with all the other independent variables. Chong's inclusion of the market return and yield curve interaction terms in his regression seems somewhat arbitrary. It is unclear why, in theory, interstate banking would affect a bank's exposure to systematic risk at all. Chong finds that interstate banking increases banks' profitability and their exposure to market risk, but not interest rate risk.

Our model differs from Chong's in three respects. First, we look for effects in quarterly stock returns, not daily returns. A day seems too short a time frame in which to detect the effects of changes in laws. Second, we look at the response of returns around the date when the law goes into effect, as well as around the date when it is passed. Third, our specification differs in that we do not allow interstate banking to affect exposure to systematic risk, but we do, unlike Chong, allow different types of laws to have different effects. In addition, we allow the laws to have different effects in different environments. Because our model is significantly different from Chong's model, we do not expect that our results should accord with his.

19. We employed three leads, a contemporaneous term, and three lags in the specification of the model. Since our observations are quarterly, this structure allows for a relatively long period over which interstate banking law changes can affect bank stock returns. Such a large window is unusual in a traditional "event study." However, such studies usually examine the effects of events, such as merger announcements, that are hypothesized to have relatively certain consequences at certain times for certain banks. In contrast, our study examines the effect of an event whose effects, even in theory, are not as well-defined in these respects. Therefore, it seems to us reasonable to assume, *a priori*, that the effects will be spread out over a relatively long period of time.

20. The estimation of a polynomial distributed lag (PDL) formulation spares degrees of freedom by introducing a specific structure to the various lag coefficients. For example, using a third-degree PDL to estimate the coefficients in a ten-lag model reduces the number of estimated parameters from ten to four. The ten coefficients, w_0, w_1, . . . , w_9 are replaced by the formula

$$w_i = c_0 + c_1 i + c_2 i^2 + c_3 i^3 \quad i = 0, 1, 2, \ldots 9$$

where the cs are the four parameters of the polynomial to be estimated.

21. One technique is to introduce dummy variables for every cross-sectional observation and time period. Entered in the regression by themselves, they permit the intercept term, *a*, to vary across banks and over time. Additionally, cross-sectional dummies can be interacted with the explanatory variables, permitting the slope coefficients, *b*, *c*, and *d*, to vary cross-sectionally. We were able to examine time variation in the intercept, but, due to software limitations, we were not able to examine any variation in the slopes.

Alternatively, an error-components model can be estimated directly, permitting the error term e_{it} to be decomposed into cross-section specific, time-series specific, and mixed effects. This technique involves a generalized least squares estimation technique that is foreclosed by computation limitations and the necessity to include lagged explanatory variables.

22. The criteria for inclusion in the Compustat bank file are that the company's stock be actively traded and that the company has high investor interest. Deletions are effected upon mergers, suspensions from trading, and bankruptcy filings.

23. We have bank holding companies in 44 different states in our sample. Our sample does not contain any bank holding companies located in Montana, North Dakota, South Dakota, Maine, New Hampshire, Vermont or Kansas, but does contain at least one bank holding company located in Washington, D.C., which is treated as a separate "state."

24. We also classified the laws according to their geographic focus (Regional versus National). However, the effect of this distinction proved to be statistically insignificant, so we omit it from the reported regression results. Because we also included the change in the number of eligible source states as an explanatory variable in the regression, it is not surprising that the national versus regional distinction was insignificant.

25. In 1983, 19 of the 44 states represented in our sample had statewide branching.

26. There are 186 observations in our sample with non-zero values of Change in States.

27. It may be argued that, just as anticipated diversification benefits may cause an increase in the stock price of potential acquirers and/or acquirees, so may anticipated competitive benefits. The anticipated increase in profits due to entry into markets where competition had been lying dormant may increase the stock price of potential merger participants. However, we expect that the negative effects felt by those banks facing increased competition but not anticipated to be involved in mergers would outweigh any positive effects felt by potential merger candidates. On the other hand, we do not expect anticipated diversification to have any effect, by itself, on those banks that are not judged by the market to be potential merger candidates. Therefore, for the market as a whole, diversification should increase stock prices.

28. There are 174 observations in our sample with non-zero values of Change in States X Reciprocal.

29. There are 51 observations in our sample with non-zero values of Change in States X De Novo.

30. There are 76 observations in our sample with non-zero values of Change in States X Statewide.

31. Studies have shown that barriers to entry in the form of branching restrictions decrease competition in local banking markets. For a review of these types of studies, see McCall (1980).

32. As in the main regression, three leads, a contemporaneous term, and three lags were included.

33. The number of observations is the original number of observations in the sample, 10,868, minus any observations deleted owing to the lag structure of the model.

34. To test further the hypothesis that a relatively competitive banking market sees less of a negative impact from interstate banking, we also estimated the full model with a four-firm concentration ratio variable added. Like the dummy variables, this variable entered in interaction terms with the Change in States variables. The estimated coefficients on these interaction terms were insignificant, and the signs and significance of the other coefficients were unaffected.

The concentration ratio does not perform as well as the statewide branching variable. This may be because, even though, on a statewide basis, markets in restricted branching states are not highly concentrated, local market power may be substantial.

35. Both these regressions and the original Full Model regression with passage dates were complicated by the existence of legislation which specifies a regional law with a national trigger date. In such instances, both future changes were passed on the same date. Thus, there are two potential values for Change in States when using the passage date: the number of states that is to be included in the region, and the number of states that is to be added at the time when national interstate banking goes into effect.

In the original Full Model, we chose 50 for Change in States in instances when a regional law with a national trigger date was passed. In the model including the interaction terms involving the number of dates from passage to implementation, we defined two Change in States variables, as described above.

36. In a study of the effect of competition on bank charter values and risk-taking, Keeley (1990) found that liberalized interstate banking does not affect the level of competition. We do not believe that his result is directly comparable to our result, since he does not allow for different effects depending upon the type of law and the number of states that can enter.

37. In a recent paper, Black, Fields and Schweitzer (BFS) (1990) find results that are not entirely consistent with ours. They find that the passage of interstate banking laws increased the stock returns of regional banking organizations and decreased the stock returns of money center banks.

The authors attribute their results to the differential treatment of source states with and without money center banks. Initially, many interstate banking laws prohibited entry from states in which money center banks are headquartered. This means that, all other things equal, money center banks faced fewer instances in which their own states' passage of legislation enabled them, through reciprocity agreements, to enter other states. Thus, the authors seem to argue, the main effect of interstate banking legislation in states with money center banks is to lower stock returns through an increase in potential competition. In regional bank states, they seem to suggest, this negative rent depleting effect is more than offset by the positive effect of an increase in the number of target states (through reciprocity agreements).

We estimated regressions that controlled for bank size, and we did not find this to be a significant determinant of the qualitative effect of interstate banking legislation. Because money center and regional banks can likely be effectively distinguished by size, our results likely disagree with the BFS results; we seem to find a negative effect on stock returns for both money center and regional banks.

At least two explanations can be given for the difference in results. First, our evidence shows that it is important to look at both the passage and the effective dates, and to look at a relatively large window on either side of the event dates. (The BFS study uses a window beginning 30 days prior to passage and ending 30 days after passage.) Indeed, we too find positive (but individually insignificant) coefficients for the third, second, and first period leads in our Partial Model with passage dates, but the *sum* of lead, contemporaneous and lag coefficients is negative.

Second, the BFS control variable is based on bank stock returns in states that did not concurrently pass their own legislation. It is unclear to what degree the passage dates in the BFS data set coincide. If there is significant coincidence, the BFS methodology presents a potentially serious endogeneity problem. This is because the timing of interstate banking legislation in various states may be dependent on factors such as the condition of banks and the competitive environment in those states. These factors may also independently influence differences between bank stock returns, thereby biasing regression results.

REFERENCES

Adkisson, J. Amanda, and Donald R. Fraser. 1990. "The Effect of Geographical Deregulation on Bank Acquisition Premiums." *Journal of Financial Services Research* 4, pp. 145-155.

American Bankers Association. 1990. "Fact Sheet on Interstate Banking." Mimeo. ABA Office of the General Counsel.

Baer, Herbert, and Sue F. Gregorash, eds. 1986. *Toward Nationwide Banking: A Guide to the Issues*. Federal Reserve Bank of Chicago.

Banking Expansion Reporter. May 15, 1989.

Berger, Allen N., and David B. Humphrey. 1990. "The Dominance of Inefficiencies over Scale and Product Mix Economies in Banking." Finance and Economics Discussion Series No. 107 (January). Board of Governors of the Federal Reserve System.

Black, Harold A., M. Andrew Fields, and Robert L. Schweitzer. 1990. "Changes in Interstate Banking Laws: The Impact on Shareholder Wealth." *Journal of Finance* 45, pp. 1663-1671.

Board of Governors of The Federal Reserve System. *Various years. Annual Statistical Digest*. Washington, D.C.

Born, Jeffrey A., Robert A. Eisenbeis, and Robert S. Harris. 1988. "The Benefits of Geographical and Product Expansion in the Financial Services Industry" *Journal of Financial Services Research* 1, pp. 161-182.

Boyd, John H., and Stanley L. Graham. 1986. "Risk, Regulation and Bank Holding Company Expansion into Nonbanking," *Federal Reserve Bank of Minneapolis Quarterly Review* (Spring) pp. 2-17.

Chong, Beng Soon. 1989. "The Effects of Interstate Banking on Commercial Banks' Risk and Profitability." Unpublished manuscript. Washington University.

de Cossio, Francisco, Jack W. Trifts, and Kevin P. Scanlon. 1987. "Bank Equity Returns: The Difference Between Intrastate and Interstate Bank Mergers." In *Proceedings of a Conference on Bank Structure and Competition*. Federal Reserve Bank of Chicago.

Goldberg, Lawrence G., and Gerald A. Hanweck. 1988. "What We Can Expect from Interstate Banking?" *Journal of Banking and Finance* 12, pp. 51-67.

Jensen, Michael C., and Richard S. Ruback. 1983. "The Market for Corporate Control: The Scientific Evidence." *Journal of Financial Economics* 11, pp. 5-50.

Keeley, Michael C. 1990. "Deposit Insurance, Risk and Market Power in Banking." *American Economic Review* 80, pp. 1183-1200.

_____, and Gary C. Zimmerman. 1985. "Determining Geographic Markets for Deposit Competition in Banking." Federal Reserve Bank of San Francisco *Economic Review* (Summer) pp. 25-45.

King, B. Frank, Sheila L. Tschinkel, and David D. Whitehead. 1989. "Interstate Banking Developments in the 1980s." Federal Reserve Bank of Atlanta *Economic Review* (May/June) pp. 32-51.

Liang, Nellie, and Stephen A. Rhoades. 1988. "Geographic Diversification and Risk in Banking," *Journal of Economics and Business* 40, pp. 271-284.

McCall, A. S. 1980. "The Impact of Bank Structure on Bank Service to Local Communities." *Journal of Bank Research* (Summer) pp. 101-109.

Rose, John T., and John D. Wolken. 1990. "Geographic Diversification in Banking, Market Share Changes, and the Viability of Small Independent Banks." *Journal of Financial Services Research* 4, pp. 5-20.

Santomero, Anthony M. 1984. "Modeling the Banking Firm: A Survey." *Journal of Money, Credit and Banking* (November) pp. 756-602.

Smith, Hilary H. 1987. "Agricultural Lending: Bank Closures and Branch Banking." Federal Reserve Bank of Dallas *Economic Review* (September) pp. 27-38.

Trigaux, Robert. 1990. "Pressure Mounts to Allow Banks Free Branching." *American Banker* (June 25).

Zuckerman, Sam. 1990. "Utah Has Opened Door to Interstate Branch Banking." *American Banker* (July 2).