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Credit derivatives: Just-in-time provisioning for loan losses  
James T. Moser  
Credit derivative contracts offer a new route for managing counterparty exposures. This article discusses two formats of these contracts. The contracts have potential for providing portfolio managers with a cost-effective, just-in-time source of liquidity.

Assessing the condition of Japanese banks: How informative are accounting earnings?  
Hesna Genay  
This article examines the accounting and stock market performance of Japanese banks from 1991 to 1997. Overall, the results indicate that the accounting, disclosure, and regulatory practices of Japanese banks have driven a wedge between their accounting and stock market returns in recent years and, furthermore, that regulatory forbearance might have become a more important source of value to shareholders than the value of assets in place.

Foreign growth, the dollar, and regional economies, 1970–97  
Jack L. Hervey and William A. Strauss  
International markets are an important contributor to U.S. economic activity. U.S. regions have varying exposure to the influences of international markets—foreign demand or exchange rate movements. Still, the overriding determinant of regional economic growth is the state of the domestic economy.

The business cycle: It’s still a puzzle  
Lawrence J. Christiano and Terry J. Fitzgerald  
The business cycle is characterized by contractions and expansions in economic activity that are synchronized across a broad range of sectors. The authors provide evidence to document this, and survey some of the theories that have been proposed to explain it. Although much progress has been made, research in this area is still at an early stage.

Index for 1998
Credit derivatives: Just-in-time provisioning for loan losses

James T. Moser

Introduction and summary
Risk managers use a “peeling an onion” analogy to illustrate their prioritization of risk management activities. The resulting priorities have produced the contracting innovations needed to manage the outer layers of this risk onion. These tools are derivative contracts whose values are driven by changes in interest rates, equity prices, and foreign exchange rates. Having dealt with these outer layers, today’s risk managers are paying increasing attention to the inner layers of the onion, most especially credit risk. Furthermore, globalization of the financial markets is increasing diversification opportunities. To remain competitive in the global marketplace, financial institutions whose borrowers are concentrated in certain business or geographic sectors are seeking methods to improve their diversification of credit exposures.

The efforts of risk managers are proceeding on two fronts. First, they are developing methods to measure credit risk exposures. Three of the better known procedures for measuring credit exposures are the Expected Default Frequency metric developed by KMV, J. P. Morgan’s CreditMetrics, and Credit Suisse’s CreditRisk+. Second, risk managers are engineering derivative contracts to enable transference of credit risk exposures. This article examines some of these contracts and compares this new risk management route with a traditional route for managing loan loss exposures.

Descriptions of growth prospects for the credit derivatives market in terms such as “the next interest rate swap” stem from a confluence of events. Smithson (1997) points out that the first steps came as over-the-counter (OTC) derivatives dealers began to recognize the need to manage their credit exposures to one another. This recognition led to efforts to quantify and then to create structures controlling credit risk exposures. One such structure is the derivative product company (DPC), in which derivative contracts are booked in a subsidiary that then books an offsetting position with its parent. Such structures shift broad market exposures, most often to interest rates, from the subsidiary to the parent firm while retaining credit exposures to original counterparties at the subsidiary level. These structures are motivated by the need to raise the credit ratings of OTC dealers and improve their ability to compete for business. DPC structures isolate credit risk from other risk sources. This enables institutions to allocate capital directed at credit risk concerns. In addition, DPC structures motivate specialization in credit risk management.

Recently, attention has focused on transferring credit risk from one party to another using credit derivative contracts. Various contracting schemes are now labeled credit derivatives. The common feature of these risk management tools is that they retain assets on the books of originating institutions, while transferring some portion of the credit exposure inherent in these assets to other parties. This accomplishes several objectives. Originating institutions have a vehicle that transfers credit risk without requiring the sale of the asset. When asset sales weaken an institution’s relationships with its borrowers, a vehicle transferring only the credit exposure permits the institution to retain its relationship. In addition, the ability to reshape credit exposures through derivatives can
be used to improve diversification. For example, an institution with loan concentrations in a problem industry can lessen credit exposures by swapping its exposures in the problem industry for credits from a broader borrowing segment. Thus, following an oil price decline, the credit exposures from loans to oil exploration firms may be regarded as excessive. A credit risk swap reduces the institution’s concentration in these firms to achieve a more diversified loan portfolio.

Current regulatory policy toward credit derivatives does not recognize their risk reducing potential. Instead, it emphasizes their potential use as risk increasing instruments. Consequently, users receive only limited relief from regulatory capital requirements. Relief from regulatory capital requirements is available when credit derivatives are used to hedge assets held in bank trading books. For assets held in banking books, regulatory capital relief is less generous, limited to instances when the credit derivative gives a one-to-one match with the loss experience of individual banking-book positions. This treatment cannot be applied to portfolio positions held within the banking book. In addition, regulatory capital can be required for the credit derivative itself. If holdings of regulatory capital are costly, banks will generally find this treatment restricts their use of these contracts. In contrast, banks’ holdings of provisions against loan losses, a traditional method for managing credit risk, can be used to fulfill their tier two capital requirements.

In view of the potential for more cost-efficient management of credit risk, current regulatory policy toward credit derivatives needs reexamination. In this article, I compare the outcome from a credit derivative contract with that of loan loss provisioning, the more traditional method of managing credit risk. The comparison illustrates that under some circumstances, credit derivatives obtain the same economic outcome and, in these circumstances, can be afforded regulatory treatment similar to that of the traditional risk management method.

**Review of credit derivatives**

The variety of credit derivative contract forms can obscure the common role of these contracts as mechanisms to transfer credit risk between counterparties and the returns for bearing this category of risk. The British Bankers’ Association (BBA) surveyed the London market in 1996. The credit derivatives it encountered fell into four categories. Below, I review two of the more important contracting formats encountered by the BBA survey: total return swaps and credit swaps.

**Total return swaps**

Figure 1 depicts the payment flows for a total return swap. The swap exchanges the payment configurations of two counterparties—actual payments made between the two counterparties being the net of the respective payment configurations. The total return payor pays out based on the return from its holdings of a risky debt obligation or a portfolio of risky debt obligations. Total return for risky debt is the sum of an interest income stream and changes in the market value of the debt. The risk of these returns is the variability in this sum. Of particular interest for credit risk managers are bond defaults and changes in the prospects for subsequent default. Box 1 describes the relationship between changes in default prospects and credit risk. Clearly, if a bond defaults, returns from the bond are affected by a curtailment of interest payments. In addition, the value of the debt will be affected by market assessments of value recovered through bankruptcy proceedings. Prospects for future default on the obligation are typically characterized as ratings changes. Yields for risky debt adjust according to changes in these prospects, rising when payment prospects worsen.

![FIGURE 1](https://example.com/figure1.png)

The counterparty to a total return swap, the total return receiver, bases what it pays on the returns from a default-free obligation less the negotiated compensation for taking on exposure to the risky debt. It receives the return from the underlying risky debt. The result of the swap is that the total return payor obtains the income stream appropriate for a default-free obligation and the total return receiver obtains the income stream appropriate for holdings of risky debt. The reconfiguration of income streams is accomplished contractually rather than by exchanging ownership of the respective debt obligations.

Payments based on principal repayment are typically omitted in this contract format. Thus, the risk reduction for total return payors is largely the income loss from ratings downgrades, rather than the amounts recovered from defaults. Since vehicles to manage losses from changes in interest rates are well
known, I proceed with the assumption that the interest rate exposure of the risky debt obligation is fully hedged. This allows me to focus on the value fluctuations from changes in default risk.  

Suppose a bank’s holding of single-A, floating-rate debt pays 200 basis points over the reference rate. If the reference rate is 8 percent, then the borrower is obligated to pay 10 percent for that period. A credit rating downgrade of the borrower that decreases the price for that debt by 8 percent implies a total return of 2 percent. The receiver of the total return swap is due to be paid 2 percent for that period. The total return payor is due to receive the 8 percent reference rate less a spread amount of say 25 basis points, totaling 7.75 percent for the period. Payments are the net of these amounts, so the total return payor receives 5.75 percent. Combining this receipt with the 2 percent obtained from the payor’s debt holding gives a return of 7.75 percent. Therefore, the payor locks in a 7.75 percent return. The appeal for the total return receiver in the swap arrangement is the ability to participate in the return stream of the underlying debt obligation without investing in the bond itself.

As demonstrated, the total return swap increases cash flow certainty. The traditional bank management strategy achieves a similar end. Provisioning that invests some assets in default-free securities also achieves a lower bound for default losses. An important distinction is that the provisioning strategy maintains an inventory of liquid assets, while the credit derivative strategy delivers cash flows as losses are realized.

**Credit swaps**

Compared with the total return swap, the contingent payout feature of credit swap contracts comes closer to matching features usually associated with insurance contracts. As displayed in figure 2, fixed payors insure against credit events by making periodic payments of a fixed percentage of the loan’s par value. On occurrence of a predefined credit event such as a
loan default, the contingent payor makes a payment compensating the insured for part of its loss. Otherwise, the contingent payor pays zero.

Taking the defined credit event to be default on a debt obligation, a credit swap might be structured as follows. As before, suppose floating-rate debt rated at single A pays 200 basis points over its reference rate. The holder of this debt negotiates a credit swap to insure against loss due to default. The debt holder is a fixed payor in the contract, paying 10 basis points per period to the contingent payor. Should the debt issuer default on the obligation, the fixed payor receives a preset payment. Otherwise, the contingent payor pays out zero. The payment offsets the loss incurred due to the default. Contracts can be structured in many ways, for example, payment of a fixed amount on default or payment proportional to loss amounts.

In the case where the credit swap pays the difference between the loan principal value and the recovered amount, the credit swap limits the loss for the defined credit event to the value of loan principal. An investment policy combining default-free securities with risky debt can replicate this lower bound for loss. Thus, traditional loan loss provisioning combined with investing in default-free securities can duplicate the benefits of a credit derivative. The difference is that the credit derivative delivers cash flows on a *just-in-time* basis, while the provisioning strategy retains cash inventories. Once credit derivatives are understood as an alternative to traditional provisioning and investing methods, the choice between the two alternatives is one of cost effectiveness.

**Simple model for choosing between credit risk management tools**

Credit derivatives fulfill purposes similar to those achieved through traditional methods of credit risk management. Suppose a bank decides its exposure to credit risk is excessive. To lessen its exposure, it reinvests some of its cash flow in default-free securities such as Treasury bills. These investments will be labeled provisions for loan losses. In making this decision, the bank foregoes other lending opportunities. Therefore, its opportunity cost from the credit risk management decision is the foregone return from extending loans. I compare the bank’s use of funds for the loss provision and the credit derivative. When the credit derivative can be had at a lower cost than the funds outlay for a loss provision, the bank has an opportunity to extend its loan portfolio. The expected return from investing this difference in loans can exceed the opportunity loss when banks invest in low-risk, low-return assets.

**Opportunity cost comparison of credit derivatives and loan provisions**

In one period a loan currently valued at $I$ will have one of two values. In the up state the borrower repays the loan, giving the lender proceeds of $ul$. In the down state, the borrower defaults on the loan and the lender recovers the fraction $d$ of the amount due from the borrower. A one-period risk-free investment can be made that returns $r$ dollars for every dollar invested in the current period. It is natural to stipulate that in the up state the loan pays more than its current value and in default it pays less than its current value, so $ul > I > dl$. Further, since the loan is risky, its return in the up state is larger than a parallel investment at the risk-free rate, so $ul > rI$.

I assume an insurance contract can be purchased that pays the difference between the face value of the loan and its recovery value when the down state occurs. The price of this contract is based on the current price of the loan, the payoffs in the up and down states, and the risk-free rate of interest. I label this contract $l(I, u, u, d, r)$. I consider two investment strategies, provisioning and credit derivatives (as shown in table 1).

Strategy 1 is the provisioning strategy. If the loan defaults, the loss will be $1 - d$ dollars per dollar of loan value for a total loss of $(1 - d)L$ dollars. Investing the amount $(1 - d)L/r$ at the risk-free rate, the one-period payoff from provisioning is $(1 - d)L$ no matter which state occurs. The portfolio includes the loan that pays off $ul$ in the up state and $dl$ in the down state. In the down state, proceeds from the provisioning investment match the loss realized on the loan. Therefore, the bank has *prefunded* the loss and locked in $I$, the face value of the loan. In the up state, the bank realizes gains on both the loan and the provisioning investment.

Strategy 2 uses a credit derivative contract to insure against cash flow disruption. Like the provisioning strategy, proceeds from the credit derivative match the loan loss realized when the down state occurs.
With respect to the down state the bank is indifferent between the two strategies. Should the up state occur, the bank realizes $ul$ from the loan but proceeds from the credit derivative contract are zero. Comparing strategies 1 and 2 in the up state, the difference is the amount of the loan loss.

The bank’s decision requires comparing the time $t$ costs of its alternatives to obtain the up state outcomes. To facilitate the comparison, I stipulate the existence of additional lending opportunities matching those of the loan considered above. The expected return from these lending opportunities is denoted $r_w$. The bank has three investment alternatives: provisioning, lending, and insuring. It can fund its provisioning account with an outlay of $(1 - d)L/r$. If the cost of the insurance contract $I(L, u, d, r)$ exceeds $(1 - d)L/r$, the bank rules out the insurance contract. This is because the outcomes from insuring and provisioning are identical in the down state and the up state return from provisioning dominates insuring for positive rates of interest.

When the cost of the insurance contract is equal to or below the outlay required for the provisioning alternative, the bank weighs the risk-adjusted expected return from investing in loans earning the loan rate $r_w$ against the return from its provisioning alternative. The investable amount in loans is $[(1 - d)L/r - I(L, u, d, r)].^{10}$ The bank then chooses the larger of the risk-adjusted expected payouts from the two strategies. Since increasing its loans potentially improves diversification of the bank’s loan portfolio, the risk increase from new loans can be negligible.

Thus far, the comparison demonstrates that two inventory management methods can fulfill risk management requirements. The loan provisioning strategy corresponds to a static inventory by choosing inventory levels in anticipation of future liquidity needs. The credit derivative strategy corresponds to a just-in-time inventory management style by contracting for deliveries as needs for liquidity arise.

There are two other ways in which credit derivatives can potentially add value, first by improving the efficiency of capital allocations and, second, by acting as a form of reinsurance.

Regulators require that banks retain 4 percent tier one capital holdings against risk-weighted assets. In strategy 1 the bank must hold capital to support both the risky loan and the default-free security. Strategy 2 also includes the loan asset, but replaces the security investment with a credit derivative. When the capital required to support this asset configuration is less than in strategy 1, additional capital is freed up to support further lending activity. Is this a plausible scenario? Consider that regulatory agencies require capital holdings against interest rate risk. The investment in the default-free security increases interest rate risk and requires that capital be held. Therefore, the bank’s avoidance of credit risk increases its capital requirement for interest rate risk. The alternative, an insurance contract, creates no additional interest rate risk, therefore credit risk is managed on par with that obtained by the security investment but with a smaller required capital outlay. This rationale is similar to that for the DPC structure described earlier. In both cases, isolating credit risk from broad-market risks, such as interest rate risk, enables more efficient capital allocations.

Finally, credit derivatives can be seen as a form of reinsurance. Reinsurance markets exist to shift risks between intermediaries. These markets become necessary when geographic or other restrictions prevent intermediaries from maintaining sufficiently well-diversified portfolios. For example, a Florida insurance firm has excessive exposure to hurricane damages and a California insurance firm has excessive exposure to earthquake damages. A reinsurance contract exchanging their respective exposures improves the financial performance of both firms by increasing the diversification of each contract participant. Diamond (1984) shows that derivative contracts used to control exposure to common risks enable institutions to improve their diversification and lower certain costs. These reductions shift the margin for loans downward, increasing the level of loans taken by the intermediary. The reinsurance aspect of credit derivatives may provide an additional and possibly more efficient mechanism for achieving diversification.

**Cost of insurance**

Cox, Ross, and Rubinstein (1979) employ risk-adjusted probabilities to compute the expected payoff
from an option contract. The risk adjustment is obtained by choosing probabilities that are consistent with an arbitrage replicating the value of the option from investments in the underlying asset and a safe asset. Since the arbitrage is riskless, the expected payoff from the option is discounted at the rate for the safe asset. Recognizing that the insurance contract above can be construed as a put option, the value of the credit derivative can be obtained using the binomial approach developed by these authors.

Considering the insurance as a one-period contract remains useful. Further, assume that the loan being insured is a one-period loan that matures on the same date as the option. Restricting the insurance policy in this way avoids the need to incorporate the covariance between the riskless rate and the rate for risky debt. Therefore, attention is focused entirely on the credit risk aspects of the loan rather than on any interest rate risk. Under these conditions, the price of the insurance contract is

\[ I(L,u,d,r) = \left[ I^u(L,u,d,r) \frac{r-d}{u-d} + I^d(L,u,d,r) \frac{u-r}{u-d} \right] r, \]

where \( I^u() \) and \( I^d() \) are, respectively, the payoffs from the insurance contract in the up state and down state. Adding to the comparison between credit derivatives and loan provisions, the pricing model offers insight into the effect of interest rates on the credit derivative decision. As the level of rates for the safe asset rises, the level of funding required to provision against losses falls. In addition, the price paid for insurance declines. The rate of decline in the price paid for insurance is greater. This implies that as interest rates rise, the credit derivative alternative becomes increasingly attractive vis-à-vis the provisioning alternative.

This pricing model assumes that the outcomes for loans are not influenced by the purchaser of the insurance contract. More likely, insurance contracts will have greater appeal when the insured has a higher expectation of loss than the insurer. These information asymmetries, or adverse selection problems, imply that a premium will be charged for insurance contracts that fail to protect the insurer against her information disadvantages. Denoting this adverse selection premium \( \rho \), the price of insurance is \( I(L,u,d,r) + \rho \). Smith and Warner (1979) show that joint benefits give the insurer and the insured an incentive to minimize adverse selection premia. My results suggest that the common interests of these counterparties lead to contracts that reduce the bank’s opportunity cost by freeing up additional funds for lending.

However, resolving adverse selection problems is not without cost. Contracts structured on state variables determined outside the firm, such as a standard reference rate, can bypass adverse selection problems. However, use of a standard reference rate introduces basis risk. Basis risk for a credit derivative exists when the correlation between the drivers that determine payments due on credit derivatives does not match the loss experience for the insured debt. For example, a lender holding a loan issued by a specific corporation may find that the returns of a security within the same industry generally reflect the prospects of defaults within that industry. Such a security is likely to resolve the adverse selection problems. However, credit problems that are unique to the individual firm will not be reflected in the reference security so payments based on the reference security may not cover losses on the loans to the individual firm. So, the resolution of adverse selection problems is obtained at the cost of mismatches between payments on the credit derivative and loan performance. This situation introduces a margin between the cost of imperfect loss protection and premia paid for adverse selection problems. Understanding this margin enables an improved prediction of the types of credit derivative contracts that are most likely to succeed.

**Rationales for loan provisioning**

Kwan (1997) describes loan loss provisioning as a contra asset account. The size of the account is maintained at the level of losses the bank expects to realize. The size decision affects earnings in two ways. First, when a bank increases its provisions, it defers recognition of earnings. This has tax implications, reducing current taxable income. Later, as loan losses are realized, the provisioning account is written down and the previously deferred earnings are recognized along with the loan loss. Because the recognized loss amount and the now-recognized deferred earnings net to zero, loan losses reduce taxable income. Second, to the extent that earnings performance signals actual cash flow performance, then bank managers have incentives to manage earnings levels. For example, when the level of earnings may incorrectly signal future prospects, managers can adjust earnings to prevent unwarranted stock price changes. More straightforwardly, earnings figures will be managed when earnings are used to gauge the performance of bank managers.

Here, I construe loan loss provisioning as follows. The bank manages its exposure to credit risk by insuring that it has access to cash sufficient for its operating requirements. It can accomplish this by investing in assets that can be readily sold to obtain
needed cash or, as previously discussed, using a credit derivative to insure its access to cash. Consider a bank constrained from using a credit derivative that is choosing the portion of its earnings to be paid out as dividends. A large dividend payout reduces cash available for investment in default-free securities. By reducing its payout, it can increase its holdings of liquid assets. These asset holdings can be thought of as liquidity buffer stocks. Absent these sources of liquidity, the bank becomes more likely to be forced to meet its obligations through the sale of its less liquid loans.

The adverse selection premium described earlier amplifies the value of maintaining these buffer stocks. Banks unable to provide credible signals for their valuations of loans put up for sale will generally find that these loans must be sold at a discount to the bank’s assessed valuations. The difference between the market price and the bank’s valuation is the adverse selection premium, which compensates purchasers for the risk that the bank is selling its weakest loans. Such revenue shortfalls can impair the ability of the bank to meet its financial obligations. To avoid this outcome, the bank can sell inventories of liquid assets without a discount and use the proceeds to fund its other obligations. Then the bank faces an inventory problem. It must maintain an inventory of liquid assets sufficient to meet its future loan loss experience. However, investments made in this inventory generally yield a lower return than the bank’s other uses for its funds. So, the bank incurs an opportunity loss for maintaining an inventory of loan loss reserves. The previous section showed that credit derivatives mitigate this opportunity loss in certain circumstances.

In this sense, the credit derivative strategy can be construed as dynamically provisioning against loan losses. Contrast this with the static inventory allocation represented by loan loss provisions. With credit derivatives, the bank maintains an off-balance-sheet position that delivers funds as the needs arise, rather than maintaining a funds inventory. The just-in-time arrival of funds via a credit derivative contract fulfills the need for immediate funds to meet financial obligations. Like manufacturing firms that adopt just-in-time inventory systems, banks may find this a cost-efficient solution to funding their operations.

The value of this alternative inventory method should be included in the franchise value of the institution. When claims against this franchise value are limited to the bank’s owners, bank managers act for the owners in their inventory decisions. These agents add value when their allocation decisions use credit derivatives to reduce the opportunity cost of carrying inventories of lower-yielding liquid assets in place of higher-yielding loans.

**Policy implications**

The conclusions outlined in this article have implications for the regulatory policy afforded to credit derivative contracts. Below, I describe current regulatory policy on capital requirements. See Watterson and Bahlke (1997) for a more comprehensive treatment of the legal and regulatory issues involved in credit derivatives.

**Regulatory policy toward credit derivatives**

Regulatory capital is broken into tiers. Tier one capital, required to be no less than 4 percent of risk-weighted assets, is an institution’s net worth. Tier two capital includes these items plus other market issuances, but also includes provisions for loan losses subject to two limitations. The first limitation is that loan loss provisions included as capital cannot exceed 1.25 percent of gross risk-weighted assets. The second is that the total value of these provisions cannot exceed that of all other forms of tier two capital. With tier two capital requirements at 8 percent of risk-weighted assets, loan loss provisions are an important component of regulatory capital. Proponents of RAROC (risk-adjusted return on capital) and similar mechanisms argue that, on correctly risk-adjusted bases, tier two capital levels generally should be around 5 percent. This implies that institutions presently having excess balances of liquid assets are bearing a large cost for holding these balances. One can expect banks to seek to lower their costs by pushing for regulations that permit substitution of credit derivative contracts for loan loss provisioning.

The Bank of England published a provisional letter on credit derivatives in late 1996. British regulators classify bank assets as trading book or loan book. Capital charges for loan-book assets are larger, reflecting their lesser liquidity. The Bank of England judged the credit derivative market to be insufficiently liquid to permit the more favorable trading-book classification. To the extent that regulatory capital requirements are binding on these institutions, this view limits use of credit derivatives.

In the U.S., the Federal Reserve and the Office of the Comptroller of the Currency (OCC) have taken different paths. The OCC holds that the credit derivative market is too new to take broad regulatory measures. OCC regulators are concerned that moving too quickly would adversely influence the innovation process. They are conducting case-by-case evaluations of institutions’ credit derivative positions, responding as appropriate. Since these decisions involve proprietary
information, the trend in these decisions is not apparent. The OCC seems aware of the potential for increasing the efficiency of risk transfers and views its case-by-case approach as supporting this emerging market segment.

The Federal Reserve has published two guidelines on credit derivatives. In addition, a Federal Reserve economist is considering the potential for these contracts to increase systemic risk (Duffee and Zhou, 1998).

The first guideline published by the Fed was a Supervisory and Regulation Letter (SR 96-17) released in August 1996. This letter primarily covers credit contracts held in the banking book, so its application pertains primarily to end users of these contracts. It directs bank examiners to base capital requirements for a credit contract on the credit exposure of the reference asset. The letter makes an analogy between the present treatment of letters of credit and the Fed's intended treatment of credit derivatives; that is, ascertain the credit exposure of the underlying credit, determine the proportion of that credit exposure present in the credit contract, then apply the capital charge for credit exposures to the product of these. This treatment does not appear to recognize risk reductions obtained through holding a diversified portfolio of credits. In addition, the letter identifies counterparty default on the credit derivative as a credit exposure and requires capital on this risk, noting that this aspect will primarily affect dealers.

The second guideline published by the Fed was a Supervision and Regulation Letter (SR 97-18) released in June 1997. This letter provides guidance for examinations of trading accounts. For trading account positions, banks can use either the standard capital charge or a capital charge based on risk levels from an approved internal model. The letter categorizes trading-book contracts as either open positions, matched positions, or offsetting positions and identifies the types of risk for each: counterparty credit risk, market risk, and credit risk from the asset underlying the derivative contract. Open positions have exposures to all three risk types. Matched positions pose only counterparty credit risk, the other two risk types being offset. Offset positions, for example, positions whose payouts match in some but not all states, are similar but the latter two types of risk are mitigated not eliminated.

The letter directs examiners to classify positions according to this matrix and apply standard capital charges. Capital charges for counterparty risk apply the following rule: If the underlying reference credit is an investment-grade asset, the equity capital charge is used; if the reference credit is a speculative-grade asset, the commodity capital charge is applied. This treatment does appear to permit consideration of diversification. The relatively favorable treatment of credit derivatives for trading book assets vis-à-vis assets held in the loan book gives banks an incentive to move assets from the banking book to the trading book. The strength of this incentive is mitigated by the somewhat less favorable accounting treatment for assets held in the trading book.

**Economic consequences of current regulatory policy**

Excepting bank trading books, regulators have placed significant restrictions on the use of credit derivatives. Credit derivatives used to insure assets held in banking books, that is, most loans, must replicate the loss experience of the loan to obtain reductions in regulatory capital requirements. This restriction implies that banks incur the full adverse selection premium as if they had sold the loan. In addition, the bank can be required to hold capital against any counterparty risk encountered should the bank's counterparty fail to perform. Thus, the credit derivative strategy will generally be dominated by a strategy of selling loans. Therefore, institutions that have previously maintained inventories of loan loss provisions will generally find these preferable to credit derivatives.

The bank can use credit derivatives to hedge credit risk in assets held in bank trading books. Thus, credit derivatives can be adopted when the bank is willing to move assets from the banking book to its trading book. This change requires the bank to mark these loans to market. Historically, banks have been reluctant to mark loans to their market values. This reluctance implies that capital relief is unlikely.

Duffee and Zhou (1998) make an argument similar to that of Grossman (1988). The lack of transparency in the pricing of OTC transfers of credit exposures can result in inefficient risk-bearing decisions. Imagine a series of contracts linked in the sense that default on any one increases the odds of other defaults. Full transparency insures that investors can accurately assess the risk and return from investing in these contracts. Less than full transparency implies that some investors may underestimate risks so that capital costs for firms creating additional contracts are too low. This situation can result in excessive contracting activity. If contracts begin to fail and loss experience reveals the extent of oversupply, the market value of outstanding contracts declines. If these failures are seen as systemic, they could lead to social costs in the form of government-sponsored bailouts.
The problem can be solved if contract transparency is increased. However, making credit risk completely transparent requires revelation of proprietary information. The Fed solves this problem by relying on its bank supervisory functions to control the extent of this risk. Absent a change in this policy, Fed policy toward credit derivatives is likely to be determined by its bank supervision concerns rather than by concerns over transparency.

Exchange-traded contracts, on the other hand, can improve the transparency of credit derivatives, but the contracts must be written on observable benchmarks such as numbers of bankruptcies or bond prices. As pointed out earlier, the use of benchmarks for credit exposure involves basis risk.

Conclusion

I have shown that under certain circumstances, credit derivatives replicate the reduction in credit risk accomplished by loan loss provisions. Using a one-period insurance contract to illustrate the functions of a credit derivative, I compared the costs of credit derivative contracts and loan loss provisions. When the loan-provision amount is greater than the cost of the credit derivative, the bank can increase its loans. When the additional income from loans exceeds the risk-adjusted opportunity cost of the loan provisioning, the bank will find that credit derivatives dominate loan loss provisions.

I then priced the insurance contract using the binomial model of Cox, Ross, and Rubinstein (1979). This price represents a lower bound for the insurance contract. Credit insurers will require compensation for any adverse selection. Smith and Warner (1979) explain the existence of joint benefits from contracts structured to mitigate contracting problems. One solution to this adverse selection problem is the specification of drivers for contract cash flows determined outside the bank. Use of an externally determined driver will generally be less well correlated to the loss experience of any single institution. This creates a tradeoff between the adverse selection premium and the cost incurred when the credit derivative fails to cover the loss experience, that is, basis risk.

A contribution of this article is the identification of two problems faced by the emerging credit derivative contract market. The first is the reluctance of bank regulators to permit relief from regulatory capital requirements. The second is that contracts that successfully avoid adverse selection problems are likely to have broader appeal. These will generally be contracts whose payouts are determined by performance indexes mimicking the loss experience of many institutions. It follows that liquidity will be greatest for contracts based on external drivers, further increasing their cost effectiveness over other forms of credit derivative contracts.

I have shown how credit derivatives can be used to lower the capital costs of banks, in particular, their costs for holding regulatory capital. I have also shown that credit derivatives can replicate the cash flows provided by provisioning for loan losses. When this insurance function is accomplished at low cost, the bank can increase its lending activities. Thus, outlays made for credit derivatives can dominate the returns offered by the safe-asset holdings generally used for loss provisioning purposes.

Notes

1KVM are the initials of the three founding partners of the KMV Corporation, Steve Kealhofer, John Andrew McQuown, and Oldrich Vasicek. Their method is described in McQuown (1993).

2Both an overview and a technical description of CreditMetrics are available on the Internet at www.riskmetrics.com/cm/index.html.

3For detailed coverage of this product, see the Internet site at www.csfp.esh.com/csfpod/html/csfp_10.htm.

4This article covers the use of credit derivatives by financial institutions. Frost (1997) describes corporate use of these contracts.

5For a thorough description of the DPC structure, see Remolona, Bassett, and Geoum (1996).

6This concern is not without merit. Hartmann (1996) points out that credit derivatives offer a speedier route for increasing credit risk exposure. Banks may be tempted to use this route to gamble for resurrection when capital levels are low.

7Certain accounting and tax benefits can also be derived by retaining title to the underlying assets.

8Implicitly, the covariation between the interest rate and default probability is also presumed to be zero.

9This is a more restrictive policy than the accountant's use of this term. A later section further develops the idea of loan loss provisioning.

10This case can also be made by pointing out that the bank can now choose between the linear combinations of default-free investments earning r and risky loans earning r_f. The bank will generally value this expansion of its opportunity set.
13This view raises the concern that financial institutions prohibited from engaging in insurance activities may be prohibited from participating in credit derivatives.

12An example of the Diamond intuition is the following. A bank is constrained from accepting new loans because it is at its total allowable level of risk. Were the bank able to increase its lending, a portion of its present risk level could be eliminated through diversification. A derivative can be used to reduce its exposure to undiversifiable risks, allowing the bank to then increase lending and lessen risk through diversification.

11When the up state pays zero, this point can be understood through the insurance pricing equation above. Since both the provisioning outlay and the credit derivative are discounted at r, this interest rate impact is the same for both alternatives. However, the down state payoff is also weighted by a term that includes u − r in the denominator. As r rises, the weight declines increasing the effect of an interest rate change on the credit derivative.

10Net worth is the residual of assets after subtracting the payments owed to all holders of non-equity claims; that is, depositors and owners of debt. For purposes of this discussion net worth can be construed as the value of the equity claims on a publicly owned institution.

1The Financial Services Authority (FSA) has taken over supervisory responsibility for UK banks. Releases by the FSA appear to conform with the earlier policy defined by the Bank of England. The releases are Board Notice 482 and Board Notice 414.

18For example, the Chicago Mercantile Exchange recently announced a futures contract on personal bankruptcies.

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Assessing the condition of Japanese banks: How informative are accounting earnings?

Hesna Genay

Introduction and summary
There is little doubt about the current weak condition of Japanese banks. Although they were never as profitable as European or U.S. banks, Japanese banks grew rapidly in the 1980s, buoyed by a strong domestic economy and rapidly increasing asset prices. In 1980, only one Japanese bank made the list of the ten largest banks in the world, compiled by The Banker magazine. By 1990, the four largest banks, and six of the top ten, were Japanese. Moreover, the rapid growth of Japanese banks was not confined to domestic markets. According to statistics compiled by the Bank for International Settlements (BIS), the share of Japanese loans in total international claims outstanding was less than 20 percent in the early 1980s. By the end of the decade, Japanese banks accounted for over one-third of international bank assets (BIS, 1998). By 1990, the size and rapid expansion of Japanese banks had earned them the moniker “mighty giants” of Japan.

The tide that carried Japanese banks to the top ranks of international banks transformed into a series of tsunami in the 1990s. The first signs of trouble emerged with sharp declines in Japanese stock and land prices. As a result, Japanese banks, which had extensive equity holdings and loans collateralized by real estate, saw significant declines in the value of their assets and capital positions. The collapse of U.S. commercial real estate prices and the 1990–91 recession in the U.S. put further pressure on Japanese banks, which had invested heavily in this market. The response of the Japanese banks was to turn to new markets, the then rapidly growing South East Asian economies. The current Asian crisis and the unresolved asset quality problems in Japan have escalated the amount of problem assets at Japanese banks to dangerous levels.

Today, even the best performing Japanese banks are facing liquidity pressures and some are struggling to stay afloat. As of October 1998, the official amount of nonperforming loans at Japanese banks was $600 billion, while some private analysts put the amount of bad loans at over $1 trillion, representing roughly 20 percent of total loans outstanding. Moreover, according to some analysts, the Japanese banking system had a shortfall of ¥8 trillion in real net worth, even after the injection of ¥10 trillion to ¥25 trillion in public funds that is expected as a result of the ¥60 trillion rescue plan passed in October 1998 by the Japanese parliament. The impact of the crisis on the Japanese economy and other financial markets is significant—low rates of corporate investment and curtailed lending are, at least partially, the result of problems in banking.1

Of course, other countries have also faced financial crises.2 Among the more notable was the thrift and banking crisis in the U.S. in the late 1980s and early 1990s, which resulted in the closure of 1,142 savings and loan (S&L) institutions and 1,395 commercial banks (Lindgren, Garcia, and Saal, 1996).3

Because banks are a source of funds for firms, have an important role in the transmission of monetary policy, and are an integral part of the payments system, the social costs of bank failures may be greater than those of other types of businesses. Previous studies on the determinants of bank profitability and the likelihood of bank survival have shown that certain bank characteristics are important in determining future bank performance.4 Following this literature, I examine

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the relationship between the performance of Japanese banks in 1991–97 and their characteristics. In particular, I focus on three questions.

One, how does the accounting performance of Japanese banks relate to their financial characteristics? Although the banking crisis in Japan is well recognized, the precise financial condition of the banks and the amount of, and losses from, their nonperforming loans are uncertain. Differences between the disclosure, accounting, and regulatory rules in Japan and other industrial economies make it difficult to assess the exact condition of Japanese banks and compare them with other international banks. Furthermore, some analysts interpret recent Ministry of Finance (MoF) actions (such as allowing banks to value their security holdings at cost to avoid reporting valuation losses) as attempts to mask the true condition of the banks; as a result, they consider the reported results of Japanese banks to be of little or no value. If the patterns between bank performance and characteristics established in previous studies are also evident in the Japanese banking system, then even if the reported numbers are not accurate, they would still provide useful signals of bank performance.

Two, how does the stock market performance of banks relate to their financial characteristics? In particular, are the patterns between stock returns, which are less subject to potential maneuvering by banks, and financial characteristics consistent with those observed in the accounting returns? If Japanese accounting, disclosure, and regulatory practices obscure the true performance of Japanese banks, then the relationship between accounting earnings and bank characteristics might not be consistent with that observed in other countries. However, if market participants are aware of these practices and their impact on the condition of the banks, then market-based measures of bank performance, such as stock returns, would be little affected by these practices. As a result, any inconsistency we might observe with accounting returns would not be evident in stock returns.

Three, how are the stock market and accounting returns of banks related? Are the stock returns correlated with the accounting returns, or do shareholders dismiss the accounting results as meaningless? If accounting and disclosure practices of Japanese banks obscure their condition to such an extent that there is no additional information in their reported results, then there would be no significant relationship between accounting and stock returns.

Throughout the analysis, I explore potential differences in these relationships among different types of Japanese banks and over time. For the most part, press reports and other analyses of Japanese banks focus on the major banks (city, trust, and long-term credit banks), which account for more than 70 percent of Japanese banking assets; however, their activities and characteristics differ significantly from those of regional banks. Furthermore, the activities of banks, underlying economic conditions, and regulatory practices have changed over time. These differences in bank characteristics and changes in the environment can potentially influence the relationships I examine.

The results using accounting measures of performance indicate that some measures of asset quality are significant determinants of Japanese banks’ earnings; and the relationships I document are consistent with the results of previous studies. However, the accounting returns of Japanese banks exhibit some unexpected correlations with the market index, increases in the number of business bankruptcies, and bank capital. For instance, bank profitability, measured by return on equity (ROE), is negatively correlated with returns on the market index, indicating that banks are less profitable when the stock market is performing well. Further analysis shows that this and other puzzling results with accounting earnings might be the result of banks’ loan loss provisioning practices. In particular, Japanese banks appear to increase their loan loss provisions when their core profits and stock market returns are high.

The results with banks’ stock returns show that such income-smoothing does not affect their market performance. Specifically, when performance is measured by market returns, the puzzling results observed with accounting returns disappear and we observe correlations with the market index and the number of bankruptcies consistent with expectations.

Despite the potential problems with the reported earnings of Japanese banks, my results suggest that accounting returns provided market participants with useful information on banks’ condition in 1991–94: Accounting and stock market returns are positively and significantly correlated during this period. However, the results also show that this relationship breaks down in 1995–97, implying that the usefulness of reported earnings has deteriorated in recent years.

As indicators of bank performance and characteristics, I use measures used by regulators and market participants to assess the financial condition of banks. My results suggest that Japanese accounting, disclosure, and regulatory practices might have driven a wedge between banks’ accounting and stock returns in recent years. To the extent that such practices make it more difficult to assess the condition of banks, they introduce additional uncertainty to the market, potentially increasing the risk premium required by investors. The “Japanese premium”—the difference
between the interest rates paid by Japanese and other international banks in the interbank markets—might be considered a manifestation of this uncertainty.

Regulatory forbearance that allows economically insolvent institutions to continue operations and extends implicit or explicit guarantees to uninsured bank claimants transfers wealth from deposit insurance agencies, and hence taxpayers, to the shareholders and debtors of insured institutions. The results in previous theoretical and empirical studies indicate that as a bank nears insolvency, more of its value is derived from the value of subsidies and forbearance and the correlation between stock market returns and the value of the underlying assets declines. According to Brickley and James (1986) and others, a bank has (in addition to its tangible assets) a valuable intangible asset in the form of access to underpriced, fixed-premium deposit insurance and government forbearance programs that modify insolvency rules. The capitalized value of this intangible asset is embedded in the bank’s stock market valuation, but is not reflected in accounting values. When most of the market value of an insured bank is in the form of this intangible asset, movements in common stock returns need not be correlated with movements in the value of the underlying assets. In recent years, Japanese regulators have delayed recognition of losses at banks and have been reluctant to take strict actions against troubled or insolvent institutions. Such regulatory forbearance might account for the lack of correlation between accounting and market returns of Japanese banks in 1995–97 when the deterioration in the banks’ financial condition accelerated significantly. More recently, the MoF has taken a number of steps to shore up banks’ reported capital base through accounting changes and injection of government funds and has extended government guarantees to all bank creditors through the end of March 2001. These actions evoke recollections of the initial response of regulators to the S&L crisis in the U.S. Experience with that crisis tell us that regulatory forbearance can be a leaking lifeboat that imposes significant costs on the economy and healthy financial institutions, instead of the intended lifeline to pull troubled firms to safety. If the financial revitalization laws passed by the Japanese parliament in October 1998 put an end to regulatory forbearance and allow orderly resolution of insolvent institutions, they might minimize the future adverse impact of the banking crisis on the economy.

Overview of Japanese banking

Until the 1980s, functional segmentation, extensive regulations, restricted competition, government intervention, and isolation from international markets were the defining characteristics of Japanese financial markets. The Japanese banking system underwent a series of reforms in the late 1970s and 1980s (outlined in appendix 1), however, the current system retains some of its traditional characteristics.

To a certain extent, the markets are still segmented across banking functions. Until the passage of the 1992 Financial System Reform Law, different institutions conducted commercial, trust, and investment banking. Similarly, until recently, different banks provided short-term and long-term business loans. City and regional banks traditionally provided short-term financing to companies and were restricted to issuing short-term liabilities. City banks traditionally have focused on providing financing to large corporations and have relied on large corporate deposits and Bank of Japan credit for their funding. City banks were also among the first Japanese banks to expand overseas. The traditional business of regional banks, on the other hand, has been the provision of short-term loans to small- and medium-sized companies. Through their branch network in their home prefecture and close community ties, regional banks have relied primarily on deposits from their loan customers and individuals for funding.

Long-term business loans are provided by the long-term credit and trust banks. Until recently, only these institutions were allowed to issue long-term liabilities. On the asset side of the balance sheet, long-term credit banks provided commercial loans, while trust banks focused on trust loans. Regulations restricted long-term credit banks to issuing deposit liabilities only to their borrowers and restricted trust banks to raising funds through loan and money trusts. However, over time, deregulation and increased competition among financial institutions have blurred the lines separating the businesses of Japanese banks.

The regulations and laws governing banking operations are formulated, implemented, and enforced by the MoF. Until April 1998, when a new, independent Financial Supervisory Agency (FSA) was established, the MoF was the primary regulator of banks. Although the MoF has the legal authority to license banks, enforce laws, and administer penalties for violations of laws and regulations, it relies primarily on administrative guidance for enforcement. Because one of the functions of the Bank of Japan is to ensure the safety and soundness of the financial system, it also has regulatory and supervisory purview over banks, albeit to a lesser extent than the MoF. Until the establishment of the FSA, both institutions conducted examinations of banks.

Other government institutions in the Japanese banking system include the Deposit Insurance Corporation, which insures bank deposits and collects
insurance premiums, and the Resolution and Collection Bank, which was established in 1995 to take over the assets of failed institutions.

Despite the deregulation of banking activities in recent years, Japanese banks have characteristics that reflect their traditional roles. Some of these characteristics are evident in Table 1, which shows the aggregate balance sheets of four types of Japanese banks as of the fiscal year ending March 31, 1997.9

For banks that have traditionally provided long-term financing (long-term credit and trust banks), loans excluding loan loss reserves (gross loans) represent approximately 65 percent of total assets. Gross loans account for approximately 72 percent of the assets of city and regional banks that have traditionally provided short-term financing. However, despite the greater concentration of assets in loans, city and regional banks have smaller loan loss reserves (both as a percentage of assets and of loans) than long-term credit and trust banks. The differences in loan loss reserves might reflect differences in the composition of loan portfolios of these institutions. For instance, on March 31, 1997, the credit exposure of the three long-term credit banks to the riskier real estate, construction, and finance sectors was 44.43 percent of their domestic loan portfolio; loans to these three sectors represented 27.14 percent of the domestic loans at city banks.

The four types of banks invest roughly the same fraction of their assets in securities. However, major banks invest more in the equity of other companies, as Table 1 indicates.

### Table 1

<table>
<thead>
<tr>
<th>Japanese banks</th>
<th>U.S. banks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
</tr>
<tr>
<td><strong>Cash</strong></td>
<td>1.90</td>
</tr>
<tr>
<td><strong>Earning assets</strong></td>
<td>94.35</td>
</tr>
<tr>
<td><strong>Gross loans</strong></td>
<td>72.44</td>
</tr>
<tr>
<td><strong>Net loans</strong></td>
<td>70.81</td>
</tr>
<tr>
<td><strong>Security holdings</strong></td>
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<tr>
<td><strong>Equity investments</strong></td>
<td>6.61</td>
</tr>
<tr>
<td><strong>Other earning assets</strong></td>
<td>9.39</td>
</tr>
<tr>
<td><strong>Fixed assets</strong></td>
<td>0.54</td>
</tr>
<tr>
<td><strong>Total liabilities</strong></td>
<td>96.65</td>
</tr>
<tr>
<td><strong>Total deposits</strong></td>
<td>89.35</td>
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<tr>
<td><strong>Demand deposits</strong></td>
<td>21.39</td>
</tr>
<tr>
<td><strong>Other liabilities</strong></td>
<td>7.30</td>
</tr>
<tr>
<td><strong>Equity capital</strong></td>
<td>3.35</td>
</tr>
<tr>
<td><strong>Total assets or total liabilities + capital</strong></td>
<td>100.00</td>
</tr>
</tbody>
</table>

### Notes

1. Large banks in the U.S. are defined as those with more than $1 billion in total assets as of March 31, 1997.

2. By Japanese accounting rules, loan loss reserves are recorded as a liability rather than as a contra-account for loans, which is the practice in the U.S. To make the Japanese and U.S. figures comparable, the Japanese numbers were recalculated per U.S. practices.

3. The Japanese sample includes all banks for which there were 1997 data in FitchIBCA's Bankscope database and does not exclude any observations. The differences in the number of banks in this table and in the tables that follow arise from exclusion of extreme values and the requirement (by the nature of the analysis) that the banks in the following analysis have more than one year of data.

4. Yen amounts are translated to dollars at ¥123.72/$, the rate that was in effect on March 31, 1997.


**Sources:** FitchIBCA, Bankscope, CD-ROM, 1998.
whereas regional banks invest more in Japanese public bonds. Equity investments account for less than 3 percent of regional banks’ assets, but they represent approximately 7 percent to 8 percent of major banks’ assets. The relatively greater investment in equity securities reflects the major banks’ role in the industrial groups, the keiretsu, as major stockholders of group companies.\(^\text{10}\)

Japanese banks also differ in how they fund their assets. Compared with major banks, regional banks fund a greater percentage of their assets with equity capital. Moreover, long-term credit and trust banks rely less on deposits (less than 40 percent of funding) than city and regional banks do (around 90 percent), reflecting the restrictions placed on deposit-taking at these long-term finance institutions.

Not only do various Japanese banks have different characteristics, but they also differ from U.S. banks in terms of their activities and characteristics. Table 1 also shows the aggregate balance sheets of all commercial banks in the U.S. and the balance sheets of U.S. banks with more than $1 billion in assets. Although there are more than 9,000 banks in the U.S., bank assets in the U.S. total to $4.6 trillion, compared with $6.5 trillion in assets of 117 Japanese banks. Furthermore, bank assets represent more than 1.5 times the Japanese nominal gross domestic product (GDP), compared with 60 percent of nominal GDP in the U.S., reflecting the greater role of banks in the Japanese economy.

Japanese and U.S. banks also differ in the extent of leverage and composition of assets. Japanese banks are more than twice as leveraged as U.S. banks. While equity capital funds approximately 8 percent of U.S. bank assets, it funds less than 4 percent of Japanese assets. Japanese banks also invest more of their assets in loans than U.S. banks. Loans excluding loan loss reserves account for nearly 70 percent of Japanese bank assets, but less than 60 percent of U.S. bank assets. Loan loss reserves, as a fraction of both total assets and gross loans, are higher at Japanese banks, reflecting the differences in the conditions of the two banking markets. However, as figure 1 shows, Japanese banks’ loan loss ratios surpassed those of U.S. banks only in 1997. In the early 1990s, U.S. banks’ loan loss reserves covered 2.5 percent of their loans, compared with less than 1 percent coverage for Japanese banks. Japanese banks began to reserve for possible loan losses aggressively only in 1996.

While the total amount of securities investment is similar for Japanese and U.S. banks (approximately 17 percent of total assets), Japanese banks have significantly more equity investments (nearly 6 percent of assets) than U.S. banks (less than 0.5 percent of assets), which are generally prohibited from making such investments.

In addition, Japanese banks rely on deposits as a source of funds more than U.S. banks. Deposits fund nearly 80 percent of Japanese bank assets, but less than 69 percent of the total assets of U.S. banks. Other liabilities (such as fed funds purchases and other nondeposit liabilities) account for 27 percent of the assets of large U.S. banks, but only about 17 percent of the total assets of Japanese banks.

Figure 2 shows the performance of Japanese banks relative to U.S. banks over the 1990–97 period. In 1990, when the U.S. was approaching the end of its banking crisis, U.S. and Japanese banks had similar ROEs and operating profits (figure 2, panels A and B). However, when Japanese and U.S. banks are compared in terms of narrower performance measures, such as operating profits before loan loss provisions and interest margins, U.S. banks were more profitable than Japanese banks even in 1990 (figure 2, panels C and D). Hence, it was the higher level of loan loss provisions at U.S. banks that made their performance in 1990 comparable with that of Japanese banks.

Since 1990, the performance of Japanese and U.S. banks has diverged significantly. During the 1990–97 period, U.S. banks improved their performance by most measures, while Japanese banks’ performance deteriorated.\(^\text{11}\) By 1997, Japanese banks were reporting negative ROEs, while U.S. banks were enjoying record levels of profitability. The differences are all the more remarkable when performance is measured by return on assets (ROA). During 1990–97, the average ROA for U.S. banks was 0.95 percent, compared with 0.04 percent for Japanese banks. (The relative performance of Japanese banks is poor even if they are put on a more equal footing with U.S. banks in terms of underlying performance measures.)
economic conditions. For example, in 1987–91, when the U.S. was in the midst of a major banking crisis, U.S. banks averaged 7.4 percent ROE, versus 0.3 percent for Japanese banks in 1991–97.\textsuperscript{13}

The stock returns of Japanese banks reflected their poor performance in 1990–97. As figure 3 shows, Japanese banks had negative stock returns in five of the eight years and underperformed the market in seven of the eight years. Figure 3 also shows the adverse impact of declining stock prices on the value of Japanese banks, which hold significant amounts of equity in other firms.

Table 1 and figure 2 show the differences in the characteristics of different Japanese banks and the poor performance of Japanese banks relative to U.S. banks. How do the characteristics of Japanese banks relate to their performance? Are the relationships between the performance and characteristics of Japanese banks similar to those observed in the U.S.? Next, I examine these issues in more detail.

**Performance and financial characteristics**

A number of studies have examined the performance of banks and related it to bank characteristics and activities. Because solvency of banking institutions is of particular importance to the stability of financial systems and because there were a large number of failures among banks and S&Ls in the U.S. during the 1980s, several studies have focused on factors that determine the profitability and solvency of depository institutions.\textsuperscript{13}

Following this literature, I examine the ROE and the stock market performance of Japanese banks in 1991–97.\textsuperscript{14} I relate these performance measures to bank characteristics that were found to be particularly important determinants of bank performance in previous studies: asset quality, capital ratio, liquidity, operational efficiency, and size.

The relationship between asset quality and bank earnings is closely related to the condition of the overall economy. Banks that invest in riskier assets
are likely to have higher expected profits. However, higher asset risk implies lower realized profits when the economy is experiencing a series of negative shocks. Previous studies found that depository institutions in the U.S. that invested in riskier, or lower quality, assets performed worse than others during the 1980s and early 1990s. One would expect a similar result in Japan, that is, a negative relationship between measures of asset quality and realized performance of Japanese banks in 1991–97, when the Japanese economy was subject to adverse shocks. I measure asset quality and credit risk by the following variables: the ratio of equity investments to total assets, the ratio of loan loss provisions to loans, the ratio of net loans to total assets, the ratio of domestic loans to total loans, and the growth rate of assets (see box 1 for variable definitions).

The ratio of equity investments to total assets measures the banks’ exposure to the performance of other firms through their equity investments. As general economic conditions deteriorate, the performance of banks with a relatively high fraction of their assets invested in the equity of other firms should be worse than that of banks with lower equity exposure. Furthermore, because equity securities are generally more risky than debt securities, banks with more equity investments may have lower realized profits when stock prices decline. On the other hand, if equity investments provide banks with more opportunities for diversification, then banks with high fractions of assets invested in equities would perform better than other banks.

The ratio of loan loss provisions to loans can be positively or negatively correlated with performance.

### BOX 1

**Definitions of variables**

- **Annual stock returns**—annual holding period returns calculated as the change in stock price plus dividends paid in the current period over the previous period’s stock price.
- **BIS capital ratio**—total risk-weighted capital-asset ratio as defined by the BIS.
- **Business bankruptcies**—annual change in the number of business bankruptcies, in percent.
- **Domestic loans/total loans**—Domestic loans divided by total (gross) loans.
- **Equity investments/TA**—equity investments at book value divided by total assets, in percent.
- **Gross loans/TA**—loans before loan loss reserves divided by total assets, in percent.
- **Growth of TA**—annual growth rate of total assets, in percent.
- **Interest margin**—net interest revenue divided by earning assets (loans plus investments), in percent.
- **Liquidity**—demand deposits divided by bank deposits plus cash plus securities in the trading account; ratio of short-term liabilities to short-term assets, an inverse measure of liquidity.

- **Loan loss provisions/loans**—Loan loss provisions (transfers to reserves, loan charge-offs, loss on sale of loans to CCPC; write-off/down of sovereign risk, loss shouldered for customers, transfer to reserve for other credit losses, write-down of other assets) divided by banking loans (excludes trust loans).
- **Market return**—annual change in the Tokyo Stock Exchange TOPIX index, in percent.
- **Net loans/TA**—net loans divided by total assets, in percent.
- **Overhead ratio**—personnel and noninterest expenses divided by earning assets (loans plus investments), in percent.
- **ROE**—net income divided by total book-value capital. Net income includes operating profits, gains/losses on sale of equity investments, valuation losses on equity investments, special items, and income taxes.
- **SIZE**—total assets in logarithms.
- **TA**—total assets in trillions of yen.
If banks with riskier assets provision more than other banks, then loan loss provisions measure credit risk, and are likely to be negatively correlated with realized profits. On the other hand, if banks that perform better, or banks with more conservative management, provision more for loan losses, then one would expect a positive relationship between loan loss provisions and performance. Empirical evidence on U.S. banks shows that loan loss provisions and loan loss reserves are negatively correlated with future bank performance.

The ratio of net loans to total assets measures the banks’ credit risk, and the ratio of domestic loans to total loans measures their domestic exposure. During the sample period, loan quality, particularly the quality of loans made to Japanese borrowers, was one of the largest sources of risk to bank profitability. Consequently, one would expect banks with higher ratios of loans to total assets and banks with more domestic loans in their portfolio to have poorer performance than other banks.

I also measure asset quality with the annual growth rate of assets. During the U.S. thrift crisis, some institutions tried to grow out of their problems by expanding rapidly. Furthermore, additions to assets at fast-growing institutions may increasingly involve riskier assets. As a result, one might observe a negative relationship between asset growth and realized profits. On the other hand, if regulators are providing sufficient discipline, they may restrain the growth of institutions that are in financial trouble and allow only strong-performing banks to expand. Alternatively, banks that grow relatively more may previously have had good performance and/or expect to have good performance in the future. In that case, one would observe a positive relationship between growth and profitability.

In theory, performance can be positively or negatively related to capital ratios. For instance, in perfect and competitive capital markets, higher capital ratios would reduce risk and expected return on equity (but would not change the weighted average cost of funds). Moreover, because interest payments are tax deductible, relying more on equity and less on debt reduces after-tax earnings, generating a negative relationship between earnings and capital. However, other factors may lead to a positive relationship between the capital and earnings of banks. Because banks retain a portion of their earnings, over time more profitable firms would have higher retained earnings, hence more capital, than less profitable firms. Furthermore, equity capital provides a cushion against losses, lowering bankruptcy costs. In imperfect capital markets, banks with more capital and lower bankruptcy costs are likely to have lower interest costs and higher profitability than other banks. In addition, when deposit insurance is present and regulators have the authority to close insolvent institutions, banks with profitable investment opportunities have an incentive to be well capitalized (Buser, Chen, and Kane, 1981; Keeley, 1990; and Demsetz, S aidenberg, and Strahan, 1996). All these factors point to a positive relationship between bank performance and capital-asset ratios. Empirical evidence indicates that banks with higher capital-asset ratios are indeed more profitable and less likely to fail than more leveraged banks. In this article, I measure the capital position of Japanese banks by the ratio of capital to risk-weighted assets, as defined by the BIS capital accord.

Profitability is also related to liquidity. More liquid banks are better able to meet adverse shocks and are likely to face lower cost of funds in imperfect capital markets, increasing their profitability. On the other hand, liquid assets have lower expected returns than illiquid assets, so banks with more liquid assets might have lower expected earnings. In addition, banks choose the level of liquidity of their assets. Therefore, if a bank expects to face adverse shocks in the future, it may choose to hold more liquid assets to cushion itself against such shocks. In that case, one would observe a negative relationship between profitability and liquidity, since banks that expect lower profits would increase their liquidity. In short, the relationship between liquidity and profitability is ambiguous in theory and is determined by the data. Empirical evidence points to a positive relationship between liquidity and performance of banks in the U.S. I measure liquidity by the ratio of short-term liabilities to short-term assets, whereby banks with higher ratios are less liquid than others.

Operational efficiency, measured by the overhead ratio, is also likely to be a key determinant of bank profitability. To the extent that banks with high overhead ratios are less efficient, one would expect these banks to perform worse than banks with lower overhead expenses. However, the overhead ratio is an imperfect measure of efficiency and may also reflect differences in banks’ product mix. For instance, non-traditional bank businesses may generate greater profits, but require more overhead expenses than traditional banking. In that case, one would observe a positive relationship between profitability and overhead ratios. In general, previous studies have found that banks with high overhead expenses perform worse than other banks.

I also include size, measured by total assets, as a control variable. Previous studies found that large banks perform better than small banks.
In addition to these bank characteristics, I explore the relationship between bank performance and measures of aggregate economic activity. In particular, I focus on stock market returns and the number of business bankruptcies. As economic conditions deteriorate, the number of bankruptcies increases. As creditors, banks are directly affected by bankruptcies. Hence, one would expect an increase in the number of bankruptcies to be associated with higher loan defaults and lower bank profits.

As noted above, Japanese banks have significant investments in the equity of other firms. Therefore, returns on the overall stock market affect the performance of banks, not only as an indicator of aggregate economic conditions, but also through their impact on the valuation of banks’ investments. As a result, one would expect bank performance to be positively correlated with returns in the stock market. Clearly, banks with a relatively high fraction of their assets in equity securities should benefit more from stock price increases than other banks. To explore this relationship, I interact the return on the market index with the ratio of equity investments to total assets. If an increase in the market index has a greater positive impact on the performance of banks with more equity investments, then the coefficient on the interaction term would be positive.

My analysis is based on accounting results for city, trust, long-term credit, and regional banks in 1991–97 from FitchIBCA’s (1998) Bankscope database. My initial analysis showed some extreme values of ROA, ROE, and growth rate of assets, which were attributable to mergers or insolvency. To avoid influencing the results by including these extreme values, I deleted observations in the top and bottom 1 percentile of the distribution of ROA, ROE, and the growth rate of total assets. The final sample contains 555 observations for 88 banks.


The top panel of table 2 shows the mean values, the standard deviations, and the minimum and maximum values of the variables for the entire sample. The average reported earnings and stock returns reflect the poor performance of Japanese banks during this period. Despite the exclusion of extreme values from the sample, profitability varies greatly across banks and over time. For instance, ROE ranges from –49.21 percent to 9.40 percent, indicating that while some banks performed very poorly, others reported large, positive profits. Similarly, banks differed in the amount of their loan loss provisions. Although the mean value for provisions was 0.59 percent, some banks had no loan loss provisions, while others had provisions as high as 9.61 percent of loans. There are also differences in the asset composition and operational efficiency of banks. For instance, net loans ranged from 45.14 percent to 82.07 percent of total assets, while equity investments ranged from 0 percent to 9.32 percent of total assets. In summary, the sample statistics suggest that differences in banks’ characteristics across institutions and over time might be significant.

The statistics in the bottom panel of table 2, the mean values for different bank types and different time periods, present further evidence of differences in bank characteristics. Major Japanese banks differ significantly from regional banks and characteristics of Japanese banks changed significantly in the latter part of the sample period. In particular, major banks performed significantly more poorly than regional banks in 1991–97. The average ROE for major banks during this period was −0.40 percent, compared with 3.17 percent for regional banks. Other variables also show significant differences in the characteristics of major and regional banks, which were foreshadowed by the statistics presented in table 1. Namely, major banks invest less in loans but more in equities than regional banks. Furthermore, major banks are more liquid and have lower interest margins and overhead expenses than regional banks. Regional banks also provision less for possible loan losses. There are, however, no significant differences in the capital ratios of major and regional banks.

The last two columns in the bottom panel of table 2 show the mean values of the variables in 1991–94 and 1995–97, respectively. These statistics indicate that bank characteristics changed significantly over time. While there was no significant difference in bank stock returns in the two periods, ROEs were significantly lower in the later part of the sample period.

Over time, Japanese banks also increased their percentage of assets invested in loans and equity securities. The increase in the ratio of domestic to total loans reflects the aggregate decline in the banks’ international loans. Furthermore, liquidity of Japanese banks declined significantly in 1995–97, which may reflect the higher costs of liquidity for Japanese banks in interbank markets. Lastly, banks raised their capital ratios and their provisioning for loan losses in 1995–97. Below, I explore the relationship between bank characteristics and performance more systematically.
### TABLE 2

**Summary statistics**  
(All banks unless indicated)

<table>
<thead>
<tr>
<th></th>
<th>All banks</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard deviation</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Interest margin</td>
<td>1.58</td>
<td>0.59</td>
<td>-0.19</td>
<td>2.53</td>
</tr>
<tr>
<td>ROE</td>
<td>2.34</td>
<td>7.45</td>
<td>-49.21</td>
<td>9.40</td>
</tr>
<tr>
<td>Annual stock return</td>
<td>-7.30</td>
<td>16.34</td>
<td>-50.01</td>
<td>58.17</td>
</tr>
<tr>
<td>TA, ¥ trillion</td>
<td>9.63</td>
<td>14.85</td>
<td>0.96</td>
<td>80.84</td>
</tr>
<tr>
<td>Growth of TA</td>
<td>0.33</td>
<td>12.58</td>
<td>-56.21</td>
<td>123.81</td>
</tr>
<tr>
<td>Equity investments/TA</td>
<td>3.12</td>
<td>1.83</td>
<td>0.00</td>
<td>9.32</td>
</tr>
<tr>
<td>Net loans/TA</td>
<td>67.04</td>
<td>6.55</td>
<td>45.14</td>
<td>82.07</td>
</tr>
<tr>
<td>Domestic loans/total loans</td>
<td>92.15</td>
<td>16.82</td>
<td>26.51</td>
<td>100.00</td>
</tr>
<tr>
<td>Liquidity</td>
<td>2.06</td>
<td>1.52</td>
<td>0.12</td>
<td>15.28</td>
</tr>
<tr>
<td>Overhead ratio</td>
<td>1.29</td>
<td>0.34</td>
<td>0.33</td>
<td>1.98</td>
</tr>
<tr>
<td>Loan loss provisions/loans</td>
<td>0.59</td>
<td>0.92</td>
<td>0.00</td>
<td>9.61</td>
</tr>
<tr>
<td>BIS capital ratio</td>
<td>9.26</td>
<td>0.81</td>
<td>7.28</td>
<td>13.61</td>
</tr>
</tbody>
</table>

**Mean values for:**

<table>
<thead>
<tr>
<th></th>
<th>Major banks</th>
<th>Regional banks</th>
<th>All banks</th>
<th>All banks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest margin</td>
<td>0.70</td>
<td>1.85**</td>
<td>1.47</td>
<td>1.72**</td>
</tr>
<tr>
<td>ROE</td>
<td>-0.40</td>
<td>3.17**</td>
<td>4.41</td>
<td>-0.25**</td>
</tr>
<tr>
<td>Annual stock returns</td>
<td>-9.26</td>
<td>-6.85</td>
<td>-8.32</td>
<td>-5.96</td>
</tr>
<tr>
<td>TA, ¥ trillion</td>
<td>31.17</td>
<td>3.17**</td>
<td>9.95</td>
<td>9.24</td>
</tr>
<tr>
<td>Growth of TA</td>
<td>-0.31</td>
<td>0.52</td>
<td>-0.10</td>
<td>0.86</td>
</tr>
<tr>
<td>Equity investments/TA</td>
<td>5.97</td>
<td>2.27**</td>
<td>2.93</td>
<td>3.36**</td>
</tr>
<tr>
<td>Net loans/TA</td>
<td>64.04</td>
<td>67.94**</td>
<td>65.77</td>
<td>68.64**</td>
</tr>
<tr>
<td>Domestic loans/total loans</td>
<td>68.14</td>
<td>99.34**</td>
<td>91.13</td>
<td>93.43</td>
</tr>
<tr>
<td>Liquidity</td>
<td>0.87</td>
<td>2.41**</td>
<td>1.58</td>
<td>2.66**</td>
</tr>
<tr>
<td>Overhead ratio</td>
<td>0.80</td>
<td>1.43**</td>
<td>1.26</td>
<td>1.32</td>
</tr>
<tr>
<td>Loan loss provisions/loans</td>
<td>1.29</td>
<td>0.38**</td>
<td>0.24</td>
<td>1.02**</td>
</tr>
<tr>
<td>BIS capital ratio</td>
<td>9.18</td>
<td>9.28</td>
<td>9.14</td>
<td>9.41**</td>
</tr>
<tr>
<td>N (N = 555)</td>
<td>128</td>
<td>427</td>
<td>309</td>
<td>246</td>
</tr>
<tr>
<td>Number of banks</td>
<td>20</td>
<td>68</td>
<td>87</td>
<td>85</td>
</tr>
</tbody>
</table>

* * indicates differences in means across bank types or subperiods that are significant at the 1 percent level.

**Excludes stock returns for long-term credit banks.**

**Note:** For variable definitions, see box 1.

**Source:** Author's calculations from FitchIBCA, Bankscope, CD-ROM, 1998.

### Determinants of accounting performance

Table 3 shows the parameter estimates when banks’ ROEs are regressed on their characteristics. Appendix 2 describes my methodology in more detail. Banks’ performance over a given period is related to their characteristics at the beginning of the period; hence, the results show the predictive power of current bank characteristics for future performance.

Are the patterns observed in the Japanese banks’ accounting earnings and characteristics consistent with those in other countries? The results in table 3 indicate the answer to this question is mixed.

For some characteristics, the relationship with earnings is consistent with patterns observed in the U.S. In particular, loan loss provisions and the ratio of net loans to total assets are negatively correlated.
with earnings, indicating that banks with higher credit risk performed worse than others. These measures of asset quality are particularly strong determinants of performance for regional banks, but are less informative for major banks. Recall that, compared with regional banks, major banks hold a smaller fraction of their assets in loans; thus, these banks’ performance may be more sensitive to fluctuations in other sources of income, such as fee income and earnings from security portfolios.

Banks with greater investments in equity securities performed worse than others. This result shows that when economic conditions were deteriorating, the equity investments of Japanese banks exposed them to greater risk and reduced their earnings. As shown in the last row of columns 4 and 5 of table 3, the negative impact was significantly worse in the 1995–97 period.

The relationship between profitability and other bank characteristics is statistically weaker. Profitability is significantly correlated with liquidity, size, and growth rate of assets in only some specifications. Furthermore, in contrast to the positive significant relationship observed between bank earnings and capital in other studies (for example, Berger, 1995, and Demirgüç-Kunt and Huizinga, 1997), Japanese banks’ earnings are not significantly related to their capital ratios. At first glance, this result suggests that BIS capital ratios have no impact on Japanese banks’ earnings. However, this conclusion is at odds with anecdotal evidence which indicates that capital management was of particular importance to Japanese banks during this period. For instance, between 1992 and 1995, Japanese banks sold ¥2.7 trillion of subordinated debt to meet BIS capital requirements and some major banks issued convertible securities to raise capital. Furthermore, comments by MoF officials and analysts suggest that the retrenchment of Japanese banks from international lending is at least partially motivated by their need to increase capital ratios. It is unlikely that significant efforts by Japanese banks to manage their capital positions had no impact on their earnings. If capital management was important for Japanese banks during the sample period, then the impact of capital ratios on bank earnings would not be measured accurately by the current analysis which treats capital ratios as exogenous variables that are

---

**TABLE 3**

<table>
<thead>
<tr>
<th>Returns on equity and bank characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>-------------------------</td>
</tr>
<tr>
<td>Intercept</td>
</tr>
<tr>
<td>Size</td>
</tr>
<tr>
<td>Growth of TA</td>
</tr>
<tr>
<td>Net loans/TA</td>
</tr>
<tr>
<td>Domestic loans/TA</td>
</tr>
<tr>
<td>Overhead ratio</td>
</tr>
<tr>
<td>Liquidity</td>
</tr>
<tr>
<td>Loan loss provisions/TA</td>
</tr>
<tr>
<td>BIS capital ratio</td>
</tr>
<tr>
<td>Equity investments/TA</td>
</tr>
<tr>
<td>Market return</td>
</tr>
<tr>
<td>Market return x equity</td>
</tr>
<tr>
<td>investments/TA</td>
</tr>
<tr>
<td>Business bankruptcies</td>
</tr>
<tr>
<td>R²</td>
</tr>
<tr>
<td>N</td>
</tr>
</tbody>
</table>

Parameter estimates when the market return and the ratio of equity investments to total assets are included in regressions without an interaction term.

*, **, and *** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

Notes: For variable definitions, see box 1. Parameter estimates that are in bold indicate that there are significant differences across bank types or subperiods at the 5 percent level.

Source: Author’s calculations from FitchIBCA, Bankscope, CD-ROM, 1998.
not influenced by bank characteristics. One would need to take into account the factors that affect banks’ capital management decisions before examining the impact of capital on earnings. This type of analysis is beyond the scope of this article.

Some of the relationships shown in table 3 are inconsistent with our expectations and patterns observed in the U.S. Specifically, higher returns in the Tokyo Stock Exchange, which imply more favorable economic conditions, are associated with poor bank performance. In addition, the coefficient estimates for the interaction term between stock returns and equity investments indicate that the negative correlation between stock returns and earnings is stronger for banks with more equity investments, particularly for major banks and in the 1995–97 period. These results are in direct contrast to our expectations. Further analysis, however, revealed that the result was evident only for measures of performance that include loan loss provisions. There is a positive correlation between pre-provision profits and stock returns. These results suggest that Japanese banks provision more when economic conditions are good.24 The correlations between loan loss provisions in the current period and other bank characteristics and economic conditions, shown in table 4, point to a similar conclusion. Specifically, banks provision more when they have higher core earnings (operating profits before loan loss provisions) and when the stock market performs well. Furthermore, banks with higher equity investments provision more than other banks. These correlations, and the results with other performance measures, are consistent with analysts’ assessment of the income-smoothing behavior of Japanese banks. The results are also consistent with Moody’s (1997, 1998) reports that to maintain their capital positions in recent years, Japanese banks have sold their equity securities to offset credit expenses.25

In addition, loan loss provisions are positively correlated with the fraction of assets invested in loans, indicating that banks with higher credit risk provision more. However, there is a strong negative correlation between loan loss provisions and the increase in the number of business bankruptcies in the current period. This result is puzzling and gives further evidence that Japanese banks’ provisioning practices do not conform with conventional wisdom.

Lastly, the well-known credit quality problems associated with Japanese borrowers in the 1990s suggest a negative relationship between ROE and the fraction of total loans allocated to domestic borrowers. The results in table 3 indicate that, in contrast to our expectations, domestic loans were associated with higher profitability in 1991–94. However, during 1995–97 this relationship loses statistical significance.

**Determinants of stock market performance**

The consistency of the results in the previous section with those in other banking studies was mixed. Some of these results might be due to efforts by Japanese banks to manage their regulatory capital and to fund their credit expenses through sale of

---

**TABLE 4**

<table>
<thead>
<tr>
<th>Correlations of loan loss provisions with other bank characteristics and economic indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>Total assets</td>
</tr>
<tr>
<td>Gross loans/TA</td>
</tr>
<tr>
<td>Domestic loans/total loans</td>
</tr>
<tr>
<td>BIS capital ratio</td>
</tr>
<tr>
<td>Equity investments/TA</td>
</tr>
<tr>
<td>Loan loss provisions/loans in the previous period</td>
</tr>
<tr>
<td>Operating profits before LLP/equity</td>
</tr>
<tr>
<td>Market return</td>
</tr>
<tr>
<td>Business bankruptcies</td>
</tr>
<tr>
<td>N</td>
</tr>
<tr>
<td>Number of banks</td>
</tr>
</tbody>
</table>

* *, **, and *** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

Note: For variable definitions, see box 1.

securities during favorable market conditions. If such actions are transparent to investors, and analysts’ reports and anecdotal evidence suggest that they are, then the puzzling results between bank characteristics and market measures of performance would not exist. Market participants would dismiss the reported numbers as irrelevant and rely on other indicators of banks’ condition (for instance, analysts’ reports). In that case, market measure of performance, such as bank stock returns, would not be related to accounting profits; and the relationship observed between stock returns and bank characteristics would differ significantly from the relationship observed with accounting profits.²⁵

To explore this issue further, I relate the stock returns of banks to the bank characteristics used above. The results, reported in table 5, suggest that while those accounting relationships that were consistent with our expectations are also evident for stock returns, the puzzling results with accounting earnings disappear when performance is measured by stock market returns. Specifically, banks with more loans and equity investments and banks with higher loan loss provisions have lower stock returns. Furthermore, size and profitability are positively correlated, particularly for major banks. These results are consistent with the results in the previous section and with the results of other banking studies.

However, in contrast to the results in table 3, the results in table 5 indicate that stock returns are positively correlated with the market index. This result implies that market participants perceive the negative correlation of the market index with reported earnings as an accounting artifact and see a positive impact from an increase in the index on banks’ future cash flows.

Another difference between reported accounting profits and stock returns is their relationship with the change in the number of bankruptcies. ROE is only weakly correlated with bankruptcies (the only significant correlation is in 1991–94) and the results in table 4 show a puzzling negative correlation between loan loss provisions and bankruptcies. In contrast to these relationships with accounting results and consistent with expectations, there is a strong negative

<table>
<thead>
<tr>
<th>TABLE 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stock returns and bank characteristics</strong></td>
</tr>
<tr>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td><img src="image" alt="" /></td>
</tr>
</tbody>
</table>

Parameter estimates when the market return and the ratio of equity investments to total assets are included in regressions without an interaction term.

* *, **, and *** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

Excludes stock returns for long-term credit banks.

Notes: For variable definitions, see box 1. Parameter estimates that are in bold indicate that there are significant differences across bank types or subperiods at the 5 percent level.

relationship between stock returns of banks and increases in the number of bankruptcies. These results suggest that although banks’ reported accounting earnings exhibit no strong association with bankruptcies, shareholders take into account the adverse impact of bankruptcies on banks’ asset quality and earnings.

**Accounting and stock returns**

Our results up to this point indicate that reported earnings and stock returns of Japanese banks are related to size and measures of asset quality in similar ways. However, the results also point to some differences in the behavior of accounting and market measures of performance. Given the differences in the two measures of performance, how do they relate to each other?

To answer this question, I examine the relationship between stock market and accounting returns directly. I first estimate the market model for Japanese bank stocks by regressing individual bank returns on the market index. I then modify the market model by including the return on equity as an additional explanatory variable. If shareholders dismiss accounting earnings as uninformative, one would expect the coefficient on ROE to be insignificant.

First, as reported in the top panel of table 6, for the entire sample, the coefficient on the market index is positive. The coefficient is less than one, indicating that when the overall stock market increases by 1 percent, bank stock returns increase by less than 1 percent. However, there are significant differences in how the stock returns of major and regional banks move with the market. A 1 percent increase in the market index moves the stock returns of major banks by more than 1 percent and those of regional banks by less than 1 percent. Major banks own significantly greater amounts of equity securities than regional banks. Thus, a movement in the stock market affects not only income from their operations, but also the value of their equity investments, magnifying the impact of changes in the market index.

Second, when the market model is augmented with ROE, the coefficient on ROE is positive and statistically significant. In addition, the fraction of the variance in bank stock returns explained by the model, $R^2$, increases in most specifications when accounting returns are included as explanatory variables. Therefore, for all the potential biases in the reported results of Japanese banks, shareholders do not dismiss accounting earnings as meaningless.

However, the correlation between banks’ stock market and accounting returns has decreased over time; accounting returns are not significantly correlated with stock returns in the 1995–97 period. Higher reported earnings in later years did not translate into higher returns in the stock market as they had in the earlier part of the 1990s, which implies that accounting profits became less informative over time. This result suggests that measures taken by banks to shore up their reported earnings and capital are not seen by market participants as significant determinants of banks’ market performance and, instead, drive a wedge between the banks’ accounting and market returns, disconnecting the two measures of performance.

These results are consistent with the results of other studies of U.S. banking showing that regulatory forbearance decreases the correlation between the

| **TABLE 6** Stock market and accounting performance of Japanese banks |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| **All banks**
| **Major banks**
| **Regional banks**
| **All banks**
| **All banks** |
| Intercept & -4.393** & -3.278** & -4.478** & -3.442** & -4.676** |
| Market return & 0.614** & 1.021** & 0.530** & 0.757** & 0.515** |
| $R^2$ & 0.40 & 0.58 & 0.36 & 0.41 & 0.42 |
| Market return & 0.643** & 1.208** & 0.557** & 0.818** & 0.538** |
| ROE & 0.217** & 0.499** & 0.313** & 1.150** & 0.128 |
| $R^2$ & 0.40 & 0.61 & 0.38 & 0.43 & 0.42 |

** indicates significance at the 5 percent level.
*Excludes stock returns for long-term credit banks.

Notes: For variable definitions, see box 1. Parameter estimates that are in bold indicate that there are significant differences in the parameter estimates at the 5 percent level across bank types or subperiods.

market value of equity and the value of net assets in place. The market value of a bank’s equity is the sum of the value of its net assets in place and the value of deposit insurance subsidies and regulatory forbearance. Accounting profits, on the other hand, only reflect earnings from assets in place. As a bank nears economic insolvency, the value of regulatory subsidies and forbearance increases and shareholders derive more of their value from subsidies rather than assets in place. Except for the unlikely situations where the value of assets in place is perfectly correlated with changes in the value of subsidies, an increase in the value of subsidies and regulatory forbearance leads to a decline in the correlation between market returns and value of assets in place.

The reluctance of Japanese regulators to force recognition of loan losses and to impose penalties on the shareholders of failing institutions is undoubtedly valuable to banks’ shareholders. As the condition of the banks deteriorated significantly in the later part of the 1990s, the value of subsidies and forbearance to shareholders might have increased significantly, potentially accounting for the lack of correlation between market and accounting returns of Japanese banks in 1995–97.

**Conclusion**

Economic malaise, ever-increasing problem loans, high credit expenses to provision for problem loans, and low core profitability have taken their toll on Japanese banks. In this article, I have examined the performance of Japanese banks in recent years and related it to variables used by regulators and analysts to assess the condition of banks. The results show significant differences between the performance and characteristics not only of Japanese and U.S. banks, but also of different Japanese banks and over time. The results also show that although most measures of bank asset quality are correlated with accounting returns in line with expectations and the results of other banking studies, other variables that were found to be important determinants of bank performance in the U.S. and elsewhere are not significantly related to the performance of Japanese banks. Moreover, accounting profits are correlated with other bank characteristics and economic variables in puzzling ways. Additional evidence suggests that these puzzling or inconsistent results may be due to income smoothing by banks. Specifically, Japanese banks appear to increase their loan loss provisions when their core earnings and the returns on the market are high. However, such actions do not appear to affect the stock returns of banks; the returns are positively correlated with the return on the market index. My analysis shows that although there might be problems with the reported earnings of Japanese banks, accounting returns still provided useful information to market participants regarding the values of bank shares in the early 1990s. However, the significance of this information has decreased in recent years.

These results may reflect an increase in the value of regulatory forbearance to bank shareholders. Since the end of the period analyzed in this article, the MoF has introduced a number of measures that indicate an increase in regulatory forbearance. As outlined in appendices 1 and 3, accounting changes have enabled banks to increase their regulatory capital, government purchases of banks’ preferred stock and subordinated loans have injected capital to institutions experiencing financial difficulties, and government guarantees have been extended to all bank creditors through the end of fiscal year 2001. Regulators typically forbear to give ailing institutions time to recover. However, experience tells us that forbearance imposes significant costs on the economy by transferring wealth from the deposit agencies, and hence taxpayers, to bank shareholders and by increasing the cost of resolving insolvent institutions. To the extent that the recent financial revitalization laws resolve the insolvent institutions and encourage solvent banks to deal with their problems in a timely manner, they should greatly improve the health of the Japanese financial system.
Developments in Japanese financial markets

Between 1952 and 1973, the Japanese economy exhibited remarkable strength, averaging 10 percent real growth per year. Financial institutions in general, and banks in particular, were instrumental in achieving this strong performance. By acting as conduits of funds from the household sector to the corporate sector, they financed exports and business investment that fueled the economy. The goal of financial regulations during this period was to provide a stable financial environment conducive to growth. Regulation of interest rates kept the cost of funds low for banks and corporations. The positive slope of the yield curve ensured profits for banks engaged in maturity transformation and fostered a culture in which banking profits increased with size. Segmentation of the financial markets across functions, restrictions on portfolio activities of banks, and controls over foreign exchange transactions and international capital flows provided a stable system with restricted competition. The collateralization requirements on all debt issued and all restrictions on security issuance meant that banks were the primary source of external funds for corporations.

The policies of the high-growth period became unsustainable, however, after the collapse of the Bretton Woods system of fixed exchange rates and the first oil crisis in 1973. As the government deficit ballooned, it became harder for banks to absorb government bonds without a secondary market for these securities. The development of secondary markets in government bonds enabled investors to circumvent interest rate regulations on deposits, while soaring inflation increased the cost of these regulations. Increased international trade and globalization of financial markets provided further impetus for change and Japanese financial markets underwent a series of reforms. By the mid- to late 1980s, Japanese financial markets were substantially liberalized. Regulations on interest rates were gradually reduced, more financial instruments for savings were allowed, restrictions on security issues were relaxed, and portfolio activities of banks and other financial institutions were expanded. For example, the Foreign Exchange Law of 1980 allowed Japanese corporations to finance their operations with foreign currency denominated loans. This gave Japanese businesses an alternative source of funding, which increased the competitive pressures on Japanese banks. At the same time, however, the law allowed Japanese banks to borrow and lend freely in foreign currencies, giving them entry into new markets. Japanese banks took full advantage of this opportunity to expand their international operations, including those in the U.S. By 1990, Japanese banks had become the largest foreign lenders to U.S. companies and financed most of the record levels of Japanese direct investment in the U.S. commercial real estate. In the meantime, soaring stock and land prices in Japan during the second half of the 1980s boosted banks’ unrealized gains on equity holdings and enabled them to increase loans collateralized by property. By some private estimates, 50 percent to 70 percent of new lending by Japanese banks in 1985–90 was collateralized by real estate.

With the collapse first of stock prices, then of land values in the early 1990s, the first cracks in the system appeared. Because a portion (up to 45 percent) of unrealized gains on banks’ security holdings counts as tier two capital under the BIS rules, the decline in stock prices put significant pressure on banks’ capital ratios. As early as mid-1991, press reports pointed to difficulties faced by Japanese banks in meeting BIS capital requirements. Regulators responded by allowing banks to issue subordinated and perpetual debt. In addition, banks sold loans and shifted lending from low-margin markets (such as European and U.S. lending) to higher margin segments (such as corporate lending and leasing in Southeast Asia).

Early in the decade, declines in land prices were welcomed by regulators. In fact, the MoF restricted the growth of real estate lending in 1990 to discourage speculative land deals. Anecdotal evidence suggests that banks responded by shifting their real estate lending to affiliates. Sharp declines in land prices throughout the 1990s, however, reduced the value of the collateral on loans and led to a significant deterioration of asset quality at nonbank affiliates of banks, such as housing loan companies. In 1993, parent banks and other creditors restructured their loans to the housing loan companies (the jusen), in order to provide liquidity to these firms. Additional declines in land prices, however, deteriorated the condition of the jusen further. In December 1995, the government announced the liquidation of seven housing loan companies and the Housing Loan Administration was established in July 1996 to takeover the assets of the failed jusen.

The decline in land prices also had significant adverse effects on the quality of loans at the banks. In January 1993, the Cooperative Credit Purchasing Company (CCPC) was established to purchase bad loans and collateral backing such loans from the banks. However, because the CCPC was funded by the banks themselves, the plan was met with skepticism by analysts from the outset. To date, the operations...
of the CCPC have not stemmed the deterioration in asset quality or have brought a decisive resolution to the problem. The deterioration in the condition of Japanese financial institutions in the 1990s and the regulators’ response to the problem were evidenced by the failure of several nonbanks and assisted mergers of insolvent small banks with stronger banks in the 1991–95 period. The details of the assisted mergers indicate that there were no losses to depositors and very little penalties imposed on shareholders of failed banks (Cargill, Hutchison, and Ito, 1997).

In November 1997, for the first time since World War II a major Japanese bank, Hokkaido Takushoku Bank, failed. Today banks continue to face continual downgrading of their ratings, severe liquidity pressures, higher funding costs in interbank markets, and declines in their stock prices. Regulators have responded by guaranteeing all deposits, including interbank deposits, through 2001 and giving unofficial guarantees on other bank liabilities. In January 1998, the government announced a ¥30 trillion program that increased the funds available to the Deposit Insurance Corporation and injected ¥1.8 trillion of funds to shore up banks’ capital base. In April 1998, prompt corrective action regulations were implemented that required fuller disclosure of nonperforming loans and more adequate provisioning for problem loans. However, the implementation of some of the prompt corrective action regulations have been delayed, and in 1998 the MoF implemented certain accounting changes aimed at increasing regulatory capital of banks (see appendix 3). In June 1998, the Financial Supervisory Agency took over the supervision of banks from the MoF. Also in June 1998, the government announced the “total plan,” designed to resolve the crisis. A modified version of this plan became law in October 1998. The ¥60 trillion bail-out package involves the injection of public money into banks on a voluntary basis to increase their capital base, as well as the nationalization of insolvent banks. On the first day the law came into force, nationalization of the Long-Term Credit Bank of Japan (LTCB), which had been rumored to be insolvent for a number of months, was announced. The initial announcements indicated that all deposits, debentures, derivative contracts, interbank deals, and subordinated debt of the bank would be honored. The plan also called for the Deposit Insurance Corporation to purchase the shares of the LTCB, which last traded at ¥2.

APPENDIX 2

**Relationship between accounting profits, stock returns, and financial characteristics of Japanese banks**

In the first part of the analysis, I relate the accounting profits of Japanese banks to a set of variables that describe the banks’ characteristics and a set of variables that measure aggregate economic activity. Specifically, I estimate the following equation, using ordinary least squares (OLS), and report the results in table 3:

1) \[ ROE_{it} = \alpha + \beta R_{mt} + \theta X_{it-1} + \gamma Z_{t} + \phi Y_{tr-1} + \epsilon_{it}, \]

where \( ROE_{it} \) is return on equity for bank \( i \) in fiscal year \( t \), \( R_{mt} \) is the return in the Tokyo Stock Exchange in period \( t \), as measured by changed in the TOPIX index; \( X_{it-1} \) is a vector of characteristics of bank \( i \), calculated using information from fiscal year \( t-1 \); \( Z_{t} \) is a set of measures for aggregate economic activity in fiscal year \( t \); \( Y_{tr-1} \) is \( R_{mt} \), multiplied by bank \( i \)’s ratio of equity investments to total assets in fiscal year \( t-1 \); and \( \epsilon_{it} \) is an error term.

Similarly, banks’ stock returns are correlated to their characteristics by estimating the following equation using OLS:

2) \[ R_{it} = \alpha + \beta R_{mt} + \theta X_{it-1} + \gamma Z_{t} + \phi Y_{tr-1} + \epsilon_{it}, \]

where \( R_{it} \) is the stock market return of bank \( i \) in period \( t \) and the \( S \) superscript indicates that parameter estimates are for stock returns. The results from the estimation of equation 2 are reported in table 5.

The interaction terms in equations 1 and 2 make it difficult to determine the correlation between profitability and the ratio of equity investments to total assets. To simplify the presentation of the results, I reestimated equations 1 and 2 without the interaction terms. The coefficient estimates for TOPIX and equity investments from the “simplified” regressions are reported as the last two rows in tables 3 and 5.

Lastly, in table 6, I report the results from the OLS estimation of the following traditional and “augmented” market models:

\[ R_{it} = \alpha + \beta R_{mt} + \mu_{it}, \]

\[ R_{it} = \alpha + \beta R_{mt} + \delta ROE_{it} + \eta_{it}, \]

where \( \mu_{it} \) and \( \eta_{it} \) are error terms.
Differences in Japanese and U.S. accounting practices

Some of the significant differences in the disclosure and accounting rules in Japan and the U.S. are summarized below.

Nonperforming loans: In the U.S., loans that are past due more than 90 days plus nonaccrual loans are considered nonperforming. In Japan, the definition of nonperforming loans has changed in recent years to become more inclusive and more in line with U.S. standards. Previously, only loans to bankrupt companies and loans past due more than 180 days were considered nonperforming. However, since March 31, 1996, nonperforming loans have also included loans to assisted companies and loans restructured to have an interest rate below the official discount rate. On March 31, 1998, the definition was expanded to include loans past due more than 90 days and all restructured loans. Despite these changes, however, loans with partial interest payments, loans sold to the Cooperative Credit Purchasing Company, nonperforming loans of subsidiaries, and other loans for which the bank may ultimately be held responsible are excluded from the definition of nonperforming loans.

Also effective April 1, 1998, each bank is required to self-assess its asset quality, dividing its credit exposures into the following four categories: 1) category I—exposures with no credit concerns are classified; category II—credit exposures on which each bank has judged adequate risk management on an exposure-by-exposure basis will be needed,” but where the classification standard “varies significantly depending on their respective management practices,” (Japan, Ministry of Finance, 1998); category III—exposures on which the banks have serious concerns and are likely to incur losses, but cannot determine the timing and amount of such losses; and category IV—credit exposures that are noncollectible or of no value. On January 12, 1998, the Ministry of Finance (Japan, MoF, 1998) announced that 12.3 percent of Japanese banks’ total loans are classified in categories II through IV. The bulk of the classified assets, 10.4 percent of total loans, are in category II.

Loan loss provisions and reserves: U.S. accounting rules require banks to maintain an allowance for loan losses based on probability of collection and expected future cash flows. Additional provisions are made through periodic charges to operating expenses and, thus, are fully tax-deductible. Loan loss reserves are treated as a contra account on the assets side of the balance sheet and, therefore, are deducted from gross loans and total assets. Until April 1, 1998, Japanese banks maintained three types of loan reserves. General reserves for loan losses were maintained at the maximum tax deductible level of 0.3 percent of total loans outstanding. The portion of loans determined to be irrecoverable was reserved under specific reserves, of which only 50 percent is tax deductible. Banks could provision more than the tax deductible amount with approval from the MoF. Analysts point out that because loan loss reserves received a less favorable tax treatment in Japan and because banks were not required to increase provisions when the present value of the loan declined below its face value, Japanese banks did not fully provision for possible loan losses. Some of these concerns were addressed by the implementation of prompt corrective action (PCA) regulations, effective April 1, 1998. Under the PCA regulations, Japanese banks are expected to make adequate provisions based on their self-assessment of problem loans as outlined above. Lastly, most banks maintain specific foreign loan reserves equal to 35 percent of loans to specific countries where transfer risk may be material. However, only 1 percent of the outstanding loan amount is tax deductible. Reserves are classified as liabilities and total loans and total assets are reported gross of reserve amounts. Furthermore, unlike U.S. banks, which can establish a loss contingency reserve only when an event is probable and the amount of losses can be established, Japanese banks are allowed to establish discretionary reserve accounts, transfers to and from such reserves might allow Japanese banks to smooth their reported income.

Charge-off policy: Under U.S. accounting practices, once the extent and timing of losses arising from a loan can be determined, expected losses are recognized through loan charge-offs. In Japan, loans are charged off only when the debtor is in bankruptcy and there is no hope of recovery, and banks need a special MoF ruling to take loans off their books.

Valuation of securities: In the U.S., banks’ security holdings are classified under three separate categories and methods of valuation. Japanese banks classify their security investments as either for trading or investment purposes; however, the classification does not affect the valuation method. Listed securities are valued at either the lower-of-cost-or-market (LOCOM) value or at historical cost. Under the LOCOM method, market value increases above cost are not recognized and unrealized losses are recognized under valuation reserves. Unlisted securities are generally valued at cost; if the condition of the security issuer
deteriorates significantly, then the securities valuation is reduced accordingly. The difference between the market and book value of security holdings is referred to as “latent revaluation reserves,” or more commonly as “hidden reserves.”

**BIS capital requirements**: Similar to banks in other countries, Japanese banks with international operations are required to achieve a minimum total capital ratio of 8 percent, based on standards issued by the BIS. Within certain guidelines, regulators in individual countries are allowed to determine what constitutes capital. Consequently, there are differences across countries in how banks can satisfy the capital adequacy requirements. For instance, under U.S. regulations, unrealized gains on securities do not count as capital, but Japanese banks can use up to 45 percent of hidden reserves as tier two capital. Low profitability, high credit expenses for problem loans, and unfavorable conditions in capital markets have put Japanese banks’ capital position under pressure. In order to provide some relief to banks, the MoF recently introduced certain measures. For example, since January 1998, Japanese banks have been allowed to value securities at cost and avoid reported valuation losses; however, if a bank chooses this valuation method, it cannot use any portion of its unrealized gains as tier II capital for BIS capital requirements. International accounting standards generally do not allow higher-of-cost-or-market valuation for securities, which in effect the MoF rule does. Again, effective January 1998, banks can value real estate at market values, and 45 percent of the valuation reserves count as tier two capital. Most of the major countries, with the exception of Germany and the U.S., also allow such valuation reserves to count toward regulatory capital. In addition, in March 1998, under its stabilization program, the government purchased ¥1.8 trillion of banks’ preferred stock and subordinated debt. All three measures have increased Japanese banks’ regulatory capital base. In addition, starting this year, if the maturities and the other contractual features of loans and deposits from the same customer meet certain requirements, banks are allowed to net loan assets with the deposits of the same customer. As a result, the risk-weighted assets of banks are reduced, increasing their BIS capital ratios.

1. These categories are for disclosure purposes; for internal purposes, Japanese banks typically classify their assets into five categories: pass, special mention, substandard, doubtful, and bankrupt.
2. The classified exposures include off-balance-sheet guarantees as well as loans, and the reserved and collateralized portion of each exposure is classified in category I, independent of the borrower’s financial condition. Because of these and other details of the classification standards, the classified assets of a bank cannot be linked directly to its disclosed nonperforming loans.
3. In addition to these reserves for possible loan losses, Japanese banks maintain reserves for expected losses on trading account securities, government bonds, futures, and securities transactions.
4. Although the BIS capital adequacy requirements were established only for banks with international operations, regulators in the U.S. require all banks to maintain the minimum BIS capital ratios. However, Japanese banks with only domestic operations are exempt from the BIS requirements. In recent years, Japanese banks that experienced difficulties meeting the BIS requirements have sold their international operations and, thus, are subject only to the 4 percent capital requirement placed on banks with no international presence. For instance, on March 31, 1998, the MoF announced that the number of “internationally operating banks” declined from 80 institutions to 45 institutions and the number of “domestically operating banks,” which are subject to the 4 percent capital requirement, increased from 67 institutions to 102 institutions.

**NOTES**

2. For instance, a recent study notes that in 1980–96, over 130 countries experienced serious banking problems (Lindgren, Garcia, and Saal, 1996).
3. For an overview of the S&L and banking crisis in the U.S., the resulting regulatory changes, and an assessment of the regulatory reform, see Benston and Kaufman (1998) and references therein.
4. For a concise review of the literature, see chapter three of Lindgren, Garcia, and Saal (1996) and references therein.
5. For instance, just as the MoF allows Japanese banks to avoid reporting valuation losses on security portfolios, in the 1980s the Federal Home Loan Bank Board allowed S&Ls to defer recognition of losses on asset sales. For details of the regulatory accounting practices allowed by S&L regulators, see Benston and Kaufman (1990), Barth (1991), and Ashley, Brewer, and Vincent (1998).
6. The cost of regulatory forbearance in the U.S. has been studied by Eisenbeis and Horvitz (1994), Brinkmann, Horvitz, and Huang (1996), Kane and Yu (1996), and others.
8. In addition to its regulatory function in the banking industry, the MoF has other, broader responsibilities, such as regulation of other financial institutions, setting fiscal policy, collecting taxes and custom duties, drawing and allocating the government budget, floating government bonds, and overseeing foreign exchange transactions.
The banks in table 1 do not represent all banks in Japan, only the largest ones. Second tier regional banks and institutions that specialize in financing of small businesses and agriculture are not included.

Keiretsu are one of the most distinguishing features of Japanese organizational structure. Keiretsu are groups of companies that maintain long-term relationships with each other through cross sharasholdings and customer-supplier relationships. Financial institutions (typically a city bank, a trust bank, and insurance companies) form the nexus of keiretsu and provide debt and equity financing to group firms. Previous studies found that keiretsu firms differ from other Japanese firms in significant ways. (For a description of keiretsu relationships, see Nakatani (1984), Sheard (1989), Genay (1991), Aoki and Patrick (1994), and the references therein.) For instance, keiretsu firms recover from financial distress faster than other Japanese firms (Hoshi, Kashyap, and Scharfstein, 1990), and they may be less cash constrained in their investments (Hoshi, Kashyap, and Scharfstein, 1991; and Hall and Weinstein, 1997). In addition, corporate governance practices appear to be different in keiretsu: Banks play a more central role in the governance of keiretsu firms through their board representation (Kaplan and Minton, 1994), and the shareholders of financial institutions in the keiretsu respond differently to risk from the shareholders of other financial firms (Genay, 1993). However, there is also evidence that keiretsu relationships involve significant costs (Gibson, 1996; Kang and Stulz, 1997; and Weinstein and Yafeh, 1998).

Although anecdotal evidence suggests keiretsu relationships are weakening, these groups and their financial institutions continue to be major players in the Japanese economy.

The slight decline in interest margins at U.S. banks during this period reflects aggressive price competition in U.S. business lending markets. Hence, the relatively greater profitability of U.S. banks during 1990–97 is due mostly to higher fee and other income.

Similarly, according to statistics reported by Demirgüç-Kunt and Huizinga (1997), Japanese banks earned, on average, 0.10 percent return on assets (ROA) in 1988–95. Over the same period, banks in the rest of the G7 countries earned 0.53 percent ROA.

For some examples of this literature and other banking studies that form the basis of the following discussion, see Brewer and Garcia (1987), Berger, King, and O'Brien (1991), Kuester and O'Brien (1991), Thomson (1992), Cole (1993), Berger (1995), Brewer, et al. (1997), Demirgüç-Kunt and Huizinga (1997), and references therein.

Lack of sufficient numbers of Japanese bank failures precludes me from analyzing the determinants of the solvency of Japanese banks.

I relate current bank performance to characteristics measured at the end of the previous period. Therefore, although ROE is negatively correlated with loan loss provisions in the current period by definition, there might be a positive relationship between current ROE and previous loan loss provisioning.

There is also evidence that nonperforming loans reported by U.S. banks are important predictors of future bank performance and are significantly related to stock market value of banks’ equity. For Japanese banks, definition of what constitutes a nonperforming loan is less inclusive and has changed several times in recent years (see appendix 3); as a result, it is more difficult to measure the impact of nonperforming loans on Japanese bank performance.

For a detailed discussion of the relationship between earnings and capital, see Berger (1995) and Brewer et al. (1997).

I also used other measures of liquidity and capital (such as book value of capital to total assets andTier one capital ratio). The results with these alternative measures were qualitatively similar to those reported in the article.

In the following analysis, I also used other measures of economic activity, such as the change in the yen-dollar exchange rate, changes in short-term and long-term interest rates, changes in term structure, and dummy variables for years. The results with respect to bank characteristics were similar to those reported in the article. The results also indicated that Japanese banks face some interest rate and foreign exchange risk. In particular, depreciation of the yen is associated with lower bank earnings and stock returns. Changes in the term structure are also negatively correlated with bank earnings. Specifically, increases in the short-term gensaki rate (the three-month, riskless rate) are associated with higher bank earnings, whereas increases in the long-term (ten-year bell-wether bond) rates are negatively correlated with bank earnings. Monthly stock returns of banks, when significant, exhibit a similar relationship with changes in the short- and long-term interest rates. However, there are significant differences in the interest rate sensitivity of Japanese banks in the pre- and post-1995 periods and across bank types. The evidence with respect to long-term interest rates is consistent with the results reported in Broussard, Kim, and Limpaphayom (1998), which looks at the sensitivity of Japanese banks in the 1975–94 period.

Excluding these observations does not qualitatively affect the results presented here.

Stock prices for the three long-term credit banks were unavailable; hence these banks are excluded from the analysis of stock returns reported in table 6.

The following results on accounting profits remain qualitatively the same if one uses ROA, rather than ROE.

There is some evidence, for example, that the cost of issuing convertible bonds was significant for Mitsubishi Bank (Ammer and Gibson, 1996).

The results with other measures of accounting profitability are available from the author upon request.

The statistics in table 2 indicate that Japanese banks have increased their equity investments in recent years. Although this might appear inconsistent with anecdotal evidence on equity sales, it is consistent with other anecdotal evidence that suggests that banks repurchased their equity stakes in other companies to maintain long-term relationships. Japanese banks accumulated their equity stakes over a long period, beginning at the end of World War II. Consequently, it is very likely that banks repurchased these shares at higher prices than they originally paid. In that case, the ratio of equity investments to total assets in table 2, reported as the lower of cost or market value, would increase.

The largest shareholders of banks are other financial institutions and, for keiretsu banks, nonfinancial firms in the group (Genay, 1993). To the extent that these shareholders are better informed about the banks than other market participants, they would be less likely to be misled by the reported numbers. If the top shareholders trade on their information, or signal this information to the market in other ways, the correlations of stock returns with bank characteristics would reflect the market’s information and would differ from those observed with accounting earnings.

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Foreign growth, the dollar, and regional economies, 1970–97

Jack L. Hervey and William A. Strauss

Introduction and summary
Midwestern manufacturing industries have undergone a substantial transformation during the past two decades that has positively influenced the region’s economic growth. Extensive industrial restructuring and technological innovation (both of which contribute to increased productivity) have contributed to this transformation. In addition, the region’s economic growth, as well as that of other U.S. regions, is often associated with economic developments external to the domestic market, such as expansion in foreign market demand, and favorable movements in the dollar exchange rate (that is, a dollar depreciation) during the 1970s and from the mid-1980s to the mid-1990s.

Since the mid-1980s, international markets have received considerable attention as drivers of growth in manufacturing for the Midwest and other U.S. regions. In particular, the coincidence of the recovery of the Midwest economy,1 expanding foreign markets, and the U.S. dollar’s depreciation in foreign exchange markets since 1985 has led some observers to forge a link between the recovery and foreign growth and the dollar’s depreciation. From the late 1980s well into the 1990s, an association between the nation’s industrial recovery and expansion, especially in the Midwest, and the dollar’s depreciation was a common topic of discussion, especially in the popular press. Examples of this view are expressed by Koretz (1988) and Prowse (1995).

In this article, we examine the impact on U.S. regional economies of exchange rate change and foreign demand growth. We address the following questions: Are there differences in the exchange rates that regions face? Did depreciation in the dollar exchange rate measurably influence economic growth in the Midwest and other regions in 1970–97? Does growth abroad faced by the regional economies differ by region? And to what degree did foreign economic activity influence U.S. and regional economies in 1970–97? It is clear that different regions have different industrial structures. We expect these differences to reflect regions’ trading partners and the industrial makeup of their export basket. Therefore one would expect these differences to be reflected in the foreign exchange rates and foreign demand faced by different regions.

We construct region-specific indexes for exchange rates and foreign economic growth. We then examine trends in these indexes. Next, we incorporate the two region-specific index measures into a regression analysis that addresses their impact on economic growth in U.S. regions in 1970–97.

The dollar experienced substantial variability in its foreign exchange value during the period under review; and the expected regional differences appear prominently in our region-specific exchange rate indexes. The period was characterized by dollar depreciation from mid-1971 to mid-1980 and again from early 1985 to mid-1995. The bulk of the latter movement occurred from 1985 to 1988, although the dollar continued to depreciate relative to several major currencies into the mid-1990s. However, our analysis suggests that Midwest manufacturing goods exporters, in the aggregate, faced an appreciating dollar exchange rate in 1988–96, rather than a continuation of the depreciating trend reflected in movements of the dollar relative to several major currencies. The Midwest-specific

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exchange rate indexes reflect the heavy concentration of the region’s export trade to other North American markets, where the dollar was relatively strong. According to this index, manufactured goods export industries faced a real aggregate dollar exchange rate that was higher (that is, had appreciated) at the end of 1996 than in 1988 or even in 1970, the last full year before the 1971 dollar devaluation and the subsequent floating of the dollar. The appreciation of the dollar exchange rate index observed for the Midwest, however, was not characteristic for all regions of the country. For example, the Far West indexes reflect the relatively greater importance of the Pacific Rim markets, and, consequently, show a weaker region-specific dollar than the Midwest indexes. Far West manufacturing industries experienced a marked dollar depreciation through the mid-1990s.

The measurable economic impact of change in the dollar exchange rate on overall regional economic activity is less clear. Our statistical analysis examines the relationship between regions’ output growth (gross regional product—GRP) and the aggregate dollar exchange rates they face. It suggests that while region-specific exchange rates may exhibit different trends for different regions of the country, variation in these region-specific dollar measures may not be an important factor explaining economic activity in manufacturing industries. The ability of these regional indexes to explain change in the gross measures of regional economic activity is weak. On the other hand, these foreign market indicators are significant with regard to explaining change in total U.S. growth, although the direction of the impact is apparently through the import sector rather than the export sector. By reducing the dollar cost of imported factors of production, such as raw materials and components, an appreciating dollar may contribute to additional domestic value-added output.

We also examine the relationship between changes in regions’ output and their region-specific foreign demand, that is, average economic growth in those markets to which specific regions export goods. The intuition is that the stronger the economic growth in a region’s foreign markets, the greater the region’s growth in exports to those markets will be and, in turn, the greater the impact on the region’s economic growth. Our results suggest that positive growth in a region’s foreign markets tends to exert a positive impact on a region’s manufacturing activity. However, the statistical significance of the link is weak. Region-specific foreign growth rates vary substantially. The concentration of the Midwest’s foreign markets in the Americas results in that region showing a substantially lower rate of foreign income growth than most other U.S. regions. In contrast, the Far West’s strong concentration in Pacific Rim markets is reflected in relatively stronger foreign market growth during the 1970–97 period. For the U.S. as a whole, foreign demand is a positive and highly significant contributor to growth.

We include within our statistical analysis a one-period lag measure of U.S. economic activity for each of the regions, which turns in positive and highly significant results. This strongly supports the contention that the U.S. economy is still the primary factor influencing regional economic growth; this is especially true for the Midwest. This result supports recent work on regional input–output analysis.

The international economy and the U.S.

International markets have become increasingly important to the U.S. economy during the past three decades. Since 1960 the constant dollar volume of U.S. goods exports has increased about eightfold. Foreign demand for U.S. goods has also increased relative to the total volume of U.S. goods production. This is reflected in a substantial increase over time in the proportion of domestic goods production entering export markets. In 1960, for example, the real value of U.S. goods shipped to foreign markets accounted for about 8.5 percent of domestic goods output. By 1970, the export share of domestic goods output had increased to about 11 percent and by 1995 it had reached about 24 percent. At the same time that exports were becoming a more important component of the U.S. economy, there was also a redistribution of output and exports among U.S. regions. While the dollar value of Midwest exports of manufactured goods increased substantially during this period, the Midwest’s share of U.S. manufactured goods exports actually declined, from over 30 percent in the early 1970s to a little over 20 percent in the early 1990s.

The postwar period also saw a change in the world’s industrial and trade regime. Seven rounds of multinational trade negotiations, beginning in the late 1940s with the establishment of the General Agreement on Tariffs and Trade (GATT), contributed to an increase in world trade flows. Foreign countries and industries recovering from the devastation of World War II seized the opportunity created by increasingly open markets. Rebuilt and relatively more efficient manufacturing infrastructure in Europe and Japan increased competitive pressure on the older, less efficient U.S. manufacturing industries.

The early postwar period also saw the U.S. dollar emerge as the exchange rate standard in world trade.
The dollar exchange rate standard, which grew out of the 1944 Bretton Woods Agreement, began to break down in 1971 when stress on the fixed exchange rate regime forced the first of two dollar devaluations. Eventual abandonment of the fixed exchange rates regime came with the adoption of a floating dollar in March 1973. Subsequent depreciation of the dollar during the remainder of the decade helped keep U.S. goods prices competitive in world markets and U.S. exports continued to expand, increasing 214 percent between 1973 and 1980. However, the value of goods imports grew 254 percent over the same period. Thus, even with the dollar’s depreciation during the 1970s, foreign competition continued to increase.

During the first half of the 1980s, a period of historically high U.S. interest rates, foreign exchange markets abruptly turned around and the dollar appreciated sharply through February 1985. This in combination with the worldwide recession of the early 1980s contributed to a deterioration in the price competitive position of U.S. goods in world markets (that is, the foreign currency cost of U.S. goods rose due to the exchange rate effect). As a result, the value of U.S. goods exports declined 10 percent between 1981 and 1983 and remained below 1981 levels until 1987. On the other hand, import growth slowed, but increased in value by 55 percent from 1981 to 1987.

The increased intensity of international competition contributed to turning the Midwest, the nation’s manufacturing heartland of earlier decades, into the Rust Belt during the late 1970s and the first half of the 1980s. An economic recovery in the Midwest that began during the second half of the 1980s coincided with a realignment and restructuring of manufacturing industries and a resumption in the rapid growth in export markets. This confluence of developments spawned the view, noted earlier, that the resurgence in manufacturing was largely attributable to the sharp depreciation of the dollar during 1985–88 and the more gradual dollar depreciation through the mid-1990s. In addition, however, one can not ignore the positive impact of economic expansion in foreign markets and the emergence of rapidly growing markets in Asia and Latin America.

In short, exchange rate change and expansion in international markets are widely held to have become a more important influence on the U.S. and its regional economies during the past three decades.

**Exchange rates and economic growth**

We examine two factors that influence U.S. international trade, with reference to U.S. regional economies. How do 1) exchange rate changes and 2) changes in foreign demand influence these regional economies? To answer this question, we construct two measures—a region-specific exchange rate index and a region-specific foreign economic growth index.

Our aim is to identify whether different regions of the U.S. face different exchange rates, whether there are differences across U.S. regions in the average economic growth (foreign demand) they face in their export markets; and whether the region-specific measures of exchange rate change and foreign economic growth contribute to explaining changes in regions’ economic activity.

**Why a regional exchange rate index?**

At any time there is only one exchange rate for the U.S. dollar vis-à-vis any other currency. We suggest, however, that different U.S. regions, by virtue of their different industrial makeup and the foreign markets in which their industries are active, face different sets of exchange rates. Thus, a general observation that the dollar is depreciating or appreciating may have different implications from one region to another. We construct a set of aggregate export-weighted dollar exchange rate indexes for selected geographic regions. We identify broad manufacturing industry classifications within each region. We focus on identifying exchange rate variations and the differences in the composition of export markets that influence selected U.S. regions. This is an area of research only beginning to receive attention in the literature; see Clark, Sawyer, and Sprinkle (1997 and 1999), Cronovich and Gazel (1998), and Hervey and Strauss (1996 and 1998).

We can identify potential differences in exchange rates faced by different regions of the country by looking at regional trade patterns. Figure 1 shows manufactured durable goods exports to major world markets for the U.S. as a whole and eight regions. For example, the Midwest sends (1993–94 average) nearly 60 percent of its manufactured durable goods exports to markets in which the dollar has been historically strong, that is, other North American markets (46 percent to Canada and nearly 13 percent to Mexico), while only 15 percent of its exports go to European markets and only 4 percent to Japan. On the other hand, durable goods industries in the Far West ship a substantially higher proportion of their exports to markets in which the dollar has depreciated: 17 percent to Japan and 25 percent to Europe.

Clearly, markets in which the dollar has appreciated in recent years (Canada and Mexico) have been more important to durable goods manufacturers in the Midwest than in the U.S. overall. The magnitude and structure of U.S. and Canada/Mexico trade (cross-border trade) is of some concern with regard to
FIGURE 1

Share of durable goods exports by region or country of destination, 1993–94

A. U.S. percent
60

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<th>Region</th>
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B. New England percent
60

<table>
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<tbody>
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C. Midwest percent
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D. Southeast percent
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E. Plains percent
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F. Mountain percent
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G. Southwest percent
60

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<tbody>
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H. Far West percent
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<tr>
<td>Africa</td>
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<tr>
<td>Other</td>
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</table>

*Excluding Mexico.
*Excluding Japan.
Source: Authors’ calculations from Massachusetts Institute for Social and Economic Research, 1993 and 1994, State of exporter location, series 2, CD-ROM.
the exchange rate and foreign demand growth issues we examine in this article. The degree of integration of these markets, especially in the production processes in the automotive and electronics industries, may substantially reduce the influence of exchange rate change on cross-border trade. Intra-firm trade, while a part of the export–import statistics, may not truly reflect a market exchange. Although there is a large volume of trade, we cannot say how much of it faces an exchange rate transaction (see box 1).

Construction of the regional dollar indexes

We identify nine regions: the U.S. and eight aggregations of states that correspond to the U.S. Department of Commerce, Bureau of Economic Analysis (BEA), geographical breakdown of the United States.8 Our primary focus is on the BEA’s Great Lakes (Midwest) region (Illinois, Indiana, Michigan, Ohio, and Wisconsin). Details of our calculations are in technical appendix 1.

A broad range of regional research examining exchange rates and/or international trade effects has focused on specific state effects, including, for example, Branson and Love (1986), Carlino (1990), Coughlin and Pollard (1998), Hayward and Erickson (1995), and a work by Cronovich and Gazel (1998) that examines the impact of exchange rate and foreign income change on state-defined measures of economic activity, such as employment or exports. We do not report individual state indexes here because of distortions in gross export data that are exaggerated when using state-level data. These distortions arise because the complete manufacture of a product may not take place within one state. More likely, the manufacture of an intermediate component may be carried out in one state, then shipped to another state or several more states for further processing. State export by destination data based on the value added in manufacturing by state are not currently available. Future work building on the regional input–output literature, such as Israilevich, Hewings, Sonis, and Schindler (1997), may provide these data.

We use regional aggregations of states’ exports by destination from the U.S. Bureau of the Census, State of export—Location of exporter series.9 These data are from the shipper’s export declaration for the state of location of the exporter, which means that the value of intermediate goods eventually exported may not be attributed to the appropriate state. The aggregation of states into BEA regions should reduce, although it will not fully eliminate, this mismeasurement. The state/region and industry weights in the indexes are based on U.S. exports by country of

---

**BOX 1**

**Round-trip-trade: Canada and Mexico**

Canada is an important market for Midwest manufacturing and, as such, a critical element in the Midwest dollar index. Mexico is similarly important to the Southwest. The unique relationships the U.S. has with Canada and Mexico raise concern about the interpretation of the regional indexes.

In certain industries, there is a high level of integration of production facilities across the borders (in particular, the automotive industry across both borders and the maquiladoras industries along the U.S./Mexico border). The question arises whether the effect of a change in the Canadian dollar/U.S. dollar or Mexican peso/U.S. dollar exchange rate is the same for an integrated firm (with cross-border intrafirm transactions, or round-trip trade) as for unrelated firms (with cross-border interfirm transactions). Are these transactions booked in U.S. dollars or do exchange rates make a difference?

There appear to be no simple answers to these questions. Conversations with individuals in the auto industry suggest that even for such a cross-border integrated industry, exchange rate change makes a difference, but in the longer-term decisions such as plant investment and location. In that case, the existence of an integrated market across borders might not bias the impact of exchange rate changes on the regional indexes viewed in a long-term context. In other integrated industries, transactions are denominated in dollars and the exchange rate translation occurs only if the final product enters a third country foreign market.

For the maquiladoras industries on the Mexico/U.S. border, most cross-border transactions are denominated in U.S. dollars. Thus, change in the peso/dollar exchange rate does not have a direct effect on these transactions. Nonetheless, a peso devaluation, for example, will influence the local value-added portion, that is reduce in terms of dollars (through cheaper labor and components), the dollar value of the transaction if the final product is shipped back (imported) to the U.S. So, even in this case exchange rate change counts to some degree.
destination by industry for 1993 and 1994.\textsuperscript{10} The Census location data are adjusted for exports unallocated by state and industry classification and are made available by the Massachusetts Institute for Social and Economic Research (MISER).\textsuperscript{11}

To make this project a more manageable size, we grouped the 20 two-digit manufacturing Standard Industrial Classifications (SICs) into three broad classes—total manufactured goods, durable manufactured goods, and nondurable manufactured goods.\textsuperscript{12} Our region and industry breakdown results in 27 exchange rate indexes. The full range of regions and industries would have resulted in 180 indexes. However, the size restriction imposes a cost. Further breakdown of the industries might provide more information on the impact of round-trip trade with Canada and Mexico—essentially intra-firm transactions where, at least in the short-term, intermediate goods traverse the border without entering the price/market system.

To provide a known index for comparison at the national level, our regional indexes incorporate the currencies of the same 44 countries as the J. P. Morgan (JPM) real effective exchange rate indexes. These countries account for more than 90 percent of U.S. goods exports.

The use of export-only weights is an unusual methodology in the construction of an aggregate exchange rate index. Aggregate exchange rate indexes typically use a weighting mechanism based on bilateral trade weights (as in the JPM noted above), for example, U.S. exports plus imports by country of destination or source, or multilateral trade weights, for example, total world trade (that is, total exports plus total imports) for each country. Due to the lack of the lack of available import data by state, we are constrained to constructing a regional index based on export weights. A multilateral trade weighting scheme (for example, as used in the Federal Reserve Board’s nominal trade-weighted index) would be better able to account for the third-country effects of exchange rate changes. However, multilateral weights are not applicable to U.S. regional indexes because the same country weight (that is, its share of world trade) would apply to each region.\textsuperscript{13}

The use of export-only weights requires that conclusions be carefully stated. These indexes relate only to an aggregation of exchange rates that exporters face directly. There are two areas of inquiry of interest with respect to exchange rates: 1) the impact of exchange rate change on the regional economy and regional manufacturers through their export markets, and 2) the impact of exchange rate change on the regional economy and manufacturers as influenced by imports. At this stage, we can only address the exporter side.\textsuperscript{14}

A final issue of concern in the construction of our regional indexes relates to the 1993–94 period we use for the export and industry weights. It is well established in the literature that there were marked changes in U.S. trade patterns from 1970 through the late 1980s. Hickok and Orr (1989–90), Hervey (1990), and Hickok (1991) document substantial changes in the foreign market shares and industrial composition of U.S. exports during that period. The selection of the fixed period (1993–94) base for trade weights raises a question about the potential bias in the indexes as they move away from the base period. Hervey and Strauss (1987) suggest that export weights that use a moving average (for example, a 12-quarter moving average) to account for change over time in the composition of trade by destination would be a considerable improvement over the fixed-period weights. In addition, Coughlin and Pollard (1998) make a case for the use of chained weights in the construction of aggregate exchange rate indexes to lessen the well-known problems associated with the fixed-period base of the Laspeyres-type index used in most aggregate exchange rate indexes, including the ones in this study. Acknowledging these shortcomings, we are constrained to use fixed-year weights here because of the limited availability of consistent historical state-export data prior to 1993.

An exchange rate is a price of one currency in terms of another. But it is not the only relevant price. Rates of change of within-country prices across countries are also of interest, especially when countries experience marked differences in inflation. A change in the exchange rates tells only half the story. The focus of exchange rate adjustment should be on real exchange rates. The preferable internal price series for this exercise is one that relates specifically to the goods traded. However, price series with such detail are not available for the spectrum of countries and industry groups included in our regional indexes. We use producer price series provided by J. P. Morgan.\textsuperscript{15}

The exchange rate series for countries in the indexes are monthly averages from the International Monetary Fund, International Financial Statistics series, except for Taiwan and Hong Kong, which are from the Federal Reserve Board series.

**Regional exchange rate indexes**

The regional export-weighted dollar indexes in some cases contradict the common perception that the dollar continued to depreciate over much of the period 1970–97, particularly in 1988–96. Figure 2 plots the region-specific dollar and the U.S. dollar for the periods 1970–97 and 1988–96. In the aggregate, the
Midwest index (figure 2, panels E and F) shows an appreciating trend for both periods, particularly for 1974–97.16

For 1988–96, divergent trends from that recorded for the U.S. appear primarily in the indexes for the Southwest, the Mountain states, and to some degree the Mideast and Far West. While the differences are not large, the deviations of the regional indexes from the U.S. index are either consistently positive (especially for the Midwest, Southeast, and Southwest) or

**FIGURE 2**
Regional exchange rate index

<table>
<thead>
<tr>
<th>Panel</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>F. U.S. and Midwest, 1988–96</td>
<td>Index, 1988–100</td>
</tr>
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</table>
negative (in the case of the Mideast, Far West, and Mountain states) (see figure 3).

Figure 4 provides an interesting perspective on the Midwest’s dollar index relative to those of the other regions. In most cases the Midwest dollar index for manufactured goods deviates substantially from the indexes of the other regions and is higher than those of the other region-specific indexes, peaking in 1995 at 20 percent versus the Mountain states, 17 percent versus the Far West, 15 percent versus the
Mideast, and about 12 percent versus New England. On the face of it, this suggests that Midwest exporters of manufactured goods are facing a substantial real exchange rate appreciation (price disadvantage) in their foreign markets, relative to other regions.

The industrial composition of exports also appears to influence the regional exchange rate pattern. The U.S. export-weighted real indexes for durables and nondurables are virtually identical. Figure 5 plots the percentage deviation in the regions’ durables and...
nondurables indexes versus the U.S. indexes. For example, in 1995 the Midwest’s exchange rate index for durable manufactures was more than 9 percent higher than the comparable U.S. index. However, the Midwest’s nondurables index was only 2 percent higher than the comparable U.S. index. Generally, the region-specific nondurables indexes are less volatile and follow the national index more closely than do...
the durable goods indexes. The Southwest is the only region to show a large positive deviation from the U.S. for nondurables (it shows a similar deviation for durables). We suspect that this atypical result for nondurables may be related to the high concentration of maquiladoras industries (mostly U.S. industries on the Mexican side of the border that produce for the U.S. market; see box 1) along the U.S./Mexico border.

![Figure 5: Deviation of regional industry exchange rate indexes from comparable U.S. indexes](image-url)
border and the large volume of crossborder trade, especially in the textile and apparel industries.

**Foreign demand faced by regional markets**

In an open economy, foreign demand contributes to overall demand on the economy's output. We would expect economic expansion or contraction in foreign markets to influence the growth in exports to those markets. Thus, we would expect economic activity in U.S. regions that export to be positively influenced by growth abroad. Furthermore, because economic growth is not uniform across countries and regions do not export uniformly across foreign markets, we would expect economic growth abroad to influence U.S. regional economies differently.

To measure foreign economic growth that is unique to the markets served by individual regions, we use an average foreign gross domestic product (GDP) growth (in real terms) that is exchange rate neutral (measured in terms of an individual country's home currency). Details of our calculations are in technical appendix 2. We construct nine “region-specific” foreign GDP growth rate series—for eight regions and the U.S. Cronovich and Gazel (1998) take a similar approach to measuring export-weighted foreign market growth for individual states.

We weight GDP growth rates for 20 major export markets for each region based on the market share of that region’s manufactured goods exports to each country (in 1993–94). Thus, the more important a specific country is for a region’s exports, the larger is the weight placed on that country’s GDP growth; and the countries included may vary across regions. We use the major markets in the MISER location of exporter series for 1993–94. Individual country GDP growth rates are from the International Monetary Fund, the United Nations, and individual country sources.

Figure 6 presents the region-specific foreign GDP growth rates relative to the U.S.-specific rate. (A positive number indicates that growth in a region’s foreign markets is larger than growth in foreign markets for the U.S.) The data suggest that, for the most part, aggregate regional foreign market growth tends to deviate substantially from the U.S. average. Certain regions appear to experience consistently faster or slower growth in their foreign markets than does the U.S. In particular, foreign demand growth in Midwest markets (heavily concentrated in the Americas) was well below the U.S. average throughout the 1970–97 period. On the other hand, the Far West markets, heavily concentrated in the Pacific Rim, recorded consistently higher growth. The Southwest shows a highly variable growth pattern with broad swings in the early and late 1980s and mid-1990s; these are probably largely attributable to the sharp deterioration in economic activity in Latin America and Mexico in the 1980s (credit crisis) and Mexico in the mid-1990s (depreciation of the peso and subsequent austerity measures).

**Regional economic activity: Regional exchange rates and foreign economic growth**

Our region-specific dollar exchange rates and region-specific foreign economic growth measures suggest that different regions of the country face different mixes of exchange rate and foreign growth change and may be influenced differently by developments in international markets. Do these regional measures of international exposure measurably influence economic growth within these regions? Studies such as Cronovich and Gazel (1998) indicate that region-specific exchange rate and foreign demand growth influence regional export markets. But are the effects large enough to significantly influence overall regional economic growth?

To explore this further, we use four regression models to explain variation in regions’ real output or gross regional product (GRP). We use four dependent variables for output—total GRP, GRP attributable to manufacturing industries, GRP attributable to durable manufacturing industries, and GRP attributable to non-durable manufacturing industries (the last three industry designations parallel the definition of the regional exchange rate indexes). The analysis views the two constructed international market variables—region-specific exchange rate indexes and region-specific foreign GDP growth—as externally generated shocks to the regional economies. One may quibble with this assumption, as clearly the relationship between the growth of U.S. and foreign economies is not entirely independent and U.S. foreign exchange rates are not independent of U.S. domestic monetary and economic policy. It is also true that within the U.S., developments in regional growth are not independent of developments in other regions or of the U.S. economy. To isolate these domestic influences on regional growth, we include two measures of recent domestic economic activity—previous period U.S. GDP growth and previous period own-region economic growth. We also include a measure of oil prices as an independent, *external shock* variable. Other researchers, for example, Davis, Loungani, and Mahidhara (1997), have found this to be meaningful in explaining regional economic growth. (One might question the external or supply shock nature of this variable. During the 1970s and early 1980s this nature of oil price determination was reasonably clear, but it has been less clear since then). Technical appendix 3 provides a more detailed discussion of the makeup of the model.
What results do we expect from this analysis? We expect the lagged measures of domestic output growth (U.S. and regional) to be positively related to current output growth. We normally expect oil price change to be related negatively to output. If oil prices increase, production that is energy intensive or product that is energy intensive in its use becomes less competitive and output declines, pending a redistribution in resources and output. However, for a region in which energy production is an important
### TABLE 1
Regression results for regional output equations

<table>
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<tr>
<th>Region</th>
<th>Total GRP</th>
<th>Manufacturing GRP</th>
<th>Durable GRP</th>
<th>Nondurable GRP</th>
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<tr>
<td>1. United States</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Region-specific foreign GDP</td>
<td>1.3701 (0.2318)</td>
<td>2.0616 (0.5392)</td>
<td>2.7035 (0.7246)</td>
<td>1.2807 (0.4734)</td>
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<tr>
<td>Price of crude oil by industry</td>
<td>-0.0271 (0.0143)</td>
<td>-0.0668 (0.0334)</td>
<td>-0.0610 (0.0453)</td>
<td>-0.0705 (0.0283)</td>
</tr>
<tr>
<td>Real GDP, U.S. by industry</td>
<td>0.0330 (0.1237)</td>
<td>0.0440 (0.1517)</td>
<td>0.1118 (0.1555)</td>
<td>-0.1926 (0.1658)</td>
</tr>
<tr>
<td>Real GRP by industry</td>
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<td></td>
</tr>
<tr>
<td>Exchange rate index by industry, one-period lag</td>
<td>0.1684 (0.0835)</td>
<td>0.2026 (0.1937)</td>
<td>0.2478 (0.2629)</td>
<td>0.1252 (0.1659)</td>
</tr>
<tr>
<td>Exchange rate index by industry, two-period lag</td>
<td>0.0859 (0.0768)</td>
<td>0.2316 (0.1813)</td>
<td>0.3796 (0.2421)</td>
<td>0.1321 (0.1541)</td>
</tr>
<tr>
<td>Significance of sum of exchange rate variables</td>
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<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.69</td>
<td>0.55</td>
<td>0.51</td>
<td>0.49</td>
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<tr>
<td>2. New England</td>
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</tr>
<tr>
<td>Region-specific foreign GDP</td>
<td>0.0026 (0.4841)</td>
<td>0.8844 (0.6093)</td>
<td>0.9461 (0.8463)</td>
<td>1.0889 (0.4559)</td>
</tr>
<tr>
<td>Price of crude oil by industry</td>
<td>-0.3369 (0.2790)</td>
<td>-0.3510 (0.4367)</td>
<td>-0.5662 (0.5155)</td>
<td>-0.2970 (0.5276)</td>
</tr>
<tr>
<td>Real GDP, U.S. by industry</td>
<td>0.8534 (0.2851)</td>
<td>0.4744 (0.1922)</td>
<td>0.4063 (0.1984)</td>
<td>0.3549 (0.1843)</td>
</tr>
<tr>
<td>Real GRP by industry</td>
<td>0.2776 (0.1016)</td>
<td>0.2972 (0.1152)</td>
<td>0.3769 (0.1389)</td>
<td>0.2707 (0.1363)</td>
</tr>
<tr>
<td>Exchange rate index by industry, one-period lag</td>
<td>0.0221 (0.0886)</td>
<td>0.1895 (0.1310)</td>
<td>0.1497 (0.1820)</td>
<td>0.2504 (0.1191)</td>
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<td>Exchange rate index by industry, two-period lag</td>
<td>0.0235 (0.0783)</td>
<td>-0.0255 (0.1198)</td>
<td>-0.0703 (0.1739)</td>
<td>0.1699 (0.1110)</td>
</tr>
<tr>
<td>Significance of sum of exchange rate variables</td>
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<tr>
<td>$R^2$</td>
<td>0.82</td>
<td>0.75</td>
<td>0.68</td>
<td>0.69</td>
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<td>3. Midwest</td>
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<tr>
<td>Region-specific foreign GDP</td>
<td>-0.3516 (0.2589)</td>
<td>-0.1828 (0.2899)</td>
<td>-0.4906 (0.4170)</td>
<td>-0.0200 (0.2438)</td>
</tr>
<tr>
<td>Price of crude oil by industry</td>
<td>-0.0737 (0.0493)</td>
<td>0.1051 (0.0840)</td>
<td>-0.3048 (0.1317)</td>
<td>-0.0410 (0.0728)</td>
</tr>
<tr>
<td>Real GDP, U.S. by industry</td>
<td>0.9262 (0.1602)</td>
<td>0.9049 (0.0972)</td>
<td>1.0667 (0.1046)</td>
<td>-0.8095 (0.1078)</td>
</tr>
<tr>
<td>Real GRP by industry</td>
<td>0.1208 (0.0868)</td>
<td>-0.0267 (0.0691)</td>
<td>-0.0094 (0.0706)</td>
<td>0.0126 (0.0659)</td>
</tr>
<tr>
<td>Exchange rate index by industry, one-period lag</td>
<td>-0.0745 (0.0594)</td>
<td>-0.0721 (0.0805)</td>
<td>-0.2360 (0.1138)</td>
<td>0.0777 (0.0762)</td>
</tr>
<tr>
<td>Exchange rate index by industry, two-period lag</td>
<td>0.0177 (0.0491)</td>
<td>-0.0549 (0.0739)</td>
<td>-0.1842 (0.1095)</td>
<td>0.0905 (0.0653)</td>
</tr>
<tr>
<td>Significance of sum of exchange rate variables</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.87</td>
<td>0.90</td>
<td>0.91</td>
<td>0.89</td>
</tr>
<tr>
<td>4. Plains States</td>
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</tr>
<tr>
<td>Region-specific foreign GDP</td>
<td>0.1290 (0.3733)</td>
<td>0.1229 (0.4719)</td>
<td>0.2111 (0.5822)</td>
<td>-0.0841 (0.2715)</td>
</tr>
<tr>
<td>Price of crude oil by industry</td>
<td>-0.1266 (0.1152)</td>
<td>-0.0130 (0.1205)</td>
<td>-0.0474 (0.1164)</td>
<td>-0.0840 (0.1107)</td>
</tr>
<tr>
<td>Real GDP, U.S. by industry</td>
<td>1.1769 (0.2583)</td>
<td>1.4066 (0.1626)</td>
<td>1.4053 (0.1692)</td>
<td>1.0179 (0.1412)</td>
</tr>
<tr>
<td>Real GRP by industry</td>
<td>0.0460 (0.1073)</td>
<td>0.0003 (0.0829)</td>
<td>-0.0656 (0.0817)</td>
<td>0.0470 (0.0654)</td>
</tr>
<tr>
<td>Exchange rate index by industry, one-period lag</td>
<td>0.0134 (0.1164)</td>
<td>0.1411 (0.1649)</td>
<td>0.2538 (0.2110)</td>
<td>0.0330 (0.0959)</td>
</tr>
<tr>
<td>Exchange rate index by industry, two-period lag</td>
<td>0.0343 (0.1078)</td>
<td>0.1907 (0.1580)</td>
<td>0.2705 (0.2013)</td>
<td>0.0916 (0.0916)</td>
</tr>
<tr>
<td>Significance of sum of exchange rate variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.79</td>
<td>0.87</td>
<td>0.87</td>
<td>0.86</td>
</tr>
<tr>
<td>5. Plains States</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Region-specific foreign GDP</td>
<td>0.5244 (0.5027)</td>
<td>0.0779 (0.3307)</td>
<td>-0.0328 (0.6044)</td>
<td>-0.1105 (0.3983)</td>
</tr>
<tr>
<td>Price of crude oil by industry</td>
<td>-0.0266 (0.2854)</td>
<td>-0.0803 (0.2368)</td>
<td>0.0743 (0.4214)</td>
<td>-0.1620 (0.3419)</td>
</tr>
<tr>
<td>Real GDP, U.S. by industry</td>
<td>0.7803 (0.2981)</td>
<td>-0.9214 (0.1060)</td>
<td>1.0802 (0.1477)</td>
<td>0.8721 (0.1811)</td>
</tr>
<tr>
<td>Real GRP by industry</td>
<td>-0.0311 (0.1255)</td>
<td>0.0343 (0.0638)</td>
<td>-0.0817 (0.0807)</td>
<td>-0.0184 (0.1437)</td>
</tr>
<tr>
<td>Exchange rate index by industry, one-period lag</td>
<td>0.1112 (0.1038)</td>
<td>-0.0276 (0.0795)</td>
<td>-0.1158 (0.1584)</td>
<td>0.0362 (0.1025)</td>
</tr>
<tr>
<td>Exchange rate index by industry, two-period lag</td>
<td>-0.0914 (0.0930)</td>
<td>0.0067 (0.0789)</td>
<td>-0.0940 (0.1580)</td>
<td>0.0790 (0.0974)</td>
</tr>
<tr>
<td>Significance of sum of exchange rate variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.67</td>
<td>0.92</td>
<td>0.88</td>
<td>0.73</td>
</tr>
</tbody>
</table>
### TABLE 1 (CONT.)
Regression results for regional output equations

<table>
<thead>
<tr>
<th>Region</th>
<th>Total GRP</th>
<th>Manufacturing GRP</th>
<th>Durable GRP</th>
<th>Nondurable GRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Southeast</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional-specific foreign GDP</td>
<td>0.3286 (0.2275)</td>
<td>0.4735* (0.1853)</td>
<td>0.6775* (0.2103)</td>
<td>0.4391 (0.2986)</td>
</tr>
<tr>
<td>Price of crude oil by industry</td>
<td>-0.2233 (0.0470)</td>
<td>-0.0839* (0.0452)</td>
<td>-0.2474* (0.0689)</td>
<td>0.0156 (0.0618)</td>
</tr>
<tr>
<td>Real GDP, U.S. by industry</td>
<td>0.7569* (0.1349)</td>
<td>0.7792* (0.0598)</td>
<td>0.7987* (0.0514)</td>
<td>0.8902* (0.1271)</td>
</tr>
<tr>
<td>Real GRP by industry</td>
<td>0.2525 (0.0720)</td>
<td>-0.1369* (0.0433)</td>
<td>-0.1112* (0.0364)</td>
<td>-0.0877 (0.0836)</td>
</tr>
<tr>
<td>Exchange rate index by industry, one-period lag</td>
<td>-0.0254 (0.0551)</td>
<td>0.0215 (0.0515)</td>
<td>0.1941* (0.0571)</td>
<td>-0.1082 (0.0857)</td>
</tr>
<tr>
<td>Exchange rate index by industry, two-period lag</td>
<td>0.0052 (0.0454)</td>
<td>0.0578 (0.0463)</td>
<td>0.0336 (0.0497)</td>
<td>0.0643 (0.0854)</td>
</tr>
<tr>
<td>Significance of sum of exchange rate variables</td>
<td>0.0608 (0.0449)</td>
<td>0.0897* (0.0475)</td>
<td>0.2413* (0.0523)</td>
<td>0.0046 (0.0845)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>+</td>
<td>+*</td>
<td>+*</td>
<td>-</td>
</tr>
<tr>
<td>7. Southwest</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional-specific foreign GDP</td>
<td>0.1457 (0.3645)</td>
<td>-0.2328 (0.4978)</td>
<td>0.6150 (0.7541)</td>
<td>-1.2066* (0.6677)</td>
</tr>
<tr>
<td>Price of crude oil by industry</td>
<td>0.5831* (0.1953)</td>
<td>0.7880* (0.4386)</td>
<td>1.0224 (0.6933)</td>
<td>0.8779 (0.5392)</td>
</tr>
<tr>
<td>Real GDP, U.S. by industry</td>
<td>0.7059* (0.2299)</td>
<td>1.2613* (0.1862)</td>
<td>0.5633* (0.2163)</td>
<td>2.0035* (0.2909)</td>
</tr>
<tr>
<td>Real GRP by industry</td>
<td>0.1856 (0.1681)</td>
<td>-0.0903 (0.1264)</td>
<td>0.0192 (0.1704)</td>
<td>0.0826 (0.1278)</td>
</tr>
<tr>
<td>Exchange rate index by industry, one-period lag</td>
<td>-0.0674 (0.1091)</td>
<td>-0.1298 (0.1511)</td>
<td>-0.0999 (0.2479)</td>
<td>-0.3202* (0.1847)</td>
</tr>
<tr>
<td>Exchange rate index by industry, two-period lag</td>
<td>-0.0696 (0.0778)</td>
<td>-0.3706* (0.1368)</td>
<td>-0.5186* (0.2365)</td>
<td>-0.1644 (0.1294)</td>
</tr>
<tr>
<td>Significance of sum of exchange rate variables</td>
<td>0.0458 (0.0810)</td>
<td>-0.0992 (0.1225)</td>
<td>0.1177 (0.2119)</td>
<td>-0.2176 (0.1497)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8. Mountain states</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional-specific foreign GDP</td>
<td>0.2707 (0.5464)</td>
<td>-0.5019 (0.4991)</td>
<td>-1.0768 (0.7794)</td>
<td>0.4088 (0.5240)</td>
</tr>
<tr>
<td>Price of crude oil by industry</td>
<td>0.9133 (0.8612)</td>
<td>1.5065 (1.5517)</td>
<td>0.1782 (2.2401)</td>
<td>3.4602* (1.8406)</td>
</tr>
<tr>
<td>Real GDP, U.S. by industry</td>
<td>0.6981* (0.3133)</td>
<td>1.0037* (0.1545)</td>
<td>1.0236* (0.1855)</td>
<td>0.8708* (0.2087)</td>
</tr>
<tr>
<td>Real GRP by industry</td>
<td>0.3770* (0.1462)</td>
<td>0.0719 (0.1019)</td>
<td>0.0218 (0.1261)</td>
<td>0.0150 (0.1499)</td>
</tr>
<tr>
<td>Exchange rate index by industry, one-period lag</td>
<td>0.0634 (0.0973)</td>
<td>-0.0029 (0.1070)</td>
<td>-0.1459 (0.1612)</td>
<td>0.2325 (0.1367)</td>
</tr>
<tr>
<td>Exchange rate index by industry, two-period lag</td>
<td>-0.0451 (0.0892)</td>
<td>-0.1803* (0.0975)</td>
<td>-0.1398 (0.1536)</td>
<td>-0.2408* (0.1175)</td>
</tr>
<tr>
<td>Significance of sum of exchange rate variables</td>
<td>-0.0205 (0.0937)</td>
<td>0.0431 (0.1049)</td>
<td>-0.0086 (0.1621)</td>
<td>0.1282 (0.1259)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>9. Far West</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional-specific foreign GDP</td>
<td>0.0991 (0.3017)</td>
<td>0.6949 (0.5131)</td>
<td>0.6058 (0.6292)</td>
<td>0.2708 (0.4996)</td>
</tr>
<tr>
<td>Price of crude oil by industry</td>
<td>-0.0411 (0.0784)</td>
<td>-0.1330 (0.2038)</td>
<td>-0.1037 (0.2124)</td>
<td>0.1416 (0.2751)</td>
</tr>
<tr>
<td>Real GDP, U.S. by industry</td>
<td>0.8021* (0.1790)</td>
<td>0.6172* (0.1636)</td>
<td>0.5373* (0.1495)</td>
<td>1.0729* (0.2003)</td>
</tr>
<tr>
<td>Real GRP by industry</td>
<td>0.3436* (0.1117)</td>
<td>0.2524* (0.1178)</td>
<td>0.3733* (0.1369)</td>
<td>-0.0155 (0.1137)</td>
</tr>
<tr>
<td>Exchange rate index by industry, one-period lag</td>
<td>0.0305 (0.0625)</td>
<td>0.2096 (0.1224)</td>
<td>0.1187 (0.1523)</td>
<td>0.2322* (0.1304)</td>
</tr>
<tr>
<td>Exchange rate index by industry, two-period lag</td>
<td>0.0052 (0.0582)</td>
<td>-0.2211* (0.1163)</td>
<td>-0.0823 (0.1540)</td>
<td>-0.4004* (0.1124)</td>
</tr>
<tr>
<td>Significance of sum of exchange rate variables</td>
<td>-0.0965 (0.0632)</td>
<td>0.1091 (0.1267)</td>
<td>0.0543 (0.1632)</td>
<td>0.1728 (0.1182)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Notes: Superscript a, b, and c indicate significance at the 10 percent, 5 percent, and 1 percent level, respectively. Numbers in parentheses are standard errors. Price of crude oil is refinery’s acquisition price relevant to given industry in given region. Exchange rate indexes are regional export-weighted exchange rate indexes. NA indicates not applicable. GDP is gross domestic product. GRP is gross regional product.

industry, higher energy prices might lead to higher output. In our model, oil prices reflect the importance of a region’s GRP (total, manufacturing, durable, and nondurable) relative to the comparable U.S. measure. Thus, the more oil-intensive an industry or region is relative to the U.S., the greater the expected impact of oil prices.

We expect foreign output to relate positively to a U.S. region’s output. The greater the importance of manufactured exports to a region’s output, the
greater the impact we expect GDP changes in its foreign markets to have on that region.

Regional exchange rate measures in this study are export-weighted. Looking at export industries only, we expect exchange rate change to have a negative impact on regional output. That is, an appreciation in the dollar exchange rate increases the foreign currency price of the U.S. region’s exports; the higher price to foreign buyers of imports from the U.S. reduces those imports (reduces U.S. exports) and contributes to reduced total purchases of the U.S. region’s output. The magnitude of that impact depends upon the elasticity of foreign demand for the goods exported by the region. However, we know that imports also influence domestic output, and they may do so in a positive way. For example, regions/industries that import large quantities of intermediate products will respond positively to an appreciation of the dollar. An appreciating dollar means lower prices to U.S. producers for imported components (the magnitude depending upon the degree of price passthrough). Lower production costs may lead to increased output. Again, the magnitude of this impact depends on price sensitivity at the production and final sales levels. The stronger the import effect, the more likely the exchange rate/output relationship will be positive. Consequently, the sign of the exchange rate variable, as it influences regional output, is ambiguous.

Table 1 (pages 48 and 49) shows the results of our regression analysis. In the U.S. (panel 1), the coefficients for foreign demand are positive as expected and highly significant at standard statistical levels. This provides strong support for the view that economic growth in foreign markets is a positive factor contributing to U.S. economic activity. The relative size of these coefficients by industry also suggests that the U.S. manufacturing sector is more sensitive to changes in foreign demand than is total U.S. GDP. (This is what we would expect given that manufactured goods exports account for a substantially larger share of exports than does manufactured goods output of total GDP.) Within manufacturing, durable goods industries are more sensitive to foreign demand change than nondurable goods industries. The oil price variable is negative, as expected, indicating that an increase in oil prices tends to be a drag on economic activity. The effect is most significant for the nondurable sector, which includes petroleum. The export-weighted exchange rate variable, which enters the regression contemporaneously and with one- and two-period lags, exhibits positive signs in all cases but is significant in only one of the 12 industry/lag relationships. Taken together, however, the exchange rate variables in the four regressions are statistically significant. The positive sign lends some support to the potential positive relationship noted earlier between exchange rates/imports and domestic output.

The results of the regional equations are highly variable. What stands out is the universally positive and significant impact on regional economic activity of the U.S. activity variable (table 1, panels 2 through 9, line 3). This result shows that the national economy is the primary influence on regional economic activity, as pointed out recently in the regional input–output literature (see for example, Hewings, Schindler, and Israilevich, 1998).

At the regional level, the impact of oil prices on output generally shows the expected negative sign. However, the impact of this variable on regional economic activity is only occasionally statistically significant. Manufacturing and durable manufacturing industries in the Southeast (table 1, panel 6) show a significant negative influence of oil price change on output. The two regions that show positive (though generally not statistically significant) oil price/output relationships are, as one might expect, in the energy producing regions—the Southwest (panel 7) and the Mountain states (panel 8).

The variables that we are particularly interested in, that is, region-specific foreign GDP growth and regional export-weighted exchange rates, also give mixed results.

The expected positive sign of region-specific foreign GDP growth on regional economic activity is supported in 21 of the 32 region/industry categories. In most cases, however, even where the expected positive relationship exists, the statistical significance is weak. In the Southeast (panel 6, line 1), the manufacturing and durable classifications record positive and significant relationships. In New England (panel 2, line 1), the foreign demand variable contributes to a positive and statistically significant impact on output in the nondurable manufacturing industry. The magnitude of the coefficients, which may be interpreted as a measure of the sensitivity of the region’s economic growth to foreign economic growth (income elasticity) is modest. In the Southeast, for example, a 1 percent increase in foreign GDP growth would have about a 0.7 percent positive impact on GRP.

The regression results reflecting the impact of changes in regional exchange rates on output also show mixed results. Of the 32 region/industry equations (excluding the U.S. equation), half of the sums of the coefficients (table 1, line 8 of each panel) of the exchange rate lag structure (table 1, lines 5, 6, and 7) are negative and half positive. Coefficients on five of
the positive sums (New England, the Mideast, and the Southeast) are significantly different from zero; three of the negative sums (Mideast and Southwest) are significant. As mentioned earlier, a negative impact of an appreciating dollar, for example, indicates that the higher price of a region’s exports results in a reduction in foreign purchases (reduced exports from the region), which has a negative impact on the region’s output. A positive impact from an appreciating dollar may indicate that the lower dollar cost of a region’s imports of production components ultimately leads to an increase in GRP. We suggest that the difference between these two outcomes may be due to variation in the industrial composition across regions, which we are unable to discern with the levels of industry aggregation we use in this study.

As noted at the outset, we are particularly interested in the economic revival of the Midwest during the late 1980s. The importance of international markets and exchange rate change in the post-1985 period have been widely touted as influential in the region’s recovery. Our results suggest that the Midwest economy is critically dependent on the U.S. economy (table 1, panel 4, line 3). Indeed, based on the magnitude of the coefficients, the Midwest economy is significantly more sensitive to conditions in the U.S. economy than are the other seven regions. This holds true for manufacturing industries overall and for durable manufacturing. The international sector variables we identify, region-specific foreign economic growth and region-specific exchange rates, do not appear to provide a significant additional explanation for Midwest economic activity, although the signs of the coefficients are plausible.

**Conclusion**

Although regional economies are part of the U.S. economy, regions differ substantially in their industrial makeup and the extent of their involvement in international markets. While they face a common external border and a common set of national exchange rates, different regions and their industries may face a different set of exchange rates and foreign demand conditions. We have examined these differences through the construction of region-specific exchange rate and foreign GDP growth indexes.

Our export-based exchange rate indexes indicate that Midwest manufactured goods exporters, for example, faced an appreciating dollar from the late 1980s until the mid-1990s related to the composition of their foreign markets and their heavy concentration in durable goods industries. This contradicts the common perception, based on exchange rate trends for major currencies, that the dollar was depreciating during that period.

Our foreign GDP growth indexes also suggest some variation in the rate of foreign economic growth/demand faced by various U.S. regions. Because the Midwest’s primary foreign markets are at the low end of the growth spectrum, its region-specific foreign growth has been the lowest of the eight BEA economic regions since 1980. With exports going mainly to high-growth Asian economies during the 1970s to mid-1990s, the Far West is at the high end of the spectrum.

These region-specific measures of foreign market influence do not appear to consistently contribute to a statistically significant, measurable impact on total regional economic activity. For the U.S., foreign GDP growth does show a strong positive and significant impact on economic activity. However, in only one region, the Southeast, is the impact of foreign demand growth strong enough to impose a positive and significant impact on GDP growth in manufacturing and durable manufacturing. The exchange rate measures show a significant impact on U.S. GDP, but this is apparently through the terms of trade effect on imports, which promotes domestic output through the lower relative cost of component imports. This pattern holds for several of the regions (New England, the Mideast, and the Southeast) for selected manufacturing classifications. In only one region, the Southwest, does the exchange rate variable appear to negatively and significantly influence the region’s overall economic activity.

The Midwest economy does not respond significantly to the foreign GDP or exchange rate variables, given the statistical formulation we use here. However, our results indicate that the impact of the domestic economy variable (the home market) is significantly more important for the Midwest on an industry by industry basis than for the other regions (though the variable is significant for all regions). The only region/industry equations with larger sensitivity measures on an industry by industry basis are nondurables, most likely petroleum-related, in the Southwest and Far West.

Finally, the main implication of this study reinforces recent work in regional input–output research. While international markets are certainly important to the U.S. economy, from a regional perspective the U.S. economy is still the primary factor influencing economic growth. A healthy U.S. economy is first and foremost in its influence on regional output; our results indicate that this is especially true for the Midwest.
**Regional export-weighted dollar**

Calculation of the regional export-weighted dollar takes the following form:

\[
RGTWD_{k,j,t} = 100 \left \{ \prod_{j=1}^{20} \left[ \frac{\text{XR}_{j,t} \cdot PPI_{j,t}}{\text{XR}_{j,0} \cdot PPI_{US,t}} \right]^{Wgt_{k,j,t}} \right \},
\]

where

- \( RGTWD = \) regional export-weighted dollar,
- \( k = \) U.S. region with \( n \) states,
- \( j = \) country (1 to 44),
- \( i = \) U.S. manufacturing industry category (SIC 20–39),
- \( t = \) time period; observations are monthly January 1970 through December 1997.

(The indexes are available through July 1998, reflecting the widespread appreciation of the U.S. dollar that began in 1996; however, the focus of this article ends with 1997.)

\( \text{XR} = \) exchange rate of country \( j \) with respect to the U.S. dollar (foreign currency/U.S. dollar),

\( \text{PPI} = \) Producer (wholesale) Price Index for country \( j \) or the U.S., 1990 = 100, and

\( \text{Wgt} = \) share of U.S. exports of industry \( i \), from region \( k \), to country \( j \).

(Weights are an average of 1993 and 1994 U.S. good exports.)

Note: The indexes are constructed with the base year 1990 = 100. For expository purposes the indexes are rescaled to 1970 = 100.

**Region-specific foreign GDP growth**

Calculation of the region-specific foreign real GDP growth rates takes the following form:

\[
GDPfrs_{k,j} = \sum_{j=1}^{20} \left( \frac{X_{k,j}}{X_{T20,k}} \right) \times (GDPf_{j,t}),
\]

where

- \( GDPfrs = \) export-weighted average of annual GDP growth rate (ln) of region \( k \)'s 20 major foreign export markets for time \( t \) (region-specific GDP),

\( GDPf = \) annual real GDP growth rates (ln) for country \( j \) for time \( t \),

\( X_{T20,k} = \) sum value of exports of manufactured goods (annual) from region \( k \) to country \( j \); 20 major foreign markets (average for 1993–94),

\( X = \) value of region \( k \)'s manufacturing goods exports (annual) to country \( j \) (average for 1993–94),

- \( k = \) U.S. regions one to eight, plus U.S. total, and

- \( j = \) country one to 20 major export markets for region \( k \).

Note: Period covered is 1970 through 1997. China is not included in the 20 major foreign markets (GDP growth rates are not available prior to 1978).

**Impact of exchange rates and foreign demand growth, OLS model**

The central question of this study is whether the interaction between U.S. regional economies and their respective international markets shows differences across regions with regard to the exchange rates they face and economic growth in their foreign markets. There appear to be differences across regions in both the exchange rate aggregates and the foreign market growth aggregates.

Do these region-specific measures of exchange rates and foreign economic growth have a measurable impact on the regions’ economic activity? We address this question using an ordinary least squares model that identifies three “shock” variables (region-specific foreign GDP, region-specific exchange rates, and oil prices) impact on the gross regional product (GRP) of the eight U.S. Bureau of Economic Analysis (BEA) regions, plus the U.S.
We base GRP for a region on data from the BEA “Gross state product by industry” series for 1977–96. These data are available in nominal and real values for total, all manufacturing industries, durable manufacturing industries, and nondurable manufacturing industries. We extended the nominal GRP series to 1970–76 and 1997 using BEA earnings data in the appropriate industry class. We then deflated the estimated nominal GRPs using one of several standard price indexes, based on the strength of the correlation between the standard indexes and the implicit deflator between nominal and real GRP by region and industry for 1977–96. Oil price (OIL) is defined as average refiners’ acquisition cost (domestic and foreign sources). Nominal prices are deflated using CPI less energy. Real oil prices enter the region and industry equations in the following form: Where total GRP for the region is the dependent variable, OIL enters the equation as the year-to-year percent change (ln) in its full price adjusted value. Where GRP for a region is defined by an industry category, for example, durable manufacturing, OIL enters the equation as the year-to-year percent change in the full price adjusted value multiplied by the region’s GRP in durable manufacturing share of U.S. durable manufacturing GRP. In this form, the more important a region’s durable manufacturing is in U.S. durable output, for example, the heavier the oil price weight will be.

The regional export-weighted exchange rate is defined in technical appendix 1. Region-specific foreign GDP growth is defined in technical appendix 2. In addition, to account for the influence of the domestic economy, we include one-period lags of U.S. GDP and the GRP of the region in question.

The regression equation takes the following form (all observations are annual)

$$\text{GRP}_{k,t} = a + b_1(\text{GRP}_{k,t-1}) + b_2(\text{GRP}_{k,t-2}) + b_3(\text{GDP}_{k,t-1}) + b_4(\text{GDP}_{k,t-2}) + b_5(\text{RGWD}_{k,t-1}) + b_6(\text{RGWD}_{k,t-2})$$

where

$$\text{GRP} = \text{gross regional product (real) as defined above, percent change (ln)}$$

$$\text{GDP}_{k,t} = \text{region-specific foreign GDP (real) as defined in technical appendix 1—enters equation in the contemporaneous period, percent change (ln)}$$

$$\text{RGWD} = \text{region-specific export-weighted dollar (real) as defined in technical appendix 2—enters equation contemporaneously and with one-period and two-period lags, percent change (ln)}$$

$$\text{OIL} = \text{refiners’ acquisition price for oil (real) defined above—enters equation with a one-period lag}$$

$$k = \text{regions one through nine (U.S. total and eight BEA regions), and}$$

$$i = \text{industry classification (all SICs, aggregated all manufacturing SICs, aggregated durable manufacturing SICs, and aggregated nondurable manufacturing SICs)}$$

Variables are in log changes, except as defined above for oil.

NOTES

1This article grew out a research project conducted as part of the Federal Reserve Bank of Chicago’s year-long study of the Midwest economy. Summaries of the six Midwest Assessment conferences and a project report are available on the Internet at www.frbchi.org. Research papers are also available from the Bank’s Public Information Department on request.

2Some would question the assertion that exchange rates and foreign economic growth are externally determined variables relative to the U.S. economy, given the interdependence of the world’s economies. Certainly international interdependence has increased during the past 20 to 30 years. However, we would argue that the advent of floating exchange rates in the early 1970s unlinked many foreign economies from the U.S. economy and the dollar, in the sense that U.S. monetary policy no longer determined world monetary policy.

3The broad-based appreciation of the U.S. dollar relative to nearly all other currencies in 1997 through mid-1998 further accentuates the apparent strength of the Midwest dollar, relative to the earlier periods. It also dramatically affects the exchange rates of those regions heavily influenced by the Asian markets.


6Clark, Sawyer, and Sprinkle (1997 and 1999) have found “nontrivial differences” between a “Southern” export-weighted dollar index and an index constructed for the rest of the U.S. They have also found differences in similarly constructed indexes of U.S. census regions versus a total U.S. index.
The seven foreign markets defined in figure 1 account for 100 percent of U.S. goods exports during 1993 and 1994. They include the 44 countries used in this study, which accounted for 91.5 percent of U.S. goods exports and “all other” markets. The groups are defined as: North America—Canada and Mexico; Latin America—Argentina, Brazil, Chile, Colombia, Ecuador, Peru, and Venezuela; Europe—Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom; Japan; Southeast Asia—Australia, Hong Kong, India, Indonesia, the Republic of Korea, Malaysia, New Zealand, Pakistan, Philippines, Singapore, Taiwan, and Thailand; Africa—Morocco, Nigeria, and South Africa; Other—Kuwait, Turkey, Saudi Arabia, and all other.

New England—Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont; Mid-Atlantic—Delaware, District of Columbia, Maryland, New Jersey, New York, and Pennsylvania; Great Lakes—Illinois, Indiana, Michigan, Ohio, and Wisconsin; Plains—Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota; Southeast—Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia; Southwest—Arizona, New Mexico, Oklahoma, and Texas; Mountain—Colorado, Idaho, Montana, Utah, and Wyoming; Far West—Alaska, California, Hawaii, Nevada, Oregon, and Washington.

The “Location of exporter” series was first made available (on a continuous basis) by the U.S. Department of Commerce for 1993. We consider this data series to be superior to the Department’s “Origin of exporter” series, available from 1987, which biases the valuation of exports by individual states toward those states where the port of export is situated.

The state export data as reported by the Bureau of the Census contain a substantial category of “unallocated” exports. The Massachusetts Institute for Social and Economic Research, “MISER state of exporter location data (series II),” adjusts these data to account for the unallocated portion. The adjusted data series are made available on a by-state-by-country of destination at the two-digit SIC classification. In 1994, these adjustments accounted for nearly 7 percent of total manufactured exports.

Durable goods: SIC-24, lumber and wood products; 25, furniture and fixtures; 32, stone, clay, and glass products; 33, primary metal industries; 34, fabricated metal industries; 35, industrial machinery and equipment; 36, electronic and other electric equipment; 37, transportation equipment; 38, instruments and related products; and 39, miscellaneous manufacturing industries. Nondurable goods: SIC-20, food and kindred products; 21, tobacco manufactures; 22, textile mill products; 23, apparel and other textile products; 26, paper and allied products; 27, printing and publishing; 28, chemicals and allied products; 29, petroleum and coal; 30, rubber and miscellaneous plastics; and 31, leather and leather products.

In sum, the third-country issue boils down to this: The dollar may experience a real depreciation or appreciation relative to a bilateral trading partner. That exchange rate change affects the relative competitiveness not only of U.S. goods versus the bilateral partner, but also of U.S. goods versus third-country trading partners. The aggregate exchange rate construction we use here does not allow us to address this issue.

A scheme utilized by Hayward and Erickson (1995), who in a somewhat different context sought to measure the size of import competing industries by state by SIC, appears potentially useful in getting to the import competitiveness issue. This work is being extended to include an aggregate bilateral index that uses a modification of the Hayward-Erickson measure for imports by region.

These price indexes were provided by the Economic Research Group of J. P. Morgan through December 1997. Based on availability of data, some countries’ price indexes are versions of their consumer price index.

The monthly regional index series for the three industry categories for each of the regions (currently January 1970 through July 1998) are available from the authors on request.

Percentage changes in the indexes are reported on a logarithmic basis.

REFERENCES


The business cycle:
It’s still a puzzle

Lawrence J. Christiano and Terry J. Fitzgerald

Introduction and summary

Good fiscal and monetary policy requires a clear understanding of the workings of the economy, especially what drives the business cycle—the periodic ups and downs in economic activity. Since at least the late 1800s, a full swing from the start of an economic expansion to a recession and back to the start of another expansion has generally taken between two and eight years. Every citizen is keenly aware of the state of the economy, whether it is in prosperity or recession.

Everyone is so conscious of the business cycle because most sectors of the economy move up and down together.1 This phenomenon, referred to as comovement, is a central part of the official definition of the business cycle. The definition is set by the National Bureau of Economic Research (NBER), which decides when recessions begin and end. Under the NBER’s definition,

“...a recession is a [persistent] period of decline in total output, income, employment, and trade, usually lasting from six months to a year, and marked by widespread contractions in many sectors of the economy.”

Even though comovement is a defining characteristic of the business cycle, in recent decades macroeconomists have tended to focus on understanding the persistence in the ups and downs of aggregate economic activity. They have generally been less concerned with understanding the synchronized nature of this pattern across sectors. In part, the omission reflects the conceptual difficulties inherent in thinking about an economy with many sectors.2 Standard models of business cycles assume there is only one good being produced and so they consider only one economic sector. These models do not encourage thinking about the comovement of economic activity across many sectors. Since these models were first introduced, in the late 1970s and early 1980s, the state of macroeconomics has advanced rapidly. The conceptual and computational barriers to thinking about multiple sectors are quickly falling away. As a result, recent years have witnessed a renewed interest in understanding comovement.

We have two objectives in this article. The first is to document business cycle comovement. We examine data on hours worked in a cross section of economic sectors. We examine the business cycle components of these data and show that the degree of comovement is substantial. Our second objective is to analyze explanations for this comovement. We find that none is completely satisfactory. Still, this is a growing area of research, and we are seeing some progress.

Identifying comovement

To study comovement across sectors over the business cycle, we need the following two things: a measure of the level of economic activity in the various sectors of the economy, and a precise definition of what we mean by the business cycle component of the data. Below, we address these two issues. After that, we present our results, characterizing the degree of comovement in the data.

Lawrence J. Christiano is a professor of economics at Northwestern University, a consultant to the Federal Reserve Bank of Chicago, and a research associate at the National Bureau of Economic Research. Terry J. Fitzgerald is an economist at the Federal Reserve Bank of Cleveland. The title of this article is modified from Kocherlakota’s (1996) article. The findings for business cycle analysis are similar to Kocherlakota’s for the equity premium puzzle. The authors are grateful for discussions with Michelle Alexopoulos, Stefania Albanesi, Paul Gomme, Henry Liu, and Robert Vigfusson.
The data

We measure economic activity in a given sector by the number of hours worked in that sector. Table 1 lists the sectors we consider. The hours worked measure that covers the most sectors is total private hours worked. This measure covers all sectors of the economy, except government and agriculture. It is broken into hours worked in goods-producing industries and in service-producing industries. Goods-producing industries are further broken into mining, manufacturing, and construction. Similarly, service-producing industries are broken into five subsectors. The subsectors of manufacturing, durable goods and nondurable goods, are broken into yet smaller sectors. The data in the third column give an indication of the relative magnitude of each subsector. In particular, any given row reports the average number of people employed in that sector, divided by the average number of people employed in the sectoral aggregate to which that sector belongs. Thus, for example, 58 percent of manufacturing employment is in the durable goods sector and 42 percent is in the nondurable

<table>
<thead>
<tr>
<th>Variable number</th>
<th>Hours worked variable</th>
<th>Relative magnitude</th>
<th>Relative volatility</th>
<th>Business cycle comovement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Total private</td>
<td>1.00</td>
<td>1.00</td>
<td>.00</td>
</tr>
<tr>
<td>2</td>
<td>Goods-producing</td>
<td>.33</td>
<td>3.91</td>
<td>.99</td>
</tr>
<tr>
<td>3</td>
<td>Manufacturing</td>
<td>.03</td>
<td>5.46</td>
<td>.38</td>
</tr>
<tr>
<td>4</td>
<td>Construction</td>
<td>.17</td>
<td>6.75</td>
<td>.88</td>
</tr>
<tr>
<td>5</td>
<td>Durable goods</td>
<td>.80</td>
<td>3.82</td>
<td>.97</td>
</tr>
<tr>
<td>6</td>
<td>Lumber and wood products</td>
<td>.58</td>
<td>6.90</td>
<td>.97</td>
</tr>
<tr>
<td>7</td>
<td>Furniture and fixtures</td>
<td>.06</td>
<td>10.18</td>
<td>.89</td>
</tr>
<tr>
<td>8</td>
<td>Stone, clay, and glass products</td>
<td>.04</td>
<td>8.14</td>
<td>.94</td>
</tr>
<tr>
<td>9</td>
<td>Primary metal industries</td>
<td>.05</td>
<td>4.98</td>
<td>.95</td>
</tr>
<tr>
<td>10</td>
<td>Fabricated metal products</td>
<td>.09</td>
<td>9.89</td>
<td>.86</td>
</tr>
<tr>
<td>11</td>
<td>Machinery, except electrical</td>
<td>.13</td>
<td>7.21</td>
<td>.96</td>
</tr>
<tr>
<td>12</td>
<td>Electrical and electronic equipment</td>
<td>.19</td>
<td>11.10</td>
<td>.93</td>
</tr>
<tr>
<td>13</td>
<td>Transportation equipment</td>
<td>.15</td>
<td>8.75</td>
<td>.88</td>
</tr>
<tr>
<td>14</td>
<td>Instruments and related products</td>
<td>.17</td>
<td>7.83</td>
<td>.89</td>
</tr>
<tr>
<td>15</td>
<td>Miscellaneous manufacturing</td>
<td>.08</td>
<td>5.03</td>
<td>.76</td>
</tr>
<tr>
<td>16</td>
<td>Nondurable goods</td>
<td>.42</td>
<td>1.39</td>
<td>.91</td>
</tr>
<tr>
<td>17</td>
<td>Food and kindred products</td>
<td>.21</td>
<td>.16</td>
<td>.50</td>
</tr>
<tr>
<td>18</td>
<td>Tobacco manufactures</td>
<td>.01</td>
<td>1.83</td>
<td>.08</td>
</tr>
<tr>
<td>19</td>
<td>Textile mill products</td>
<td>.11</td>
<td>3.92</td>
<td>.76</td>
</tr>
<tr>
<td>20</td>
<td>Apparel and other textile products</td>
<td>.15</td>
<td>2.64</td>
<td>.85</td>
</tr>
<tr>
<td>21</td>
<td>Paper and allied products</td>
<td>.09</td>
<td>1.97</td>
<td>.85</td>
</tr>
<tr>
<td>22</td>
<td>Printing and publishing</td>
<td>.16</td>
<td>.91</td>
<td>.90</td>
</tr>
<tr>
<td>23</td>
<td>Chemicals and allied products</td>
<td>.13</td>
<td>1.01</td>
<td>.80</td>
</tr>
<tr>
<td>24</td>
<td>Petroleum and coal products</td>
<td>.02</td>
<td>2.02</td>
<td>.16</td>
</tr>
<tr>
<td>25</td>
<td>Rubber and misc. plastics products</td>
<td>.09</td>
<td>7.82</td>
<td>.89</td>
</tr>
<tr>
<td>26</td>
<td>Leather and leather products</td>
<td>.03</td>
<td>2.71</td>
<td>.64</td>
</tr>
<tr>
<td>27</td>
<td>Service-producing industries</td>
<td>.67</td>
<td>.25</td>
<td>.93</td>
</tr>
<tr>
<td>28</td>
<td>Transportation and public utilities</td>
<td>.10</td>
<td>.87</td>
<td>.95</td>
</tr>
<tr>
<td>29</td>
<td>Wholesale trade</td>
<td>.01</td>
<td>.65</td>
<td>.07</td>
</tr>
<tr>
<td>30</td>
<td>Retail trade</td>
<td>.31</td>
<td>.36</td>
<td>.87</td>
</tr>
<tr>
<td>31</td>
<td>Finance, insurance, and real estate</td>
<td>.10</td>
<td>.35</td>
<td>.48</td>
</tr>
<tr>
<td>32</td>
<td>Services</td>
<td>.38</td>
<td>.19</td>
<td>.49</td>
</tr>
</tbody>
</table>

Notes: The column labeled "Relative magnitude" reports an indication of the relative magnitude of each sector. Any given row reports the average number of people employed in that sector divided by the average number of people employed in the sectoral aggregate to which that sector belongs, for example, 58 percent of manufacturing employment is in the durable goods sector and 42 percent is in the nondurable goods sector. The column labeled "Relative volatility" reports the variance of the business cycle component of the logarithm of hours worked in the indicated row variable divided by the variance of the business cycle component of the logarithm of total private hours worked. The column labeled "Business cycle comovement" is calculated using the process described in note 6 of the article.

Source: Authors' calculations from data of GRI Basic Economics database, 1964–96.
goods sector. Also, the largest goods-producing industry, by far, is manufacturing, which has 80 percent of all goods-producing employees.

Next, we try to characterize how much business cycle comovement there is across the economic sectors we consider. That is, if we limit ourselves to the business cycle range of fluctuations in the data—fluctuations that last between two and eight years—to what extent do the data move up and down together?3

**Business cycle component of the data**

A detailed discussion of our notion of the business cycle component of the data is in technical appendix 1. Figure 1 illustrates the basic idea behind what we do. The choppy line in panel A of figure 1 displays total private hours worked. The reported data are the logarithm of the raw data. The advantage of using the logarithm of the data in this way is that the resulting movements correspond to percent changes in the underlying raw data. The deviations between the actual data and the trend line in panel A of figure 1 are graphed in panel B. Those deviations contain the rapidly varying, erratic component, inherited from the choppy portion of the data that is evident in panel A. The smooth curve in panel B is our measure of the business cycle component of the total private hours worked data. Specifically, that measure excludes both the trend part of the data and the rapidly varying, erratic component. It includes only the component of the data that contains fluctuations in the range of two to eight years. According to our approach, the economy is in recession when our business cycle measure is negative and in prosperity when it is positive.

Figure 1 also compares our measure of the business cycle with the one produced by the NBER. The start of each shaded area indicates the date when, according to the NBER, the economy reached a business cycle peak. The end of each shaded area indicates a business cycle trough. Note how total private hours worked fall from peak to trough and then generally grow from trough to peak. An obvious difference in the two business cycle measures is that ours is a continuous variable, while the NBER’s takes the form of peak and trough dates. As a result, our measure not only indicates when a recession occurs, but also the intensity of the recession. Apart from these differences, however, the two measures appear reasonably consistent. For example, note that near the trough of every NBER recession, our measure of the business cycle is always negative. But the two measures do not always agree. According to our measure, the economy was in recession in 1967 and in 1987, while the NBER did not declare a recession during those periods. In part, this is because there must be several months’ negative employment growth before the NBER declares a recession. However, our procedure only requires a temporary slowdown.

Figure 1 provides informal evidence in support of the facts we wish to document. As noted in the introduction, the NBER must see a broad-based decline before declaring a recession. Thus, the NBER dates in figure 1 indicate periods when many economic sectors showed weakness. Since these dates roughly coincide with periods of weakness in total
private hours worked, this is consistent with the view that most sectors move up and down together, at least in the two- to eight-year frequency range. We stress, however, that the NBER’s dating procedures are informal. Our objective in this section is to provide a formal, quantitative assessment of the degree of comovement among economic sectors.

We computed a business cycle component for each of the 33 series listed in Table 1. As we anticipated, we find that the business cycle components in most of the series move together closely. This is true, despite a striking lack of uniformity in other respects. For example, note how different the trends in Figure 2 are. The first two columns report data for the goods-producing industries and its major components. The second two columns report the analogous data for the service-producing industries. Generally, trend employment is down in the goods-producing industries and up in the service-producing industries. The levels of volatility in the business cycle components of the various series are also very different. The fourth column of Table 1 reports the variance of the business cycle component of a variable, divided by the variance of aggregate hours worked. The relative variance of hours worked in goods-producing industries is typically quite high, substantially above 2, and it is quite low for service-producing industries. That goods-producing industries are volatile relative to the service-producing industries is well known.

**Measuring business cycle comovement**

Despite the very substantial differences in the trends of the data series shown in Figure 2, their movements over the business cycle are quite similar. Figure 3 illustrates the business cycle components of the same variables used in Figure 2. In each case, we computed the business cycle component using exactly the same method underlying the calculations in panel B of Figure 1. Each graph contains the business cycle component of the variable indicated and the business cycle component for total private hours. This was taken directly from panel B of Figure 1.

In most of the series in Figure 3, the data move up and down closely with the business cycle component of total hours worked. There are some exceptions. For example, the business cycle movements in mining bear little resemblance to the business cycle movements in total hours worked. At the same time, mining represents a very small part of the private economy and employs only 3 percent of workers in the goods-producing industry. Another exception is the finance, insurance, and real estate (FIRE) industry, whose business cycle component exhibits reasonably high comovement with aggregate employment until the 1980s, after which this relationship breaks down.

To measure the degree of business cycle comovement between a given series and total hours worked, we use a statistic that is like the square of the correlation between the business cycle components in the two variables. Our statistic measures the fraction of the variance in the series that can be accounted for by the total hours worked. 6 If this number is, say, 98 percent, this means that 98 percent of the business cycle variance in the variable can be accounted for by the business cycle in aggregate hours worked. These results are reported in the fifth column of Table 1. As expected, the results indicate that this measure of comovement is relatively low, in the sense of being below 0.50, for the mining, FIRE, and services sectors. Overall, however, the degree of comovement by this measure is high.

Going one step further in the level of disaggregation, we can get an idea about the comovement in the components of durable and nondurable manufacturing. Figure 4, panel A displays the business cycle movements in the components of durable manufacturing sectors. Panel B does the same for nondurable manufacturing. In each case, the data series graphed at the top of the figure is the business cycle component of total hours worked. The series are presented so as to allow one to focus exclusively on the degree of comovement between them. Thus, we added a constant to each series to spread them out across the figure and divided each series by its sample standard deviation, so that the standard deviation of the reported data is unity in each case. 7 The number to the right of each line in the figure identifies the data series. Figure 4 also displays the NBER peak and trough dates as a convenient benchmark.

Figure 4, panel A shows that the comovement among sectors in durable manufacturing is very high. With only one minor exception, the variables move closely with each other and with aggregate employment. The exception is that instruments and related products, series 15, does not move closely with the other variables during 1987, when the other business cycle components are signaling a recession. However, overall the degree of comovement is strikingly high. Figure 4, panel B shows that the business cycle comovement in the nondurable goods manufacturing industries is lower than in the durable goods sector. Two variables that do not comove closely with the others at business cycle frequencies are tobacco manufactures, series 19, and petroleum and coal products, series 25. Both these variables are rising in the first and last NBER recession periods in our data. The
FIGURE 2

Hours worked in various sectors: Data and trends

A. Goods-producing industries logarithm
B. Manufacturing, durable goods logarithm
C. Manufacturing, nondurable goods logarithm
D. Mining logarithm
E. Construction logarithm
F. Wholesale trade logarithm
G. Service-producing industries logarithm
H. Transportation and utilities logarithm
I. Services logarithm
J. Retail trade logarithm
K. Finance, insurance, and real estate logarithm

Source: Authors’ calculations from data of DRI Basic Economics database, 1964-96.
FIGURE 3

Business cycle component comparison: Total hours worked versus hours worked in various sectors

A. Goods-producing industries
B. Manufacturing, durable goods
C. Manufacturing, nondurable goods
D. Mining
E. Construction
F. Wholesale trade
G. Service-producing industries
H. Transportation and utilities
I. Services
J. Retail trade
K. Finance, insurance, and real estate

Note: The information displayed in the “total hours worked” line is “business cycle component,” taken from figure 1, panel B.
Source: Authors’ calculations from data of DRI Basic Economics database, 1964–96.
comovement statistic for these variables reported in table 1 is very low, 0.08 for tobacco manufactures and 0.16 for petroleum and coal products. The other variables in nondurable manufacturing display stronger comovement, with comovement statistics of 0.50 or higher.

Up to now, the statistics we have used to characterize comovement emphasize association with aggregate hours worked. This nicely complements the visual evidence in the graphs. However, there is a pitfall to relying exclusively on statistics like this to characterize comovement. A simple example illustrates the point. Suppose there is a variable, $y$, which is the sum of two other variables, $x_i$ and $y_i$:

$$y = x_i + y_i$$

Suppose further that $x_i$ and $y_i$ are uncorrelated. No one would say there is comovement between these variables. Still, each variable is strongly correlated with the aggregate. To see this, take the simple case where the variance of $x_i$ and $y_i$ is $\sigma^2$. Then, the correlation between $x_i$ and $y$ is 0.71, for $i = 1, 2$, despite the absence of comovement between the variables.8 This example exaggerates the point somewhat, since results are less severe when there are more than two sectors.9 Still, this pitfall is of some concern.

With this in mind, we consider the correlation between the business cycle components of all the variables. A difficulty with this is that there are many such correlations. For example, with three variables, there are three possible correlations, with four there are six, with five there are ten, and with $n$ there are $n(n - 1)/2$. So, with $n = 33$, there are 528 possible correlations. It is a challenge to organize and present this many correlations in a coherent way. We present the mean and histogram of the correlations for different subsectors in figure 5. The histograms display, on the vertical axis, the fraction of correlations lying within a given interval, whose midpoint is indicated on the horizontal axis.10

Figure 5, panel A displays the correlations for the finest levels of aggregation for which we have data. This means hours worked in mining, construction, the 20 components of manufacturing, and the five components of the service-producing industries. Thus, we
have 27 data series, with 351 correlations between them. Figure 5, panel A indicates that the mean of these correlations is 0.55. When we eliminate the three data series that we already know do not display strong business cycle comovement, the mean rises to 0.68. The histogram shows that there is a substantial fraction of high correlations in these data. We infer that the data are consistent with the impression from the preceding statistics that there is considerable evidence of comovement.

In conclusion, we find that there is substantial business cycle comovement in the data. Only two relatively small sectors—tobacco manufactures and petroleum and coal products—exhibit little tendency to move up and down with general business conditions over the business cycle.

**Explaining business cycle comovement**

What is it that at times pulls most sectors of the economy up, and at other times pushes them down again? This is one of the central questions in business cycle analysis. Although economists have developed a number of possible explanations, the phenomenon remains a puzzle.

In a classic article devoted to this puzzle, Robert E. Lucas, Jr., conjectures that the resolution must lie in some sort of shock that hits all sectors of the economy, a so-called aggregate shock (Lucas, 1981). Many economists today would probably agree with this conjecture. That is why, in practice, the search for the ultimate cause of business cycles often focuses...
on identifying an aggregate shock. However, research conducted since Lucas published his article suggests that identifying the cause of business cycles may not be so simple.

First, even if we do manage to identify a shock that clearly affects the whole economy, it does not necessarily follow that shock is responsible for the business cycle. A shock might well be experienced by all sectors of the economy, but they need not all respond in the same way. The business cycle shock, if indeed there is only one, seems to lead to a synchronized response across sectors. Second, we now know that the search for a single aggregate shock may itself be off base. Following the work of Long and Plosser (1983), we know that, at least in theory, disturbances to individual industries, even if they are uncorrelated across industries, could result in comovement.

Currently, there is no consensus among economists as to what causes business cycles and, in particular, their key feature, comovement. At the same time, researchers are exploring a large range of possibilities. Next, we provide a selective overview of this research.

A natural starting point is what is perhaps the most thoroughly developed theory of business cycles, the real business cycle theory associated with Kydland and Prescott (1982), Long and Plosser (1983), and Prescott (1986). We focus specifically on the standard real business cycle model, developed in Hansen (1985) and analyzed in Prescott (1986). Although such models posit an aggregate shock, it is inconsistent with business cycle comovement. We then explore two sets of modifications to this model. The first can be viewed as natural extensions of the model. The second depart more significantly from the model’s assumptions.

Standard real business cycle theory

A key component of real business cycle theory is a production technology. This is a relationship that specifies how much output a firm can obtain from a given amount of capital and labor resources. This technology is subject to shocks. Sometimes a good shock occurs and more output can be produced for a given level of inputs. In this case, we say the technology has been shifted up. A good technology shock might reflect the implementation of a more efficient way to organize the work force, the acquisition of more efficient manufacturing equipment, or perhaps the discovery of a way to alter the firm’s product so that it better meets customers’ needs. At other times, a bad technology shock can shift a production technology down. A bad shock might reflect bad weather, a labor dispute, an accident in the workplace, a machine breakdown, or a government policy that encourages an inefficient way of organizing production. According to real business cycle theory, business cycle expansions reflect that shocks affecting firms are mostly on the positive side, while recessions reflect periods when most firms’ shocks are on the negative side. Standard formulations abstract from the differences between firms and simply assume they all have the same production technology and are affected by the same shock. Thus, real business cycle theory proposes that the aggregate shock to which Lucas refers is a productivity shock.

The standard real business cycle model not only assumes that all firms are affected by the same productivity shock, but also that there is just one type of good produced (and, therefore, one industry sector) in the economy. At least at first glance, this model does not seem useful for examining business cycle comovement among many sectors. However, it has recently been pointed out that this impression is misleading. In fact, one can use the model to examine business cycle comovement. When we do so, we find that its implications are strongly counterfactual. The standard real business cycle model is at variance with the observation of business cycle comovement, despite the fact that it views the economy as being driven by a single aggregate shock. Understanding why it is incompatible with comovement is useful for gaining insight into the various lines of inquiry researchers have pursued.

The standard real business cycle model imagines that households interact with firms in competitive markets, in which they supply labor and physical capital and demand goods for consumption and to add to their stock of capital. Although there is only one type of production technology in this model, we can reinterpret the model to suggest that one type of firm produces goods for consumption (the consumption goods industry) and another type produces new investment goods for maintaining or adding to the stock of capital (the investment goods industry).

When a positive productivity shock hits, so that the real business cycle model shifts into a boom, the output of both consumption and investment goods industries increases. However, there is a relatively larger increase in the output of investment goods. This reflects a combination of two features of the model. First, a positive technology shock increases the expected return to investment, raising the opportunity cost of applying resources to the consumption sector. Second, the model assumes that households prefer not to increase consumption substantially during booms but to smooth consumption increases over a
longer time horizon. The increase in the demand for investment goods relative to consumption goods that occurs in a boom implies, in the standard model, that capital and labor resources are shifted out of the production of consumption goods and into the production of investment goods. The model does predict a small rise in consumption in a boom. However, this rise is driven by the favorable technology shock, which is not fully offset by the flow of productive resources out of that sector. Thus, the model implies that hours worked in the consumption sector are countercyclical, in contrast with our empirical findings in the previous section. This is a feature of the model, despite its implication that total hours worked rise in a boom. That is, the additional hours of work all flow into the investment good sector. The standard real business cycle model also implies that investment in capital for use in the consumption sector is countercyclical. This too, is counterfactual, according to the results reported in Huffman and Wynne (1998).

So, this model is strongly at variance with comovement. Why is this so? The result may seem especially surprising to those who expect an aggregate shock to all sectors of the economy to produce comovement.

Intuitively, there are two related ways to understand the model’s implication that inputs are allocated away from the sector that produces consumption goods during a boom. One is that the model overstates the value of leisure at that time. This inflates the cost of allocating labor resources to the consumption sector then. The other is that the model understates the value of the output of the sector producing consumption goods in a boom. This undercuts the incentive to allocate resources to that sector then.\(^{15}\)

**Natural extensions of the standard theory**

Among the various extensions to the model that economists have pursued,\(^ {16}\) we focus on approaches that stress 1) factors that prevent the rise in the marginal utility of leisure in a boom and 2) factors that prevent the decline in the value of the output of the consumption sector in a boom. As in the discussion above, the work we survey here assumes two market sectors.\(^ {17}\)

**Value of leisure**

One factor that can slow the decline of the marginal utility of leisure when the economy moves into a boom was explored in Benhabib, Rogerson, and Wright (1991) and Einarsson and Marquis (1997). Each of these papers points out that if there is a third use of time, in addition to leisure and time spent working in the market, and if that use of time declines during a boom, the marginal utility of leisure need not increase as market effort increases.\(^ {18}\)

Benhabib, Rogerson, and Wright (1991) suggest that the third use of time may be working in the home. For example, the amount of leisure time enjoyed by a homemaker may not change significantly if the homemaking job is exchanged for a market job. Considerations like this lead Benhabib, Rogerson, and Wright to argue that work time can be reallocated from the home to the market during a boom without substantially raising the marginal utility of leisure.\(^ {19}\)

Einarsson and Marquis (1997) suggest that the third use of time may be time spent accumulating human capital, such as going to school. In principle, this is an appealing idea, since it is known that time spent in educational pursuits goes down in business cycle expansions. Their work is primarily theoretical, however. A crucial issue one would have to address in pursuing this explanation at the empirical level is whether the time spent on education is sufficiently countercyclical, in a quantitative sense, to have a substantial effect in a suitably modified real business cycle model. In assessing this, one would have to confront a substantial measurement problem. In particular, time spent in educational institutions is only part of the time spent in education. Some of that time is applied in the workplace, by diverting workers from direct production. Our understanding is that there do not exist reliable measures of this use of time.

**Value of the output of the consumption sector**

Several papers attempt to get at comovement by reducing the decline in the value of output in the consumption sector during booms. For example, Baxter (1996) adapts the standard real business cycle model by assuming that the consumption of market goods and the services of home durables are good substitutes. An example of two goods that substitute is a movie watched in a theater (a market good) and a movie watched on a home television set (a home durable good).\(^ {20}\)

Under Baxter’s substitutability assumption, the appropriate measure of household consumption is not just market consumption, but consumption of market goods plus the service flow on the stock of home durables. If home durables consumption is sufficiently large, then a given jump in the consumption of market goods leads to a smaller percent drop in the marginal utility of consumption. In the extreme case where the stock of home durables is extremely large and accounts for essentially all of consumption, then a rise in market consumption would produce essentially no drop in the marginal utility of consumption.\(^ {21}\) Although
Baxter shows that this mechanism does indeed produce comovement in employment across consumption and investment sectors in her model, there is a sense in which the comovement is not strong enough. That is because investment in the capital used in the two sectors is essentially uncorrelated. As noted above, the data suggest that investment across sectors comoves as well, in addition to output and employment.

One can also view the home production approach of Benhabib, Rogerson, and Wright (1991) as a strategy to generate comovement by reducing the decline in the value of output in the consumption sector during booms. In a boom, as labor is allocated away from home-produced goods toward the production of market goods, the marginal utility of the market good does not fall much because the market and home goods are assumed to be highly substitutable. This allows the value of output in the consumption sector to rise sufficiently so that employment in that sector is procyclical. A shortcoming of the analysis, emphasized by Benhabib, Rogerson, and Wright (1991), is that the high substitutability between home and market goods needed for comovement of labor inputs hurts on another dimension. It has the effect that purchases of durables are countercyclical over the cycle.

Christiano and Fisher (1998) take another approach. Following Boldrin, Christiano, and Fisher (1995), they modify a standard real business cycle model in two ways. First, they specify that it takes time before labor can shift between economic sectors in response to a shock. The reasons for this are not modeled explicitly, but the assumption is motivated with an informal reference to such factors as the search and training costs which inhibit real world labor mobility between industry sectors. This assumption alone is not sufficient to guarantee comovement, however. Without further changes, their model predicts that resources would be reallocated out of the consumption sector and into the investment sector as soon as labor becomes fully mobile, which they specify to occur in three months’ time. As a result, this version of the model is still inconsistent with the evidence on business cycle comovement. Christiano and Fisher therefore introduce a second modification, by changing the specification of household preferences over consumption. They assume that households have a tendency to become accustomed to the level of consumption they have enjoyed in the recent past. This property of preferences is known as habit persistence. A household with habit persistence preferences whose consumption has recently increased is particularly unhappy if later it must return to its previous level of consumption. Habit persistence preferences have the implication that when consumption rises in a boom, the marginal value of continuing to maintain consumption at a high level is increased.

Christiano and Fisher show that habit persistence and limitations on the intersectoral mobility of labor are sufficient to produce comovement in hours worked and investment. To our knowledge, this is the only quantitative model in the comovement literature with this property.

The credibility of this result depends on the credibility of the underlying assumptions. The assumption that there are limitations on the speed with which productive resources can be transferred across sectors seems uncontroversial, though the model certainly takes an extreme stance. What does call for a defense is the assumption of habit persistence preferences. One defense is that these preferences help to account for observations that otherwise seem puzzling. For example, Boldrin, Christiano, and Fisher (1995) show that, consistent with results in Constantinides (1990), habit persistence and limited intersectoral mobility can account for the magnitude of the observed average premium in the return on equity over risk-free securities. The solution to this premium has eluded many researchers. In addition, Christiano and Fisher (1998) show that habit persistence can help account for the so-called inverted leading indicator property of interest rates, that high interest rates tend to forecast bad economic times. King and Watson (1996) document that standard models have difficulty accounting for this observation.

A third approach toward understanding comovement was recently pursued by Hornstein and Praschnik (1997). They observe that some of the output of the sector that produces consumption goods (the nondurable goods sector) is also used as intermediate goods in the production of investment goods. For example, both households and investment-good producing firms make use of the services of the transportation sector. Hornstein and Praschnik (1997) modify a real business cycle model to accommodate this feature of the economy. The modification has the effect of increasing the value of output in the consumption sector in a boom. This increased value reflects the increased need for the output of the consumption good sector during a boom for use in the investment good sector. We refer to this demand channel going from investment sector to the nondurable goods sector as the intermediate goods channel.

There are two shortcomings of the Hornstein and Praschnik (1997) analysis. First, the model is not
consistent with the observed comovement in investment across sectors. That is, the intersectoral linkages in the model are not strong enough to produce full comovement. Second, data on subsectors of the nondurable goods sector cast doubt on the notion that the intermediate good channel is the only reason there is comovement. We studied the subsectors of the nondurable goods sector and found that there is considerable variation in the fraction of total output sent to the investment goods industry. But, as documented in the previous section, most of these sectors nevertheless display strong business cycle comovement. Figure 6 is a scatter plot of the subsectors’ degree of comovement, drawn (with one exception) from the fifth column of numbers in table 1, against the strength of each sector’s intersectoral linkage with the investment sector, \( I \). The variable \( I \) is the fraction of the gross output of a sector which is allocated to intermediate goods destined directly or indirectly for the production of final investment goods. Technical appendix 3 has details of how we computed this. The numbers in parentheses in figure 6 indicate the relative magnitude of the gross output of the sector (gross output of the sector in 1987, divided by the sum of the gross outputs across all 17 sectors). Hornstein and Praschnik’s concept of the nondurable goods sector is broader than the one in table 1. They also include agriculture; retail trade; wholesale trade; transportation, communication, and utilities; services; FIRE; and mining.  

Figure 6 shows that employment in most (13 of 17) nondurable good sectors is substantially procyclical (that is, the comovement statistic is 0.45 or higher), even though the strength of the intermediate good channel (the magnitude of \( I \)) varies from almost zero in the case of food to nearly 0.25 in the case of wholesale trade. Interestingly, although the comovement in mining is moderately weak in our data set, it is one of the sectors in which the intermediate goods channel is the strongest. Conversely, the comovement in apparel is strong, although this sector’s intermediate goods channel is almost nonexistent. Based on these results, we suspect that the intermediate goods channel to the investment sector plays at best only a small role in accounting for comovement of employment in nondurable goods.  

To further explore the Hornstein and Praschnik hypothesis, one would have to construct a version of their model with a disaggregated nondurable goods sector and see if it is consistent with comovement, in the sense of being able to reproduce patterns like those in figure 6.

### Alternative approaches

Here, we summarize three other approaches that may ultimately lead to a satisfactory explanation of business cycle comovement—strategic complementarities, information externalities, and efficiency wage theory. The first two approaches emphasize the importance in business decisions of expectations about the future. They draw attention to the possibility that general shifts in expectations may trigger business cycle fluctuations. If so, these shifts in expectations may well constitute the aggregate shock to which Lucas (1981) refers. The third approach looks at efficiency wage theory. Although promising, the ability of these three theories to quantitatively account for the comovement aspect of business cycles is yet to be fully explored.

#### Strategic complementarities

Suppose there are two people, A and B. Each has to decide on a level of work effort: high or low. Suppose that the net gain to A of exerting a high level of effort is greater if B exerts a high level of effort and that B is in a similar position. The situation is depicted in table 2. Table 2 has four entries, one for each possible combination of work effort. In each entry, the first number indicates the net gain to A, and the second number indicates the gain to B. Suppose A exerts high effort. Then, if B is putting...
out high effort too, A receives 5. But, if B exerts low effort, then A receives –5. The situation is the same for B. Table 2 captures the idea that the gain to either person from exerting high effort is high only when the other person exerts high effort. A situation like this is said to be characterized by strategic complementarity. What do we expect to happen? If the two people could sit down and reach an agreement, they would clearly both choose to exert high effort. But what if they have difficulty coordinating in this way? There are now two possibilities. One is that each expects the other to exert low effort, in which case each finds it optimal to exert low effort. This would put the two people in the bottom right box, with a low payoff going to each. They would stay there until they found a way to communicate and reach an agreement or until something happened to alter their expectation about the other’s plans. Another possibility is that each expects the other to exert high effort, in which case it is in the private interest of each person to exert high effort. This situation could persist for a while, again, unless something happens to shift one person’s expectations about what the other one will do.

What does this have to do with business cycles and comovement? Possibly a lot. There are aspects of business decisions that exhibit strategic complementarity. For example, suppose a firm is considering reopening a plant or starting a large capital investment project. Suppose the project involves a substantial outlay of funds, not just to hire more workers but also to purchase materials and supplies from other firms. The higher the sales the firm expects in the future, the more inclined it will be to shift to a high level of activity in this way. However, much of a firm’s sales come from other firms. And those sales are greater if other firms are themselves operating at a high level of activity, for example, reopening plants or undertaking new capital investment projects. So, firm A has a greater incentive to shift to a high level of activity if it believes firm B plans to operate at a high level of activity.

What do we expect in this situation? Coordination in this setup is much more difficult than in the two person example. There are millions of firms in the economy and, even if it were technically feasible for some firms to coordinate, the antitrust laws represent another barrier. In light of these considerations, we might well expect to find results similar to those in the two person example. Thus, if firms were pessimistic about prospects for future sales, they would choose to be inactive and their pessimistic expectations would be fulfilled. Optimistic expectations would be self-fulfilling in the same way. It is clear that in this setting, expectations have the potential to act as an aggregate shock driving the business cycle. Of course, that does not guarantee that they can necessarily account for comovement. This is an important topic of research.

**Information externalities**

Another potential source of comovement is the way information about the state of the economy is transmitted to individual firms. Forecasts of the future strength of the economy are a factor in individual firms’ current investment decisions. If a firm observes a series of construction projects being initiated by other firms, it may infer that those other firms have information that bodes well for the general economic outlook. When the firm combines this inference with its own information about the economic outlook, it may decide to invest too. Other firms may follow for similar reasons.

These considerations are logically distinct from the strategic complementarities discussed above. There, a firm is interested in the actions of other firms because these actions have a direct impact on the firm’s profitability. Here, a firm is interested in the actions of other firms because of the associated information externality. The externality refers to the fact that a firm’s action may reveal information it has on something of interest to other firms, such as the state of the economy. It is a positive externality, unlike the more familiar examples of externalities which tend to be negative. We present an example, taken from Banerjee (1992), to illustrate the sort of things that can happen when there are information externalities. When firms look to what other firms are doing for guidance in deciding what they should do, this can lead to what Banerjee (1992, p. 798) calls herd behavior, a situation with “everyone doing what everyone else is doing, even when their private information suggests doing something quite different.” It hardly needs to be stated that herd behavior sounds like comovement.

Here is the example. Suppose there are 100 people trying to decide between two restaurants, A and B. Each person knows very little about the two

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<th>Table 2: Example of strategic complementarity</th>
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<td><strong>Person B</strong></td>
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restaurants, but thinks the odds favor A slightly. In addition, each person receives a signal about the relative quality of the two restaurants. For example, one person may read a review of the two restaurants in a travel guide. The review is several years old, however, and the signal may not be accurate. The signals received by each of the 100 persons are equally reliable. Everyone knows this, but they do not know what signal the others received. Now, suppose that 99 people get a signal that suggests B is better than A, while one person gets a signal that A is better than B. If all information were known to everyone, they would recognize that the preponderance of the evidence favors restaurant B and all 100 people would go to B. However, what actually happens is that the 99 people whose signal indicates B is better ignore their signal and flock to restaurant A, following the one person who received the signal that A is better.

This result is not due, as one might suppose, to an assumption that agents are irrational. On the contrary, the example assumes agents are completely rational. The result reflects that not all people make their decisions at the same time. Some have to be first, and as a result, the information they have has disproportionate impact, since almost everyone else is watching them. This timing assumption does not seem unrealistic. In practice, the exact timing of firms' decisions is not completely under their control.36

The example adopts an extreme version of the assumption that the timing of a decision is out of the agents' control, specifying that someone must choose first, then someone else must choose second after observing the choice of the first, and so on. The person choosing first happens to be the one who receives the signal that A is better than B. Since person 1's suspicion that A is better is apparently confirmed by the signal, this person rationally chooses A. The second person's signal suggests that B is better. However, person 2 knows that person 1's signal must have favored A. Since the two signals are equally reliable, they cancel in the mind of person 2. Since person 2 originally thought restaurant A was better, the rational thing for person 2 to do is to go to restaurant A. Person 3 is in precisely the same position as 2, because person 3 knows that, given person 1 went to A, person 2 would have gone to A no matter what signal she received. That is, person 3's observation that person 2 went to A provides no information at all about the relative quality of the two restaurants. Being in the same position as 2, person 3 also chooses A regardless of the signal received. In this way, all 99 people after the first ignore their own signal and go to restaurant A. Although there is a lot of information in the economy about the relative quality of the restaurants, one person acts on a small piece of it, and everyone else follows.

This example and others like it hold out some hope that a fully developed business cycle model incorporating information externalities might exhibit the synchronization of behavior across economic sectors that we observe over the business cycle. However, the above example only illustrates how information externalities can lead rational people to ignore information and synchronize on bad decisions. Synchronization of actions would have occurred anyway, even if there had been no information problem and all signals had been known to everyone. Another concern with this example is how heavily dependent it is upon details of the environment. For example, the outcome is very different if two people are required to choose a restaurant first. In this case, the 99 people who received the signal that B is better than A go to B.37,38 Despite these considerations, we believe the growing literature on information externalities may eventually provide at least part of the explanation for business cycle comovement.39

Efficiency wage theory

A third strategy for understanding comovement is to make use of efficiency wage theory.

Efficiency wage theory: A sketch

Under this view of labor markets, the amount of effort a worker makes (the worker's efficiency) depends on the wage that the worker is paid. Development economists hypothesized that in economies at a very early stage of development, a higher wage leads to greater worker efficiency because it facilitates improvements in diet and health. Efficiency wage theory holds that a higher wage also results in greater worker efficiency in a modern, developed economy, but for different reasons. Because employers cannot perfectly monitor the amount and quality of work effort expended by their employees, there is a temptation for workers to shirk. Efficiency wage theory says that a high wage rate is an effective way to combat this temptation. The higher the wage, the more a worker has to lose if caught and fired for poor job performance.

The simplest version of this idea was articulated by Robert Solow,40 who theorized that the firm selects a wage rate, the efficiency wage, which maximizes worker effort per dollar paid. The firm is not willing to pay more because the resulting increase in worker effort would not be enough to warrant the extra cost. The firm is also not willing to pay less, because the
resulting fall in effort would exceed the fall in cost. In the Solow model, the amount of effort expended per hour by a worker is a function only of the current wage and, for example, does not depend on the general state of business conditions. As a result, the efficiency wage rate does not vary over the business cycle under Solow’s efficiency wage theory.

The firm also has to decide how many workers to hire. It hires workers up to the point at which the marginal productivity of the last worker is equal to the efficiency wage. The downward sloping marginal productivity of labor curve in figure 7 shows how the marginal productivity of labor is lower at higher levels of employment. At the level of employment, $L$, the marginal productivity of the last worker hired is equal to the efficiency wage. Since the efficiency wage in the Solow model is a constant, it follows that employment over the business cycle is determined by the requirement that the marginal product of labor does not change. The downward sloping curve in figure 7, marginal productivity of labor, shows the marginal productivity curve after it has been shifted up by a positive technology shock. If the firm kept employment fixed at $L$ when technology shifted up, marginal productivity would rise to $W^*$, a point far above the efficiency wage. By increasing $L$ to $L'$, the firm keeps marginal productivity unchanged despite the shift up in technology.

A notable feature of efficiency wage theory is that labor supply plays no role in the determination of the wage rate. The theory assumes that there are more workers willing to work than the firm is willing to hire at the efficiency wage. Still, unemployed workers cannot bid the wage down below the level of the efficiency wage. Firms are not interested in hiring workers at such a low wage because they fear it would not provide workers with enough incentive to work hard. The quantity of unemployed people is the number who are willing to work at the efficiency wage, minus the number that firms want to hire. Note how the upward sloping labor supply curve in figure 7 is shifted to the right. At the efficiency wage, $L'$, workers would like to work, but only $L$ are hired, so unemployment is $L^* - L$. At the higher level of technology, unemployment falls to $L^* - L'$.

Efficiency wage theory and business cycle comovement

How might efficiency wage theory help account for business cycle comovement? Suppose the business cycle is driven by an aggregate, real-business-cycle-type technology shock. As we explained earlier, in the standard real business cycle model such a shock does not lead to comovement in employment. In that model, a positive shock leads to a transfer of resources—labor and capital—away from the firms producing consumption goods and toward the firms producing investment goods. Now suppose the labor market part of the real business cycle model is replaced by efficiency wage theory, which implies that firms vary the number of workers they employ to ensure that the marginal product of labor remains constant and equal to the efficiency wage rate. So, when a positive technology shock shifts up the marginal productivity of labor, employment must increase to maintain equality between the marginal product of labor and the efficiency wage.

We indicated earlier that a positive real-business-cycle-type shock pushes up the production functions and the marginal labor productivity curve of all firms. According to efficiency wage theory, this results in an increase in employment by all firms, as they seek to maintain equality between marginal labor productivity and the unchanged efficiency wage rate. This is the intuition underlying the idea that efficiency wage theory may help explain business cycle comovement.

Have we now established that efficiency wages are sufficient to account for comovement? Absolutely not. When we examine efficiency wage theory more closely, we discover that it need not necessarily work
as just outlined. The relationship between how hard a worker works and the wage rate (the worker’s effort function) is a function of the household’s attitude toward risk, the resources it has available if the worker is caught shirking and fired, the probability of being caught conditional on shirking, and the precise consequences of being fired for shirking. The household effort function used in the analysis must integrate all these factors in a logically coherent way. In addition, it must be consistent with other household decisions, such as how to split income between consumption and saving. To build confidence in the idea that efficiency wage theory helps account for comovement, we must integrate all these aspects of the household into a coherent framework which also includes firms and their decisions to see if it works.

To understand why it might not work, recall the Solow model’s assumption that worker effort is a function only of the wage rate. That is what led to our conclusion that the efficiency wage is a fixed number, unrelated to the state of the business cycle. But the logic of the efficiency wage argument suggests that the Solow assumption may not be consistent with rational behavior by households. According to efficiency wage theory, what motivates hard work is the fear of losing a high-wage job. Of course, the cost of that loss is not a function of the wage rate alone. It is also a function of the amount of time the worker can expect to be out of a job after being fired. This suggests that the horizontal line in figure 7 shifts up in a boom, when the duration of unemployment is low. However, if it shifts up high enough, the comovement result could disappear. This highlights the importance of integrating efficiency wage theory into a logically coherent model, before we conclude that it provides a solid foundation for understanding business cycle comovement.

Important steps have been taken in this direction, for example, Shapiro and Stiglitz (1984) and Danthine and Donaldson (1995). Recent work by Gomme (1998) and Alexopoulos (1998) makes a significant further contribution toward understanding the implications of efficiency wage theory for business cycles. However, this work does not focus on the implications for business cycle comovement. We argue that doing so is a good idea.50

Conclusion

A key feature of the data is that, in a frequency range of two to eight years, output, employment and investment across a broad range of sectors move up and down together. We have documented this phenomenon—business cycle comovement—as it pertains to employment. Our survey of possible explanations for it is by no means exhaustive. Many other approaches—those based on sticky prices and wages, countercyclical markups, and credit market frictions—also deserve consideration.51 Still, we have covered a wide range of models, from straightforward modifications to standard business cycle theory to theories that suggest analogies between businesspeople and herds of animals.

Many of the approaches we have surveyed are in early stages of development, while some have been developed to the point where their implications have been quantified and compared with the data. Among these, only one has been shown to be consistent with the observed strong comovement in output, employment, and investment across sectors of the economy—the model presented in Christiano and Fisher (1998). This model incorporates a specification of household preferences, habit persistence, that is not currently standard in the macroeconomics literature. We believe that the success this model has in generating comovement warrants giving this specification of preferences further consideration.

Because comovement is such a central feature of business cycles and because we do not have a generally agreed upon theory of comovement, we conclude that the business cycle is still a puzzle.

TECHNICAL APPENDIX 1

Extracting the business cycle component of a time series

In casual discussions of economic time series, we often think of the data as being the sum of components that have different frequencies of oscillation: the business cycle component lasting two to eight years, components lasting shorter periods, etc. The theory of the spectral analysis of time series makes this intuition rigorous. It clarifies how one can think of data as being composed of components that fluctuate at different frequencies. The method we use to extract the business cycle component of economic time series builds on this theory. For this reason, we begin with a brief section which attempts to convey the basic intuition of spectral analysis. The second section uses this intuition to describe and motivate our method for extracting the business cycle component of a time series.
Decomposing a time series into frequency components

At the core of the spectral analysis of time series is the view that the data can be thought of as the sum of periodic functions. The purpose of this section is to explain this. We begin by reviewing the basic periodic function used in spectral analysis, which is composed of a sine and a cosine function.

Consider the following cosine function of time, \( t \):

\[
\cos(t\omega), \quad t = 0, 1, 2, \ldots
\]

A graph of this, with \( \cos(t\omega) \) on the vertical axis and \( t \) on the horizontal axis, exhibits the oscillations between 1 and \(-1\) familiar from high school trigonometry. Recall that, the period of the cosine function is \( 2\pi \). That is, \( \cos(y) = \cos(y + 2\pi h) \), for \( h = 1, 2, \ldots \). Thus, after the argument of the cosine function increases by \( 2\pi \), the function repeats itself in a periodic fashion.

What is of interest here is the period of oscillation of \( \cos(t\omega) \), expressed in units of time. This is the amount by which \( t \) must increase so that \( t\omega \) increases by \( 2\pi \). Thus, suppose \( t \) is a given point in time. We want to know what is the later point in time, \( t' \), when the cosine function begins to repeat itself. This is just \( t \) such that \( t\omega - t'\omega = 2\pi \), or \( t' - t = 2\pi/\omega \). Thus, the period of oscillation of \( \cos(t\omega) \), in units of time, is \( 2\pi/\omega \). The parameter \( \omega \) is referred to as the frequency of oscillation.

The function, \( \sin(t\omega) \), behaves similarly. It fluctuates between 1 and \(-1\), and has a period of oscillation of \( 2\pi/\omega \). Thus, the two functions have the same amplitude (magnitude of vertical variation) and period. However, the sine function has a different phase than \( \cos(t\omega) \). For example, a graph of the two functions together shows that one looks like the other, apart from a horizontal shift. The phase difference between the two functions is a measure of the magnitude of this horizontal shift. Figure A1 displays sine and cosine functions for \( t = 0, 1, \ldots, 200 \). The period of oscillation is 100, so that the frequency is \( \omega = 2\pi/100 \). Thus, the figure displays the graphs of \( \cos(2\pi t/100) \) and \( \sin(2\pi t/100) \).

We can now describe the central periodic function in spectral analysis, namely the linear combination of a sine and a cosine function

1) \( a\cos(t\omega) + b\sin(t\omega) \),

where \( a \) and \( b \) are parameters. This function obviously has a period, in units of time, equal to \( 2\pi/\omega \). But, its amplitude and phase depend on the values of \( a \) and \( b \). If \( a \) and \( b \) are both very small, the resulting function has very small amplitude and if \( a \) and \( b \) are both very large it has a large amplitude. Also, as the size of \( a \) is increased and the size of \( b \) is decreased, the phase of the function shifts, as more weight is allocated to the cosine and less to the sine.

It turns out that sums of periodic functions like equation 1 look very much like actual data. Thus, suppose we have a time series of data, \( x_t, \quad t = 1, \ldots, T \). To see that \( x_t \) can be expressed as a sum of periodic functions, suppose we specify \( T/2 \) (suppose \( T \) is even) such functions, each with a different frequency of oscillation \( \omega \). For concreteness, let \( \omega_j = 2\pi j/T, \quad j = 1, \ldots, T/2 \). To distinguish the parameters associated with each of these functions, we denote them by \( a_{j,0} \) and \( b_{j,0} \)

for \( j = 1, \ldots, T/2 \). That is, we can always find values for the \( T \) parameters, \( (a_{j,0}, b_{j,0}, \ldots, T/2) \), so that the \( T \) equations, equation 2 for \( t = 1, \ldots, T \), are satisfied. To see this, consider the following regression. Let the explanatory variables be:

\[
X = \begin{bmatrix}
\cos(\omega_1) & \sin(\omega_1) & \cdots & \cos(\frac{\omega_{T/2}}{2}) & \sin(\frac{\omega_{T/2}}{2}) \\
\cos(2\omega_1) & \sin(2\omega_1) & \cdots & \cos(2\frac{\omega_{T/2}}{2}) & \sin(2\frac{\omega_{T/2}}{2}) \\
\vdots & \vdots & \ddots & \vdots & \vdots \\
\cos(T\omega_1) & \sin(T\omega_1) & \cdots & \cos(T\frac{\omega_{T/2}}{2}) & \sin(T\frac{\omega_{T/2}}{2})
\end{bmatrix}
\]
Let the \( T \times 1 \) vector of independent variables, \( Y \), and the \( T \times 1 \) vector of regression coefficients, \( \beta \), be

\[
Y = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_T \end{bmatrix}, \quad \beta = \begin{bmatrix} a_1 \\ b_1 \\ \vdots \\ a_T \\ b_T \end{bmatrix}
\]

Then, the regression is

\[
Y = X\beta + u.
\]

Note, however, that since the number of explanatory variables is \( T \), the error term is exactly zero, and \( \beta \) is computed from \( (X'X)^{-1}X'Y = X^{-1}Y \). Thus a time series of length \( T \) can be expressed exactly as the sum of \( T/2 \) simple processes like equation 1, each having a different frequency of oscillation.

Unfortunately, taken literally, equation 2 is not a very sensible way to think of the data. With \( T \) observations, one has only to compute the \( a_s \) and the \( b_s \) and then the \( T + 1 \) observation can be predicted exactly. No one believes that there is any way to use \( T \) observations on any economic data series and predict the next observation exactly. Imagine, for example, that you could do this with the Dow Jones Industrial Average. If you could, then after one minute of reading this appendix, you would have the information needed to go out and become fabulously wealthy.

Of course, one could instead suppose that the data are a realization from an expression like equation 2, in which the number of periodic functions exceeds the number of observations by, say, 10. In this case, there is no longer the implication that one can perfectly predict next period’s value of \( x_t \). However, there is the implication that after 20 more periods, the data series will then become perfectly predictable. No one would think this is a sensible way to view economic data either. The theory of spectral analysis assumes, sensibly, that no matter how many observations on \( x_t \) one accumulates, the data never become perfectly predictable. That is, it in effect assumes that the number of periodic functions in equation 2 is infinitely large by comparison with the size of the available data set. When this is so, equation 2 is written in the form of an integral, as follows:

\[
3) \quad x_t = \int_{-\infty}^{\infty} \left[ a(\omega) \cos(\omega t) + b(\omega) \sin(\omega t) \right] d\omega,
\]

where \( a(\omega) \) and \( b(\omega) \) are functions of \( \omega \). In view of these observations, it is perhaps not surprising that any covariance stationary time series process, \( x_t \), can be expressed in the form of equation 3 (Koopmans, 1974).

**Extracting the business cycle component**

Equation 3 allows us to make precise the notion of extracting the business cycle component of \( x_t \). That representation views the time series process, \( x_t \), as the sum of components with periods of oscillation \( 2\pi/\omega \) for \( \omega \) lying in the interval 0 to \( \pi \). In monthly data, the business cycle corresponds to components with period greater than 24 months and less than 96 months. In terms of frequencies of oscillation, this corresponds to \( \omega = 2\pi / 96 \) to \( \omega = 2\pi / 24 \). Thus, we seek the business cycle component of \( x_t \), \( y_t \), such that

\[
4) \quad y_t = \int_{-\infty}^{\infty} \left[ a(\omega) \cos(\omega t) + b(\omega) \sin(\omega t) \right] d\omega.
\]

It is well known that \( y_t \) can be computed as a particular centered moving average of observations on the observed data, \( x_t \).

\[
5) \quad y_t = B_0 x_t + B_1 (x_{t-1} + x_{t+1}) + B_2 (x_{t-2} + x_{t+2}) + \ldots,
\]

where

\[
B_j = \frac{\sin(j\omega)}{\pi j}, \quad j = 1, 2, \ldots
\]

There is a major practical stumbling block to using equation 5 for extracting the business cycle component of \( x_t \). It requires an infinite amount of data! Some sort of approximation is needed, if one is to estimate \( y_t \) given only the available data, \( x_1, \ldots, x_T \).

An extensive analysis of this problem appears in Christiano and Fitzgerald (1998), which also provides a review of the related literature. We provide only the briefest review of that discussion here, just enough to enable us to describe exactly how we isolated the business cycle component of the data.

We denote our approximation of \( y_t \) by \( \hat{y}_t \). Here, we focus on the approximations of the following form:

\[
7) \quad \hat{y}_t = \hat{B}_0 x_t + \hat{B}_1 (x_{t-1} + x_{t+1}) + \ldots
\]

That is, we approximate \( y_t \) by a finite ordered, centered, symmetric moving average. But, how should we choose the weights? The natural way is to choose
them so that  is as close to  as possible, that is, so that they solve

\[ \min_{\hat{y}_t} \sum_{t=1}^{T} (y_t - \hat{y}_t)^2. \]

The solution to this problem is a function of the details of the time series representation of  . For example, if we suppose that  is a random walk, that is, , is a process that is uncorrelated over time, then the solution is:\(^5\)

\[ \hat{y}_t = B_j, j = 0, \ldots, K-1 \]
\[ \hat{B}_K = \left[ \frac{1}{T} B_0 + B_1 + B_2 + \ldots + B_{K-1} \right]. \]

Suppose the data at hand are , so that the objects of interest are , . We computed , as follows. For , we applied equation 7 with , for , we applied equation 7 with , and so on. For each  that we computed, we used the largest value of  possible. Christiano and Fitzgerald (1998) argue that this procedure for estimating  works well in terms of optimizing equation 8, even if the true-time series representation of  is not a random walk. They show that an even better approach uses an asymmetric set of weights, so that the estimate of  for each  uses all the available data on .

\(^5\)Note that for all integers . Since the right column of  is zero in this case,  is singular and so cannot be inverted. In practice, the last column of  is accommodated by a column of ones, to accommodate a non-zero sample mean in . Under these conditions, the columns of  are orthogonal, so that  is trivial to compute. In particular, for , 1:

\[ a_j = \frac{1}{T} \sum_{t=1}^{T} \cos(\omega_j t) x_t, \]
\[ b_j = \frac{1}{T} \sum_{t=1}^{T} \sin(\omega_j t) x_t. \]

Also,

\[ a_{T/2} = \left[ \sum_{t=1}^{T} \cos(\omega t) x_t \right] / T, \]
\[ b_{T/2} = \left[ \sum_{t=1}^{T} \sin(\omega t) x_t \right] / T. \]

To gain further intuition into the relationship between equations 2 and 3, it is useful to recall the simplest definition of an integral, the Riemann integral. Thus, let  be a function, with domain . Let  be a set of numbers that divide the domain into equally spaced parts. That is, , where . The integral of  over its domain is written,

\[ \int f(y) dy. \]

This is approximated by the sum of the areas of the  rectangles:

\[ \sum_{j=1}^{M} f(y_j) \Delta M. \]

The Riemann interpretation of the integral is that it is the limit of the above sums, as . The relationship between the above finite sum and the integral resembles that between equations 2 and 3 if we adopt where . The relationship between the above finite sum and the integral resembles that between equations 2 and 3 if we adopt where . This requires a constant term in equation 8. See Christiano and Fitzgerald (1998) for more details.

TECHNICAL APPENDIX 2

Comovement and the elasticity of substitution

The standard real business cycle model assumes that the elasticity of substitution between capital and labor in production is unity. In the text, we discussed a result due to Benhabib, Rogerson, and Wright (1991): With this kind of production function and with utility functions consistent with balanced growth, comovement in employment is impossible (see note 16). Here, we show that comovement is a technical possibility when the elasticity of substitution is different from unity. However, we find that comovement does not occur for plausible parameter values. These results suggest that attempts to account for comovement by adjusting the elasticity of substitution in production in a standard real business cycle model are unlikely to be successful.

We begin by describing a version of the standard real business cycle model. We assume that households have identical preferences of the following form:

\[ E_{0} \sum_{i=0}^{\infty} \frac{C_{i} (1 - L_{i})^{\sigma}}{1 - \sigma}. \]
where $\sigma, \psi > 0$ satisfy the various conditions required for utility to be strictly concave. Also, $C_s > 0$ denotes per capita consumption, and $L_s$ denotes per capita hours worked. We require $0 \leq L_s \leq 1$. The resource constraint is

$$c_t + k_{s, t+1} - (1 - \delta) k_s \leq \left[ (1 - \alpha) k^\psi_s + \alpha L_e^\psi \right]^{-1} z_t.$$  

Here, $0 < \delta < 1$ is the rate of depreciation on capital and $0 < \alpha < 1$ is a parameter. The elasticity of substitution between capital and labor is $\psi > 0$. Also,

$$\log(z_t) = \rho \log(z_{t-1}) + \epsilon_t, \quad 0 < \rho < 1,$$

where $\epsilon_t$ is a zero mean random variable, that is independently distributed over time. Finally, $k_s > 0$ denotes the beginning of period $t$ stock of capital, which is a given quantity at time $t$.

As noted in the body of the article, it is possible to interpret this as a two sector model: one in which consumption goods, $c_t$, and investment goods, $k_t - (1 - \delta) k_s$, are produced in different sectors by different firms. It is assumed that both sectors use the same production function, the one stated above, and that capital and labor can move freely between the two sectors, subject only to the obvious constraint that the sum of capital and labor in the two sectors equals $k_t$ and $L_t$, respectively. Thus, letting $I_{c,t}$, $k_t$, and $L_t$, $k_t$ denote the amount of labor and capital, respectively, used in the consumption and investment sectors, we require

$$I_{c,t} = I_{c,t} - (1 - \delta) k_t, \quad I_{l,t} = I_{l,t} - (1 - \delta) k_t.$$  

In our first experiment, we considered values of $\psi$ on a grid between 0.7 and 20. For each value of $\psi$, 1,000 observations on $I_{c,t}$ and $I_{l,t}$ and

$$I_{c,t} = k_{c,t} - (1 - \delta) k_t, \quad I_{l,t} = k_{l,t} - (1 - \delta) k_t,$$

were generated using our approximation to the model’s solution. The 1,000 observations were then used to compute the correlations, $r_{ct}$, between $I_{c,t}$ and $I_{l,t}$ and the correlations, $\rho_{ct}$, between $I_{c,t}$ and $I_{l,t}$, A model exhibits comovement in employment and investment if both $\rho_{ct} > 0$. We found $r_{ct} > 0$, $\rho_{ct} < 0$ for each value of $\psi$ using the benchmark parameterization.

We repeated these calculations several times, each time perturbing one, and only one, of the parameters in the benchmark parameterization. We considered the following alternatives: $\sigma = 5, \rho = 0.99; \rho = 0.99; \text{steady state hours equal to 0.1; steady state labor’s share equal to 0.3; } \delta = 0.05, \delta = 0.01; \text{ and } \beta = 0.97, 0.995$. The perturbations in $\sigma, \rho, \beta, \text{ and } \delta$ did not produce a parameterization exhibiting comovement. The reduction in labor’s share resulted in comovement in employment, but not investment, for values of $\psi$ between about 3 and 13. Lowering steady state hours to 0.10 also resulted in comovement in employment but not investment. Hence, we conclude that altering the elasticity of factor substitution in production does not improve the standard real business cycle model’s ability to reproduce full comovement for reasonable parameter values.
Analysis of the input–output tables

Our analysis of the input–output tables is based on the 1987 benchmark, 95 variable input–output table for the U.S. economy. Our main objective here is to define the fraction of a sector’s final output which is used directly or indirectly in the production of final investment goods. Let Y denote the vector of gross outputs for the production sectors of the economy. Let A = [a_{ij}] be the matrix of input–output coefficients. That is, a_{ij} is the quantity of the jth industry’s output produced by the ith industry. Let f, c, g, o denote the vectors of gross private fixed investment, personal consumption expenditures, government (federal, state, and local) purchases, and ‘other’ for each sector. Here, ‘other’ is essentially exports minus imports. Total output, Y, is broken down into a part allocated to intermediate inputs, AY, and a part allocated to final output, F + C + G + O as follows:

\[ AY + Y' + C + G + O = Y. \]

Solving this for Y, we get

\[
Y = Y_{f} + Y_{c} + Y_{g} + Y_{o},
\]

\[
Y_{i} = [I - A]^{-1} i, i = f, c, g, o.
\]

For convenience, we report \( Y_{i}, i = f, c, g, o \) for the 95 sectors of the U.S. economy which are included in the input–output table underlying the analysis reported in figure 6. Table A1 reports results for the 17 sectors of the nondurable goods industry, as defined in the Hornstein and Praschnik (1997) analysis. This table reports the input–output table industry numbers that make up the industries whose name is in the middle column. Table A2 reports the numbers for the other sectors. The sum of the numbers in a row must be unity.

<table>
<thead>
<tr>
<th>I-O industry number</th>
<th>I-O industry title</th>
<th>( Y_{f} )</th>
<th>( Y_{c} )</th>
<th>( Y_{g} )</th>
<th>( Y_{o} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1+2+3+4</td>
<td>Agriculture, forestry, and fisheries</td>
<td>0.060</td>
<td>0.894</td>
<td>0.052</td>
<td>-0.006</td>
</tr>
<tr>
<td>5+6+7+8+9+10</td>
<td>Mining</td>
<td>0.207</td>
<td>0.893</td>
<td>0.181</td>
<td>-0.292</td>
</tr>
<tr>
<td>14</td>
<td>Food and kindred products</td>
<td>0.018</td>
<td>0.962</td>
<td>0.041</td>
<td>-0.021</td>
</tr>
<tr>
<td>15</td>
<td>Tobacco products</td>
<td>0.000</td>
<td>0.914</td>
<td>0.000</td>
<td>0.066</td>
</tr>
<tr>
<td>16+17</td>
<td>Textile mill products</td>
<td>0.185</td>
<td>0.995</td>
<td>0.072</td>
<td>-0.252</td>
</tr>
<tr>
<td>18+19</td>
<td>Apparel and other textile products</td>
<td>0.037</td>
<td>1.284</td>
<td>0.041</td>
<td>-0.362</td>
</tr>
<tr>
<td>24+25</td>
<td>Paper and allied products</td>
<td>0.103</td>
<td>0.833</td>
<td>0.112</td>
<td>-0.047</td>
</tr>
<tr>
<td>26A+26B</td>
<td>Printing and publishing</td>
<td>0.058</td>
<td>0.795</td>
<td>0.121</td>
<td>0.026</td>
</tr>
<tr>
<td>27A+27B+28</td>
<td>Chemicals and allied products</td>
<td>0.180</td>
<td>0.698</td>
<td>0.138</td>
<td>-0.016</td>
</tr>
<tr>
<td>31</td>
<td>Petroleum refining and related products</td>
<td>0.105</td>
<td>0.782</td>
<td>0.145</td>
<td>-0.032</td>
</tr>
<tr>
<td>32</td>
<td>Rubber and miscellaneous plastics products</td>
<td>0.246</td>
<td>0.761</td>
<td>0.127</td>
<td>-0.134</td>
</tr>
<tr>
<td>33+34</td>
<td>Footwear, leather, and leather products</td>
<td>0.031</td>
<td>2.154</td>
<td>0.037</td>
<td>-1.222</td>
</tr>
<tr>
<td>65A+...+68C</td>
<td>Transportation, communications, and utilities</td>
<td>0.107</td>
<td>0.740</td>
<td>0.123</td>
<td>0.029</td>
</tr>
<tr>
<td>69A</td>
<td>Wholesale trade</td>
<td>0.232</td>
<td>0.589</td>
<td>0.098</td>
<td>0.082</td>
</tr>
<tr>
<td>69B</td>
<td>Retail trade</td>
<td>0.066</td>
<td>0.919</td>
<td>0.015</td>
<td>0.000</td>
</tr>
<tr>
<td>70A+70B+71A+71B</td>
<td>Finance, insurance, and real estate</td>
<td>0.061</td>
<td>0.877</td>
<td>0.043</td>
<td>0.020</td>
</tr>
<tr>
<td>72A+...+77B</td>
<td>Services</td>
<td>0.076</td>
<td>0.879</td>
<td>0.044</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Notes: \( Y \) measures amount of gross output of industry in indicated row sent directly or indirectly to industry \( i \), where \( i = f, c, g, o \).
Row numbers are scaled so they sum to unity.

Source: Authors’ calculations based on data from U.S. Department of Commerce, Bureau of Economic Analysis, 1992, Survey of Current Business, Volume 72, Number 4, April.
<table>
<thead>
<tr>
<th>I-O industry number</th>
<th>I-O industry title</th>
<th>Y_f</th>
<th>Y_c</th>
<th>Y_g</th>
<th>Y_s</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>New construction</td>
<td>0.805</td>
<td>0.000</td>
<td>0.195</td>
<td>0.000</td>
</tr>
<tr>
<td>12</td>
<td>Maintenance and repair construction</td>
<td>0.180</td>
<td>0.574</td>
<td>0.243</td>
<td>0.002</td>
</tr>
<tr>
<td>13</td>
<td>Ordnance and accessories</td>
<td>0.011</td>
<td>0.051</td>
<td>0.838</td>
<td>0.100</td>
</tr>
<tr>
<td>20–21</td>
<td>Lumber and wood products</td>
<td>0.542</td>
<td>0.340</td>
<td>0.169</td>
<td>-0.051</td>
</tr>
<tr>
<td>22–23</td>
<td>Furniture and fixtures</td>
<td>0.477</td>
<td>0.586</td>
<td>0.067</td>
<td>-0.128</td>
</tr>
<tr>
<td>29A</td>
<td>Drugs</td>
<td>0.018</td>
<td>0.963</td>
<td>0.125</td>
<td>-0.107</td>
</tr>
<tr>
<td>29B</td>
<td>Cleaning and toilet preparations</td>
<td>0.018</td>
<td>0.949</td>
<td>0.033</td>
<td>0.000</td>
</tr>
<tr>
<td>30</td>
<td>Paints and allied products</td>
<td>0.422</td>
<td>0.445</td>
<td>0.168</td>
<td>-0.036</td>
</tr>
<tr>
<td>35</td>
<td>Glass and glass products</td>
<td>0.202</td>
<td>0.798</td>
<td>0.116</td>
<td>-0.116</td>
</tr>
<tr>
<td>36</td>
<td>Stone and clay products</td>
<td>0.575</td>
<td>0.314</td>
<td>0.206</td>
<td>-0.095</td>
</tr>
<tr>
<td>37</td>
<td>Primary iron and steel manufacturing</td>
<td>0.515</td>
<td>0.501</td>
<td>0.207</td>
<td>-0.223</td>
</tr>
<tr>
<td>38</td>
<td>Primary nonferrous metals manufacturing</td>
<td>0.400</td>
<td>0.485</td>
<td>0.247</td>
<td>-0.132</td>
</tr>
<tr>
<td>39</td>
<td>Metal containers</td>
<td>0.057</td>
<td>0.891</td>
<td>0.084</td>
<td>-0.012</td>
</tr>
<tr>
<td>40</td>
<td>Heating, plumbing, and fabricated structural metal products</td>
<td>0.604</td>
<td>0.201</td>
<td>0.198</td>
<td>-0.002</td>
</tr>
<tr>
<td>41</td>
<td>Screw machine products and stampings</td>
<td>0.358</td>
<td>0.641</td>
<td>0.132</td>
<td>-0.131</td>
</tr>
<tr>
<td>42</td>
<td>Other fabricated metal products</td>
<td>0.377</td>
<td>0.573</td>
<td>0.175</td>
<td>-0.124</td>
</tr>
<tr>
<td>43</td>
<td>Engines and turbines</td>
<td>0.377</td>
<td>0.362</td>
<td>0.246</td>
<td>0.015</td>
</tr>
<tr>
<td>44–45</td>
<td>Farm, construction, and mining machinery</td>
<td>0.731</td>
<td>0.151</td>
<td>0.097</td>
<td>0.021</td>
</tr>
<tr>
<td>46</td>
<td>Materials handling machinery and equipment</td>
<td>0.876</td>
<td>0.134</td>
<td>0.105</td>
<td>-0.115</td>
</tr>
<tr>
<td>47</td>
<td>Metal working machinery and equipment</td>
<td>0.779</td>
<td>0.261</td>
<td>0.108</td>
<td>-0.147</td>
</tr>
<tr>
<td>48</td>
<td>Special industry machinery and equipment</td>
<td>0.962</td>
<td>0.154</td>
<td>0.028</td>
<td>-0.145</td>
</tr>
<tr>
<td>49</td>
<td>General industrial machinery and equipment</td>
<td>0.729</td>
<td>0.305</td>
<td>0.130</td>
<td>-0.164</td>
</tr>
<tr>
<td>50</td>
<td>Miscellaneous machinery, except electrical</td>
<td>0.309</td>
<td>0.438</td>
<td>0.258</td>
<td>-0.006</td>
</tr>
<tr>
<td>51</td>
<td>Computer and office equipment</td>
<td>0.786</td>
<td>0.148</td>
<td>0.156</td>
<td>-0.090</td>
</tr>
<tr>
<td>52</td>
<td>Service industry machinery</td>
<td>0.636</td>
<td>0.528</td>
<td>0.120</td>
<td>-0.045</td>
</tr>
<tr>
<td>53</td>
<td>Electrical industrial equipment and apparatus</td>
<td>0.639</td>
<td>0.308</td>
<td>0.168</td>
<td>-0.114</td>
</tr>
<tr>
<td>54</td>
<td>Household appliances</td>
<td>0.242</td>
<td>0.842</td>
<td>0.045</td>
<td>-0.129</td>
</tr>
<tr>
<td>55</td>
<td>Electric lighting and wiring equipment</td>
<td>0.471</td>
<td>0.447</td>
<td>0.185</td>
<td>-0.104</td>
</tr>
<tr>
<td>56</td>
<td>Audio, video, and communication equipment</td>
<td>0.626</td>
<td>0.564</td>
<td>0.206</td>
<td>-0.396</td>
</tr>
<tr>
<td>57</td>
<td>Electronic components and accessories</td>
<td>0.338</td>
<td>0.437</td>
<td>0.322</td>
<td>-0.097</td>
</tr>
<tr>
<td>58</td>
<td>Miscellaneous electrical machinery and supplies</td>
<td>0.321</td>
<td>0.687</td>
<td>0.148</td>
<td>-0.156</td>
</tr>
<tr>
<td>59A</td>
<td>Motor vehicles (passenger cars and trucks)</td>
<td>0.478</td>
<td>0.776</td>
<td>0.051</td>
<td>-0.304</td>
</tr>
<tr>
<td>59B</td>
<td>Truck and bus bodies, trailers, and motor vehicles parts</td>
<td>0.437</td>
<td>0.746</td>
<td>0.080</td>
<td>-0.263</td>
</tr>
<tr>
<td>60</td>
<td>Aircraft and parts</td>
<td>0.134</td>
<td>0.049</td>
<td>0.546</td>
<td>0.270</td>
</tr>
<tr>
<td>61</td>
<td>Other transportation equipment</td>
<td>0.145</td>
<td>0.543</td>
<td>0.336</td>
<td>-0.024</td>
</tr>
<tr>
<td>62</td>
<td>Scientific and controlling instruments</td>
<td>0.442</td>
<td>0.166</td>
<td>0.372</td>
<td>0.020</td>
</tr>
<tr>
<td>63</td>
<td>Ophthalmic and photographic equipment</td>
<td>0.347</td>
<td>0.590</td>
<td>0.228</td>
<td>-0.165</td>
</tr>
<tr>
<td>64</td>
<td>Miscellaneous manufacturing</td>
<td>0.175</td>
<td>1.121</td>
<td>0.071</td>
<td>-0.368</td>
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<tr>
<td>70</td>
<td>Federal government enterprises</td>
<td>0.079</td>
<td>0.814</td>
<td>0.104</td>
<td>0.003</td>
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<tr>
<td>79</td>
<td>State and local government enterprises</td>
<td>0.033</td>
<td>0.928</td>
<td>0.043</td>
<td>-0.003</td>
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<tr>
<td>80</td>
<td>Noncomparable imports</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
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<tr>
<td>81</td>
<td>Scrap, used, and secondhand goods</td>
<td>-9.699</td>
<td>7.493</td>
<td>1.330</td>
<td>1.377</td>
</tr>
<tr>
<td>82</td>
<td>General government industry</td>
<td>0.000</td>
<td>0.000</td>
<td>1.000</td>
<td>0.000</td>
</tr>
<tr>
<td>83</td>
<td>Rest of the world adjustment to final uses</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>84</td>
<td>Household industry</td>
<td>0.000</td>
<td>1.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>85</td>
<td>Inventory valuation adjustment</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>1.000</td>
</tr>
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</table>

Notes: Y_f measures amount of gross output of industry in indicated row sent directly or indirectly to industry j, where i = f, c, g, o.
Row numbers are scaled so they sum to unity.
An important exception is Long and Plosser (1983), which does allow for multiple sectors. Their model economy is straightforward to analyze because they adopt several key simplifying assumptions. For example, they assume the entire stock of capital in each sector wears out within three months. However, these assumptions make the model ill-suited for quantitative, empirical analysis. It took many years before economists undertook a systematic empirical analysis of versions of the Long and Plosser model without the key simplifying assumptions (see Horvath [1998a, b]).

Employment data are taken from DRI Basic Economics database. The hours worked data are indexes of aggregate weekly hours of production or nonsupervisory workers on private nonagricultural payrolls by industry. The data on numbers of workers are workers on nonagricultural payrolls, by industry. All data are monthly and seasonally adjusted and cover 1964Q1–95Q3.

Our statistic is the regression $R^2$ obtained by regressing the business cycle component of that series on the business cycle component of total hours worked, at lags 0, 1, and –1. We allow next month’s employment and the previous month’s employment to enter this relationship because we do not want our measure of comovement to be low just because a variable may be out of phase with total private hours worked by only one month. If we did not include these lags, our regression $R^2$ would coincide exactly with the square correlation referred to in the text. We construct our statistic as follows. Let $y_t$ denote the business cycle component of a given sector’s employment. Let $x_t$ denote the corresponding measure of total hours worked. We consider the regression of $y_t$ on $x_{t-T}$ and $x_{t-1}$, $y_t = \alpha_{0}x_{t-T} + \alpha_{1}x_{t-1} + \epsilon_{t}$, where $\epsilon_{t}$ represents the estimated coefficients. Then, the $R^2$’s reported in the table are $\text{var}(\epsilon_{t})/\text{var}(y_{t})$. The correlation between $y_t$ and $x_t$ is $\text{corr}(y_{t}, x_{t}) = \text{Cov}(y_{t}, x_{t})/\sqrt{\text{Var}(y_{t})\text{Var}(x_{t})}$. But, $\text{Cov}(y_{t}, x_{t}) = \sigma$ and $\text{Var}(x_{t}) = 2\sigma^2$, $\text{Var}(y_{t}) = \sigma^2$. Substituting these results into the formula, we get $\text{corr}(y_{t}, x_{t}) = 1\sqrt{2} = 0.71$.

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Suppose $y_{t} = y_{t} + \ldots + y_{t}$. The logic of the previous note leads to $\text{corr}(y_{t}, y_{t}) = 1/n$. With $n = 33$, this is 0.17, after rounding.

The midpoints are $-0.35, -0.25, -0.15, \ldots, 0.85, 0.95$. In each case, the interval has length 0.1 and extends 0.05 above and below the midpoint.

Real business cycle theory has evolved considerably in recent years and now encompasses a wide variety of conceptions of the economy. The definition proposed by Prescott (1991, p. 3) reflects this: “Real business cycle theory is the application of general equilibrium theory to the quantitative analysis of business cycle fluctuations.”

This section and the next one draw heavily on work by Christiano and Fisher (1998).

Some might want to dismiss the notion of a technology shock that affects all firms simultaneously as too preposterous to deserve consideration. Such a person may find it more plausible to think of technology shocks as things that are idiosyncratic to individual firms. Most of the examples of technology shocks given in the text certainly suggest this. This is the line that Lucas took when he dismissed the idea that a technology shock might be the aggregate shock needed to account for business cycles. He argued that, although technology shocks are no doubt important at the firm level, they could not be important for economy-wide aggregate output: He expected that firms affected by positive productivity shocks would be balanced by firms experiencing negative shocks. Work of Shleifer (1986) and Dupor (1998) suggests that the Lucas reason for dismissing technology shocks as an important impulse to business cycles may be premature. These researchers emphasize the distinction between the time that a new technological idea arrives in the firm, and the time the firm implements it. Consistent with Lucas’s intuition, the exact timing of arrival of ideas may well be idiosyncratic at the firm level. In this case, the economy-wide average rate of arrival of new ideas would be constant: Firms discovering ideas for new products or labor-saving ways to produce output would be balanced by firms experiencing no progress or even regress. What Shleifer and Dupor emphasize, however, is that it is not the arrival of new ideas per se that shifts up production functions. Rather, it is the implementation of the new ideas that does this. They point out that there may well be plausible mechanisms in an economy which lead firms to implement new, technology-shifting ideas at the same time. These mechanisms involve “strategic complementarities,” which are discussed further below.

See, for example, Benhabib, Rogerson, and Wright (1991).

Formally, this is what we have in mind. A standard real business cycle model, with unit elasticity of substitution in production between capital and labor, implies that the value of the output of the sector producing consumption goods, measured in utility units, is proportional to the value of the labor used in that sector, also measured in utility units. The value of the output of the consumption sector is the product of the total output of that sector, $Y$, and the marginal utility of consumption, $u$. The value of the labor used in the sector producing consumption goods is the product of the labor used in producing consumption goods, $L$, and the marginal utility of leisure, $u$. Thus, 

$$aY = uL$$

This is just a rearrangement of the usual static efficiency condition that specifies that the marginal product of labor in producing the output of the consumption sector, $aY/L$, must equal the marginal rate of substitution between consumption and leisure, $u/L$. Note that if the term on the left of the equality falls (‘the value of the output of the sector producing consumption goods falls’) and $u$ rises (‘the marginal utility of leisure rises’), then $L$ must fall.

The inability of the standard real business cycle model to produce comovement is surprisingly robust. Standard specifications of that model hold that the marginal rate of substitution between consumption and leisure is $\psi/(1 - L - L)$, where $L$ is employment in the consumption sector, $L$ is employment in the investment good sector, and $1 - L - I$ is leisure. Also, $\psi$
and \( \xi \) are non-negative constants. In Hansen’s (1985) indivisible labor model, \( \xi = 0 \). In his divisible labor model, \( \xi = 1 \). The standard model assumes a Cobb–Douglas production function, so that the marginal product of labor is proportional to average labor productivity in the consumption good producing sector. Equally between the marginal product of labor and the marginal rate of substitution between consumption and leisure implies:

\[
\frac{\alpha C}{L_c} = \frac{\psi C}{(1 - L_c - L_y)^{\gamma}}.
\]

Cancelling consumption on the two sides and rearranging, we get

\[
\frac{\alpha}{\psi} (1 - L_c - L_y)^{\gamma} = L_c.
\]

From this it is easy to see that if, for whatever reason, \( L_c \) or \( L_y \) moves, then the other variable must move in the opposite direction. This demonstration summarizes a discussion in Benhabib, Rogerson, and Wright (1991) and in Murphy, Shleifer, and Vishny (1989). The result holds for the entire class of utility functions identified by King, Plosser, and Rebelo (1988) as being consistent with balanced growth. However, the same cannot be said for the entire class of production functions consistent with balanced growth. In particular, the result does not hold for production functions in which the elasticity of substitution between capital and labor differs from unity. We demonstrate this in technical appendix 2. We also show, however, that for plausible parameterized versions of the standard real business cycle model, departures from unit elasticity of substitution in production do not help the model reproduce comovement.

One paper that is often mentioned in the comovement literature is Huffman and Wynne (1998). However, their focus is primarily on comovement in investment and output. They largely abstract from comovement in employment by making assumptions that make labor in the consumption sector essentially constant. They specify that the elasticity of substitution between labor and capital in the consumption sector is nearly unity, and that \( \xi = 0 \). The argument in note 16 explains why their model has the implication that \( L_c \) is essentially constant.

Suppose \( L_c \) is the third use of time. Then the equation in note 16 is modified as follows:

\[
\frac{\alpha}{\psi} (1 - L_c - L_y)^{\gamma} = L_c.
\]

Evidently, now it is possible for both \( L_c \) and \( L_y \) to be procyclical, as long as \( L_c \) is sufficiently countercyclical.

Closely related to this is their recommendation that economists work with the following utility function in consumption and leisure: \( u [c - \psi, \frac{1}{C} (1 + \psi)] \), where \( \psi, \xi > 0 \) and \( u \) is a covariance, increasing utility function. The marginal rate of substitution between consumption and leisure with this utility function is \( \psi L^{\psi} \). Substituting this into the employment condition in note 16 results in

\[
\frac{\alpha C}{L_c} = \psi (L_c + L_y)^{\psi}.
\]

The argument in that note that \( L_c \) and \( L_y \) cannot move in the same direction does not work with this utility function.

Baxter’s model is a convenient vehicle for illustrating an issue that has to be confronted in macroeconomic models generally. The text provides an illustration of Baxter’s assumption that durable goods and market goods are substitutes. However, it is just as easy to think of examples in which they are complements.

Consider a car, for example. Ownership of a car makes it more attractive to go out on long road trips that require purchasing market goods like hotel and restaurant services. This suggests that cars and market goods are complements. A moment’s further thought about this example suggests that most household durables actually cannot be neatly labeled as either complements or substitutes for market consumption. For example, an automobile is also a substitute for market goods because it reduces the need for market services like cab, train, and airplane rides. Similarly, consider the biggest household durable of all, the home. It substitutes for hotel and restaurant services and complements market goods such as party goods, telephone services, and food. Thus, intuition is ultimately not a good guide to assessing Baxter’s assumption about the substitutability of durables and market goods. Ultimately, this must be assessed through careful econometric work to determine whether, on average, market goods and durables are more like substitutes or complements.

Consider the limiting case of perfect substitutability, so that consumption is \( C + D \), where \( C \) is market consumption and \( D \) is the service flow from the stock of home durables. With log utility, the marginal utility of market consumption is \( 1/(C + D) \). Suppose \( D \) is fixed. Then a given jump in \( C \) reduces marginal utility by less, the larger is \( D \).

Remarks in note 20 about Baxter’s work are obviously relevant here too. Intuition is a very confusing guide, at best, regarding the plausibility of Benhabib, Rogerson, and Wright’s assumption that the elasticity of substitution between home-produced and market-produced goods is high. The parameter must be estimated econometrically. This was done in Rupert, Rogerson, and Wright (1995), who report, based on data from the Panel Study on Income Dynamics, that the elasticity of substitution indeed is high.

Because the model predicts that consumption rises in a boom, the high degree of substitutability between home and market goods causes the marginal value of home goods to drop in a boom. This in turn causes a drop in the value of home durables, leading households to reduce their purchases of new durables. This implication is strongly countercyclical, however, since durables are in fact highly procyclical. Interestingly, Baxter’s (1996) model seems to avoid this tension. In particular, her model generates comovement between employment in the consumption and investment industries simultaneously implies that durable goods purchases are procyclical.


See Koehlerlakota (1996) for a recent review. Although habit persistence helps to account for the observed average of the premium in equity over risk-free debt, it does not account well for the volatility of these variables. For a further discussion, see Boldrin, Christiano, and Fisher (1997) and Heaton (1995).

See Constantinides (1990) and Sundaresan (1989) for more evidence on the plausibility of habit persistence preferences.

In the Hornstein and Praschnik (1997) modification, the output of the consumption sector is \( C + m \), where \( m \) is intermediate goods sent to the investment good sector. Suppose the marginal utility of market consumption is \( 1/C \). Then, the value of the output of the consumption sector is \( (C + m)/C = 1 + m/C \). Note that this jumps with a rise in \( C \) as long as \( m \) rises by a greater percentage than \( C \). With \( m/C \) sufficiently procyclical, it is possible for employment in the investment and consumption good sectors to move up and down together over the cycle.
We are very grateful for instructions and advice from Mike Kouparitsas on how to analyze the input-output data.

We do not have an index of hours worked for this sector. Instead, we used LHA4i, which is CitiBase's mnemonic for number of persons employed in the agricultural industry. We obtained a measure of comovement for this variable in the same way as for the other variables.

The least squares regression line through the data in figure 6 is $\rho_{y_1} = 0.48 + 1.35f$. Thus, if a sector was not connected to the investment sector at all (that is, $f = 0$), employment in that sector would still exhibit substantial procyclicality (that is, $\rho_{y} = 0.48$).

Such an exercise could be pursued by building on the models in Long and Plosser (1983) and Horvath (1998a, b). To our knowledge, comovement in the sense studied in this article has not been investigated in these models.

A slightly different mechanism, whereby a firm’s expectation that other firms will be inactive leads all firms to be inactive was analyzed by Shleifer (1986) and Dupor (1998) and summarized in note 13.

For example, Benhabib and Farmer (1994, 1996) incorporate strategic complementarities by way of an externality in the production function. Because their production function is of the Cobb-Douglas form, the argument in note 16 applies to these models too. In particular, in these models, employment in the production of consumption and investment goods must move in opposite directions over the business cycle.


An example of a negative externality is the pollution that is generated as a byproduct of a manufacturing process.

For an analysis of the case where there are information externalities and timing is under the control of managers, see Chamley and Gale (1994). They find, as one might expect, that there is a tendency to delay decisions under these circumstances.

We are grateful to Henry Siu for pointing this out to us.

The example is similarly sensitive to the assumption that people view the signals they receive as equally reliable to the signals received by others. It is possible that, in practice, the type of individual making investment decisions has greater confidence in her ability to interpret signals than her counterparts at other firms. This is the implication of empirical evidence that suggests that these types of people are overly confident in their own abilities. See Daniel, Hirshleifer, and Subrahmanyan (1998), and the references therein for further discussion. According to them, (p. 5–6): “Evidence of overconfidence has been found in several contexts. Examples include psychologists, physicians and nurses, engineers, attorneys, negotiators, entrepreneurs, managers, investment bankers, and market professionals such as security analysts and economic forecasters. Further, some evidence suggests that experts tend to be more overconfident than relatively inexperienced individuals.”


See Romer (1996) for a review.

Let $e(w)$ be the amount of effort a worker expends per hour, given the hourly wage rate, $w$. The efficiency wage is the value of $w$ that maximizes $e(w)/w$. One type of $e$ function that guarantees that this has a maximum for $0 < w < \infty$ is one in which $e$, when expressed as a function of $w$, has an S shape: convex for $w$ near zero and turning concave for larger values of $w$ (see Romer, 1996). The optimal $e(w)/w$ is the slope of the ray drawn from the origin, tangent to the concave part of the $e$ function. At the optimum, the elasticity of effort with respect to the wage is unity, that is, $e'(w)/w = 1$. Optimality requires that, when evaluated at the efficiency wage, the second derivative of $e$ with respect to $w$, is negative.

The algebra underlying this analysis is simple. Let the production function be $f(e(w),L,K,z)$, where $eL$ is the total amount of effort expended in $L$ hours of work, $z$ is a shock to technology, and $K$ is the stock of capital. We assume that the derivative of $f$ in its first argument is positive and strictly decreasing in $eL$ and increasing in $z$. Revenues net of labor costs are $f(e(w)L,K,z) = wL$. The firm maximizes this with respect to $w$ and $L$. It is convenient, however, to adopt a change of variables, $X = wL$, and let the firm choose $X$ and $w$ instead. Then, the revenue function is

$$f\left(\frac{e(w)}{w}L,K,z\right) = X.$$

Evidently, maximizing this with respect to $w$ is equivalent to maximizing effort per dollar cost, $e(w)/w$ with respect to $w$. For a further discussion of this maximization problem, see the previous note. Maximization with respect to $X$ implies:

$$f\left(e\left(\frac{w^*}{w}\right)L,K,z\right)e\left(\frac{w^*}{w}\right) = w^*,$$

that is, the marginal product of labor must equal the wage rate.

The marginal product of labor in figure 7 graphs $f\left(e\left(\frac{w^*}{w}\right)L,K,z\right)e\left(\frac{w^*}{w}\right)$ as a function of $L$, holding $K$ fixed. Here, $w^*$ is the efficiency wage rate. The curve marked marginal product of labor’ graphs $f\left(e\left(\frac{w^*}{w}\right)L,K,z\right)e\left(\frac{w^*}{w}\right)$ for $z > z^*$.

These observations motivate why efficiency wage theory is sometimes viewed as a way to fix another set of counterfactual implications of the standard real business cycle model: that wages tend to fluctuate too much and employment too little over the business cycle.

This argument implicitly assumes that the stock of capital used by a firm, once put in place, cannot be shifted to another firm. The assumption guarantees that a positive technology shock which drives up the marginal productivity of labor curve, must be accompanied by a rise in employment if marginal productivity is to remain unchanged. If capital were mobile between sectors, this could even be accomplished with a fall in labor, as long as capital in that sector fell by an even greater percentage. The standard real business cycle model assumes that capital is freely mobile between sectors. Thus, the intuition in this article is based on two modifications to the real business cycle model: incorporation of efficiency wages and sectoral immobility of capital. The second of these is not sufficient to produce business cycle comovement. This is because the argument in note 16 holds even if capital is immobile between sectors.
In addition to verifying the logical coherence of efficiency wage theory as an explanation of comovement, there are two empirical issues to be investigated. How hard is it to monitor worker effort? If it can be monitored easily, then efficiency wage theory is irrelevant. Also, if the penalty for being fired for shirking is enormous, workers will behave as if they are being monitored continuously, and once again the theory becomes irrelevant. For a further discussion of these issues, see Alexopoulos (1998).

We stress that the intuition developed here relies on two assumptions—efficiency wages and sectorally immobile capital.

To be precise, suppose $e(w, D)$ is the effort supplied by workers when the wage rate is $w$ and unemployment duration is $D$. At the efficiency wage, $e_u(w, D) = 0$. Also, we assume $e_u(w, D) > 0$. Totally differentiating the first order condition for the efficiency wage, we get $w(D)dw = 1$, with respect to $w$ and $D$, and imposing the restrictions on $e_u$ and $e_i,$ yields the result, $dw/dD < 0$.

In the literature, what we have called the worker’s effort function, $e$, is referred to as the "incentive compatibility constraint."

Alexopoulos and Gomme have reported to us privately that their models are only partially consistent with business cycle comovement. In both cases, employment in the consumption and investment sectors is positively correlated, but investment in these two sectors is negatively correlated. However, both models assume that capital can be transferred instantaneously across sectors in response to a shock. The analysis here suggests that sectoral capital immobility may be important for obtaining comovement.

For an introduction to the literature on sticky prices and wages, see Romer (1996). To see why countercyclical markups might help, recall the key equation in note 16, used to show why hours worked making consumption goods and hours worked making investment goods in a standard real business cycle model must move in opposite directions. A version of that model with market power, for example, the model of Rotemberg and Woodford (1992), implies that it is the ratio of the marginal product of labor to the markup that must equal the marginal rate of substitution between consumption and leisure. That is, that equation must be modified as follows:

$$\frac{\alpha}{\mu} \frac{C}{I} = \frac{\psi}{(1 - L_c - L_f)^{\frac{c}{p}}}$$

where $\mu$ is the markup of price over marginal cost. Cancelling consumption on the two sides and rearranging, we get

$$\frac{\alpha}{\psi} \frac{(1 - L_c - L_f)^{\frac{c}{p}}}{\mu L_c}.$$

Suppose a boom occurs, driving up $L_f$. If $\mu$ falls, as in the Rotemberg and Woodford model, then it is possible for $L_f$ to rise too. (For another model with countercyclical markups see Gali [1994]). See Murphy, Shleifer and Vishny (1989) for a conjecture about how limited intersectoral labor mobility, together with credit market restrictions, may help account for comovement.

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