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In This Issue . . .

In the first article of this *Review*, "Cash Flow or Present Value: What's Lurking Behind That Hedge?", Michael T. Belongia and G. J. Santoni investigate the effectiveness of various strategies by which depository institutions might attempt to hedge interest rate risk. The authors note that a substantial share of the professional literature on this subject emphasizes the maintenance of a fixed nominal cash stream to secure a certain level of *earnings*. In contrast to this advice, it is noted that the classical definition of interest rate risk pertains to changes in the *wealth* of a firm's owners. With these two contrasting views of interest rate risk and conflicting advice on hedging strategies, Belongia and Santoni compare the effectiveness of cash flow hedging to equity hedging.

Using examples based on a simple portfolio of interest-sensitive financial assets and liabilities, Belongia and Santoni illustrate the existence of a fundamental relationship in hedging interest rate risk: If a hedge fixes a certain cash stream, the firm's wealth will vary with changes in the interest rate; if equity is hedged, the amount or timing of cash flows will vary but the wealth of the firm's owners will be insulated. On the basis of this fundamental principle, the authors conclude that cash flow hedges do not eliminate interest rate risk.

In the second article, "A Descriptive Analysis of Economic Indicators," Ronald A. Ratti analyzes the indexes of leading, coincident and lagging indicators. The author describes the way in which these indexes are constructed and explains why they might provide useful information on future economic conditions. He finds the magnitude of successive revisions in estimates of the indexes examined to be quite substantial.

Ratti then examines the forecasting performance of the index of leading indicators using both two and three months of consecutive movement in the index as a criteria for prediction. The author shows that the large magnitude of revisions in preliminary estimates of change in the leading indicator index complicates the interpretation of signals in the short run. The use of preliminary and final estimates of the leading indicator index are shown to give sometimes different predictions about the onset of recession.

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Cash Flow or Present Value: What's Lurking Behind That Hedge?

Michael T. Belongia and G. J. Santoni

OVER the past few years, banks and savings and loan associations have adopted various techniques to moderate swings in their earnings induced by unexpected changes in interest rates. Among other things, financial institutions are increasing the percentage of their portfolios devoted to short-term consumer loans and are making greater use of adjustable rate mortgages, floating rate loans and interest rate swaps. In addition, a growing number of these firms are using financial futures to reduce their exposure to interest rate risk.[1]

Financial futures are relatively new. As with any new tool, learning how to use it has been a costly experience.[2] Most troublesome has been the realization that seemingly well-designed hedges have left the firm exposed to interest rate risk. In some cases, at least, firms have experienced this problem because they have tried to hedge their net cash flow.[3]

The purpose of this paper is to show that any hedge designed to maintain the net cash flow of a portfolio in the face of unexpected interest rate changes necessarily does so at the expense of allowing the market value of the portfolio to vary with interest rates. Since any relationship between the portfolio's market value and interest rates is typically what is meant by interest rate risk, these hedges are ineffective in insulating the value of the portfolio against this risk.[4]

On the other hand, hedging to maintain the market value (rather than net cash flow) of the portfolio necessarily results in a stream of cash that changes as the interest rate changes. Some simple hedging examples are constructed in this paper to show that different methods of hedging can produce equivalent results in terms of the maintenance of the portfolio's market value even though the net streams of cash (in terms of both total amount and timing) differ across the various methods.

TWO EFFECTS OF INTEREST RATE CHANGES

Unexpected interest rate changes have two important effects on the typical financial portfolio. First, a change in the interest rate means that the present

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[1]See Booth, Smith and Stolz (1984). In addition, the Federal Home Loan Bank Board has recently adopted a set of regulations designed to deal with the problem of interest rate risk. See Federal Home Loan Bank Board (1984).

[2]See Zaslow (1984).

[3]Hedging strategies designed to minimize the variance of net cash flow (net interest margin) are discussed in Hill, Liro and Schneeweis (1983); Jacobs (1982); Koch, Steinhauser and Whigham (1982); Parker and Daigler (1981); Pitts and Kopprasch (1984); Toevs (1983); Asay, Gonzalez and Wolkowitz (1981); and Drabenstott and McDonley (1984).

[4]See Samuelson (1944), p. 19. His footnote 1 is particularly instructive on this point. Another important problem that the hedger must confront is basis risk. This is the risk that the spread between the prices of the futures and cash instrument may change during the period of the hedge. See Cicchetti, Dale and Vignola (1981), Ederington (1979), Franckle (1980), Franckle and Senchack (1982) and Koppenhaver (1984). A special case of basis risk, one that is particularly relevant in hedging financial portfolios, is the possibility that the slope of the yield curve may change during the period of the hedge. Having warned the reader, we ignore the problem of basis risk in the following discussion.

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(market) value of any given stream of cash has changed.[5] For example, a rise in the interest rate is equivalent to a fall in the present value of the given cash stream. Second, a given change in the interest rate will not result in proportional changes in the present values of different cash streams. Roughly, the more distant the net cash receipts are from the present (that is, the greater the stream's duration), the larger the percentage change in the present value of the stream for a given change in the interest rate.[6] This can be summarized by stating that different assets, liabilities or portfolios generally have different interest rate elasticities.[7]

THE RELEVANCE FOR FINANCIAL INSTITUTIONS

Financial institutions, particularly savings and loan associations, maintain portfolios that are very sensitive to interest rate changes. This sensitivity arises because savings and loan association portfolios are composed of financial assets whose lives (durations) are long relative to the lives of their liabilities. In short, the market value of assets contained in the portfolio are more interest-elastic than liabilities. As a result, increases in the interest rate are accompanied by larger percentage reductions in the present value of assets than in the present value of liabilities. On balance, these changes cause the net present value of the portfolio to shrink. The reverse occurs when interest rates fall. The different interest elasticities of assets and liabilities give the net present value of the portfolio an accordion-like quality with the interest rate calling the tune.[8]

An Illustration

Table 1 illustrates the effect that a change in the interest rate can have on the net present value (and owner's wealth) of a portfolio composed of relatively long-lived assets and short-lived liabilities. For simplicity's sake, the life of the portfolio (firm) is assumed to be one year. The firm has extended a loan with a face value of $1,000 to be paid at the end of the year at an interest rate of 10 percent. The present value of the loan and, thus, the amount paid to the borrower is $909.09. To fund the loan, the firm borrows $909.09 for 90 days at 8 percent interest. The spread (net interest margin) between the lending and borrowing rates is the return the firm earns for employing its specialized capital in intermediating between borrowers and lenders.[9]

The firm's liability must be rolled over every 90 days if it plans to hold the asset to maturity. The amount the firm will owe in 90 days is $926.75 ($=\$909.09(1.08)^{.25}$). The firm plans to refinance this amount by borrowing for another 90 days.[10] Since the proceeds from the new liability are used to pay the old liability, the firm's net receipts at this time are zero. The firm *expects* to roll over its borrowings every 90 days at the same rate of interest. At the end of the year, the firm anticipates having to pay $981.82 ($=909.09 \times 1.08$), which will be paid out of the $1,000 proceeds it receives from its matured asset. The firm's expected net receipt at year-end is $18.18. At a market rate of interest of 10 percent, the present value of this amount is $16.53 ($=\$18.18/1.10$). Panel A of table 1 shows the streams of expected receipts and payments that generate this increase in the firm's net present value.

A Change in Interest Rates

Panel B of table 1 illustrates the effects on the planned streams of receipts and payments of an unexpected 50 basis-point increase in all interest rates that occurs immediately after the initial loan and borrowing contracts are signed. Since the interest rate on the loan the firm has made does not change, this receipt remains fixed. However, the firm's refunding costs are higher at the liability refundings that occur on days 90, 180 and 270, so that at the end of the year the firm expects to pay $985.22 out of the proceeds of its loan. Its net receipts at year-end fall to $14.78, while the present value of its net receipts (the market value of the firm's equity) declines to $13.38.

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[5]Since this paper is concerned with changes in interest rates that leave the term structure unaltered, "the" interest rate is used as a shorthand method of referring to the whole complex of interest rates.

[6]For discussions of duration, see Kaufman (1984); Bierwag, Kaufman and Toevs (1983); Toevs (1983); Santoni (1984); Samuelson (1944); Hicks (1939), pp. 184–88; and Alchian and Allen (1977), pp. 143–68.

[7]Interest elasticity is the ratio of the percentage change in the present value of an asset, liability or portfolio to the percentage change in the interest rate. In the case of single assets or liabilities, interest rate elasticity is always negative, indicating that present value is inversely related to the interest rate. However, for a portfolio containing both assets and liabilities, interest rate elasticity may be positive, negative or zero. See Samuelson (1944).

[8]See Santoni (1984).

[9]In particular, we assume that the spread does *not* arise because the firm is taking advantage of an upward-sloping yield curve. Rather, the above examples assume that the yield curve is flat.

[10]For a discussion of present and future values, see Alchian and Allen (1977), pp. 143–68.

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Table 1
Changes in Present Value and Interest Rate Elasticity

	Expected Streams of Receipts and Payments Day				
	0	90	180	270	360
Panel A: No Change in Interest Rates					
Asset (loan)					
Receipts					$1,000.00
Payments	$909.09				
Liabilities (CDs)					
Receipts	909.09	$926.75	$944.76	$963.11	
Payments		926.75	944.76	963.11	981.82
Net Receipts	–0–	–0–	–0–	–0–	$ 18.18
Present Value = $18.18/1.10 = $16.53					
Panel B: Interest Rates Rise by 50 Basis Points					
Asset (loan)					
Receipts					$1,000.00
Payments	$909.09				
Liabilities (CDs)					
Receipts	909.09	$926.75	$945.85	$965.33	
Payments		926.75	945.85	965.33	985.22
Net Receipts	–0–	–0–	–0–	–0–	$ 14.78
Present Value = $14.78/1.105 = $13.38					
Panel C: An Estimate of Interest Elasticity					
$\%\Delta PV = [(13.38 - 16.53)/16.53] \times 100 = -19.056$					
$\%\Delta i = [(10.5 - 10)/10] \times 100 = 5.00$					
$n_i = \%\Delta PV/\%\Delta i = -19.056/5.00 = -3.811$					
or					
$\%\Delta PV = -3.811 \times \%\Delta i$					

Interest Elasticity

The ratio of the percentage change in the portfolio's present value to the percentage change in the interest rate is the interest rate elasticity of the portfolio (n_i). This ratio is estimated in panel C of table 1.[11] Interest elasticity is negative in this example, indicating that the present value of the portfolio is related inversely to the interest rate. Furthermore, the absolute value of the elasticity is about 3.8, indicating that the percentage change in the present value of the firm's portfolio is about 3.8 times larger than the percentage change in the interest rate. The present value of this portfolio is very sensitive to interest rate changes.[12]

Interest rate elasticity is essentially a measure of the interest rate risk to which the firm is exposed. The larger the absolute value of interest rate elasticity, the greater the firm's exposure. A manager who wishes to minimize this exposure must apply a hedge that, in the limit, reduces the interest elasticity of the portfolio to zero.

Hedging Cash Flow Does Not Eliminate Risk

As mentioned above, a prevalent hedging objective

[11]Interest elasticity is "estimated" in panel C because, strictly speaking, interest elasticity accurately measures the relationship between net present value and the interest rate only for small changes in the interest rate. See Hicks (1939), pp. 184–88.

[12]Santoni (1984) estimates the elasticity to be about –2.5 for savings and loan associations and about –1.0 for banks.

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has been to hedge the net cash flow (net interest margin) of the portfolio. It is relatively simple to show that pursuing this objective, even if successful, does not eliminate the firm's exposure to interest rate risk.

Consider the example in panel B of table 1. Interest rates have risen by 50 basis points, and the net receipt at year-end has declined to $14.78 from its anticipated level of $18.18. Suppose, however, the firm had hedged so as to "lock in" each period's refunding cost at 8 percent and thereby protect its year-end receipts from interest rate changes.[13] As a result, the firm receives $18.18 at year-end even though interest rates have increased. While the firm's net cash flow (2 percent on the loan of $909.09 = $18.18) is the same as if no change in interest rates had occurred, the present value of the portfolio (its market value and owner's wealth) falls from $16.53 to $16.45.

This reduction in present value is considerably smaller than the reduction that would occur if the firm took no action to protect its net cash flow. It is clear, however, that this method of hedging leaves the firm exposed to interest rate risk, and the larger the unexpected change in the interest rate, the greater is the change in the present value of the portfolio and the wealth of firm owners.[14]

Furthermore, this example assumes that the planned life of the firm is only one year. The planned lives of most "real world" firms are much longer so that, in the limit, the percentage change in the present value of the portfolio for a firm that perfectly hedges its net cash flow will be equal (in absolute value) to the percentage change in the interest rate.[15] For example, if the interest rate should rise from, say, 8 percent to 9 percent, the present value of the portfolio falls by 12.5 percent. Firms that adopt hedging strategies with the objective of locking in net interest margin leave themselves exposed to considerable interest rate risk.

HEDGING NET PRESENT VALUE

The table 1 example can be extended to show how hedging in the financial futures market can be used to protect the net present value of the firm.[16] The following example will illustrate that, as interest rates change, the net stream of cash must diverge from the stream initially planned in terms of its total amount, its timing or both, if the net present value of the portfolio is to remain unchanged.

There also appears to be some confusion concerning whether a "stack" or a "strip" of financial futures is more effective as a hedging technique. A stack is the sale or purchase of a series of futures with the same delivery date. A strip, on the other hand, is the sale or purchase of a series of futures with different delivery dates. The following examples show that, in principle, both stacks and strips can be used effectively to hedge the portfolio's present value even though each generates a different cash stream for a given change in the interest rate.

Hedging with a Stack

The example shown in panel A of table 2 is the same as the panel A, table 1 example except that it assumes the firm has sold a stack of 13-week Treasury bill futures contracts that will mature in 90 days at a 10 percent discount.[17] Ninety days from now the firm must deliver Treasury bills with a face value of $2,918.67 (not shown in table 2) and a remaining maturity of 13 weeks. (The method used to calculate values for the various hedges is described in the appendix.) Since the discount rate specified in the contract is 10 percent, the firm will receive a payment of $2,849.94 ($= \$2{,}918.67/(1.10)^{.25}$) when it delivers the Treasury bills. The firm must acquire these bills in order to make delivery, and the expected purchase price, given the current structure of interest rates, is $2,849.94.[18] If interest rates remain unchanged, expected and actual costs will be the same so that the actual receipts and payments generated by the futures contract will net out. The firm's net flow of receipts is zero until year-

[13]At this point we are not concerned with exactly how this is accomplished. Particular methods of hedging are discussed below.

[14]A number of factors influence the magnitude of the percentage change including net interest margin and the interest elasticities of assets and liabilities. See Belongia and Santoni (1984b).

[15]Let P represent present value and C be a perpetual and constant net stream of cash. If r is the interest rate, the present value of the cash stream is:

$$P = \frac{c}{r} \text{ and}$$

$$\frac{dP}{dr}\frac{r}{P} = -\frac{c}{r^2}\frac{r}{P} = -1 .$$

[16]For ease of exposition, the following example assumes that the costs of transacting in the futures market is zero. While these costs are relatively low, they are not trivial. See Kane (1980).

[17]The assumption that the yield curve is flat and that there is no borrower-specific risk means that the discount rate on 90-day government securities will be the same as the discount rate the firm obtains on its one-year loan.

[18]In fact, most futures contracts are settled by simply reversing the original transaction so that a firm that is short Treasury bill futures may not actually acquire the Treasury bills to settle its contract.

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Table 2

Hedging with a Stack

	Expected Streams of Receipts and Payments Day				
	0	90	180	270	360
Panel A: No Change in Interest Rates					
Asset (loan)					
Receipts					$1,000.00
Payments	$909.09				
Asset (futures)					
Receipts		$2,849.94			
Liabilities (CDs)					
Receipts	909.09	926.75	$944.76	$963.11	
Payments		926.75	944.76	963.11	981.82
Liabilities (futures)					
Payments		2,849.94			
Net Receipts	–0–	–0–	–0–	–0–	$ 18.18
Present Value = $18.18/1.10 = $16.53					
Panel B: Interest Rates Rise by 100 Basis Points					
Asset (loan)					
Receipts					$1,000.00
Payments	$909.09				
Asset (futures)					
Receipts		$2,849.94			
Liabilities (CDs)					
Receipts	909.09	926.75	$946.93	$967.56	
Payments		926.75	946.93	967.56	988.63
Liabilities (futures)					
Payments		2,843.50			
Net Receipts	–0–	$ 6.44	–0–	–0–	$ 11.37
Present Value = $6.44/(1.11)$^{.25}$ + $11.37/(1.11) = $16.52					
Panel C: Interest Rates Fall by 100 Basis Points					
Asset (loan)					
Receipts					$1,000.00
Payments	$909.09				
Asset (futures)					
Receipts		$2,849.94			
Liabilities (CDs)					
Receipts	909.09	926.75	$942.56	$958.64	
Payments		926.75	942.56	958.64	974.99
Liabilities (futures)					
Payments		2,856.46			
Net Receipts	–0–	$ –6.52	–0–	–0–	$ 25.01
Present Value = –$6.52/(1.09)$^{.25}$ + $25.01/(1.09) = $16.56					

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end when it receives $18.18. The present value of this amount at the 10 percent market interest rate is $16.53.[19]

In panel B of table 2, all interest rates are assumed to rise unexpectedly by 100 basis points immediately after the loan and funding contracts are signed. As a result, the firm's refunding costs rise so that the expected net receipt at year-end falls to $11.37. Notice, however, that the increase in the interest rate reduces the expected cost of acquiring the Treasury bills to $2,843.50 ($= \$2,918.67/(1.11)^{.25}$). Since the price the firm will receive for the delivery of the Treasury bills is fixed by the contract at $2,849.94, the futures contract will generate an expected net receipt of $6.44 upon delivery 90 days from now. The present value of this amount plus the present value of the expected year-end receipt is $16.52 and is very close to the portfolio's present value for the case in which interest rates remain unchanged.[20]

Panel C of table 2 shows the effect of a 100 basis-point decline in all interest rates. This lowers refunding costs and raises the expected net receipt at year-end to $25.01. It also raises the expected cost of acquiring the Treasury bills to $2,856.46 ($= \$2,918.67/(1.09)^{.25}$), resulting in a net cash outflow of $6.52 in 90 days. The present value of the year's expected cash stream is $16.56, which again is almost the same as the case in which interest rates remained unchanged.

Notice that the expected net cash flows experienced by the firm in panels B and C are considerably different in both timing and amount from the cash stream in panel A. Yet, the present value of the portfolio is virtually identical in all three cases. Clearly, protecting net cash flow is not necessary to protect the portfolio's net present value. Rather, as shown above, hedges that hold net cash flow constant ensure that the portfolio's present value will vary with interest rates.

Had interest rates changed by more than 100 basis points, the year-end receipts indicated in panels B and C of table 2 would have been smaller if interest rates had increased and larger if interest rates had fallen. The gains or losses generated by the futures contract, however, would have been larger as well, with the result that the present value of the portfolio would be little affected by the change in interest rates. Of course, interest rates might vary erratically during the hedging period, rising one day and falling the next. However, the resulting changes that occur in the expected stream of net receipts induced by the changes in the interest rate will be sufficient to hold the present value of the portfolio very close to its original level.

Two cautions are important when interpreting this example. First, the analysis above is static. It considers the present value of the portfolio at a single point in time. As the firm moves through time, the hedge must be monitored because the size of the hedge depends upon the interest elasticity of the portfolio, which will change, along with the present value of the portfolio, as the assets and liabilities age. It also is important to note that, when the stack is settled on day 90, the firm must sell new contracts to protect itself in the subsequent period.

Hedging with a Strip

The example presented in table 3 considers the same set of conditions as those presented previously except that the firm chooses to hedge its portfolio with a strip of 13-week Treasury bill futures contracts at a discount of 10 percent. One contract is dated for delivery in 90 days, one in 180 days and one in 270 days. Each contract has a face value of $997.27 (see the appendix for the method of computing this amount). Since the contracted rate of discount is 10 percent, the firm will receive $973.79 ($= \$997.27/(1.10)^{.25}$) on each delivery date. Currently, this amount also is the expected cost of covering the contract.

Panel A lists the firm's receipts and payments, assuming no change in the interest rate. Again, payments and receipts cancel until year-end when the net receipt is $18.18 (present value of $16.53).

Panel B shows the effect on the streams of receipts and payments of an unexpected 100 basis-point increase in all interest rates. The firm's refunding costs rise, causing the net year-end receipt to fall to $11.37. The expected cost of covering each of the futures contracts, however, falls to $971.59 ($= \$997.27/(1.11)^{.25}$), resulting in a net cash receipt of $2.20 at the end of 90,

[19]For a more detailed discussion of the types of financial futures available, discounting methods, terms of the contracts, etc., see Stigum (1981), pp. 151–70. Belongia and Santoni (1984a) discuss some basic principles of hedging with financial futures as well as some of the problems of employing them to hedge financial portfolios.

[20]Large changes in the interest rate will have some noticeable effect on the present value of the portfolio. The interest rate elasticity of the portfolio enters the calculation of the risk-minimizing hedge. Strictly speaking, this elasticity is an accurate measurement of the relationship between the interest rate and the portfolio's present value only for small changes in the interest rate. The change in the interest rate is 10 percent in the panel B, table 2 example. This relatively large change in the interest rate is the reason that the portfolio's present value does not remain constant.

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Table 3

Hedging with a Strip

	Expected Streams of Receipts and Payments Day				
	0	90	180	270	360
Panel A: No Change in Interest Rates					
Asset (loan)					
Receipts					$1,000.00
Payments	$909.09				
Asset (futures)					
Receipts		$973.79	$973.79	$973.79	
Liabilities (CDs)					
Receipts	909.09	926.75	944.76	963.11	
Payments		926.75	944.76	963.11	981.82
Liabilities (futures)					
Payments		973.79	973.79	973.79	
Net Receipts	–0–	–0–	–0–	–0–	$ 18.18
Present Value = $18.18/1.10 = $16.53					
Panel B: Interest Rates Rise by 100 Basis Points					
Asset (loan)					
Receipts					$1,000.00
Payments	$909.09				
Asset (futures)					
Receipts		$973.79	$973.79	$973.79	
Liabilities (CDs)					
Receipts	909.09	926.75	946.93	967.56	
Payments		926.75	946.93	967.56	988.63
Liabilities (futures)					
Payments		971.59	971.59	971.59	
Net Receipts	–0–	$ 2.20	$ 2.20	$ 2.20	$ 11.37
Present Value = $2.20/(1.11)^{25} + $2.20/(1.11)^{50} + $2.20/(1.11)^{75} + $11.37/(1.11) = $16.51					
Panel C: Interest Rates Fall by 100 Basis Points					
Asset (loan)					
Receipts					$1,000.00
Payments	$909.09				
Asset (futures)					
Receipts		$973.79	$973.79	$973.79	
Liabilities (CDs)					
Receipts	909.09	926.75	942.56	958.64	
Payments		926.75	942.56	958.64	974.99
Liabilities (futures)					
Payments		976.01	976.01	976.01	
Net Receipts	–0–	$ –2.22	$ –2.22	$ –2.22	$ 25.01
Present Value = –$2.22/(1.09)^{25} – $2.22/(1.09)^{50} – $2.22/(1.09)^{75} + $25.01/(1.09) = $16.56					

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180 and 270 days. The present value of this stream of cash added to the present value of the year-end receipt is $16.51.

Panel C shows the effect of a 100 basis-point decline in interest rates. While the net stream of cash is different in both timing and amount, the net present value of the portfolio remains very near its original value.

The Equivalence of Strips and Stacks

The above examples illustrate that strips and stacks, if constructed properly, are equivalent in terms of protecting the net present value of the portfolio (and wealth of the firm's owners) in the face of interest rate changes. However, the two methods result in different net cash flows both in timing and amount, and this may lead management to prefer one method to the other. Furthermore, we have ignored the transaction and administrative costs associated with hedging, which may be different for strips vs. stacks. Other things the same, the firm will prefer the method that minimizes these costs.

CONCLUSION

The financial literature contains many examples of hedging strategies designed to protect the firm's net cash flow or net interest margin. This, of course, may be a management objective. Any hedge that maintains net cash flow as interest rates change, however, does so at the expense of subjecting the present value of the portfolio and the wealth of firm owners to interest rate risk.

In contrast, hedges that protect the present value of the portfolio necessarily imply net cash flows that vary with interest rates. There are various reasons why particular cash flows may be important to the management of the firm. If, however, these concerns permit some degree of substitution between the total volume of the flow, its timing or both, they do not necessarily conflict with the objective of hedging the present value of the portfolio.

REFERENCES

Alchian, Armen, and William R. Allen. *Exchange and Production: Competition, Coordination, and Control,* 2nd ed. (Wadsworth, 1977), pp. 143–68.

Asay, Michael R., Gisela A. Gonzalez, and Benjamin Wolkowitz. "Financial Futures, Bank Portfolio Risk, and Accounting," *Journal of Futures Markets* (Winter 1981), pp. 607–18.

Belongia, Michael T., and G. J. Santoni. "Hedging Interest Rate Risk with Financial Futures: Some Basic Principles," this *Review* (October 1984a), pp. 15–25.

_____ . "Derivation of the Set of Exact Hedges for the Financial Portfolio," Working Paper No. 84-026, Federal Reserve Bank of St. Louis (October 1984b).

Bierwag, G. O., George G. Kaufman and Alden Toevs. "Bond Portfolio Immunization and Stochastic Process Risk," *Journal of Bank Research* (Winter 1983), pp. 282–91.

Booth, James R., Richard L. Smith, and Richard W. Stolz. "Use of Interest Rate Futures by Financial Institutions," *Journal of Bank Research* (Spring 1984), pp. 15–20.

Cicchetti, Paul, Charles Dale and Anthony J. Vignola. "Usefulness of Treasury Bill Futures as Hedging Instruments," *Journal of Futures Markets* (Fall 1981), pp. 379–87.

Drabenstott, Mark, and Anne O'Mara McDonley. "Futures Markets: A Primer for Financial Institutions," Federal Reserve Bank of Kansas City *Economic Review* (November 1984), pp. 17–33.

Ederington, Louis H. "The Hedging Performance of the New Futures Markets," *Journal of Finance* (March 1979), pp. 157–70.

Federal Home Loan Bank Board. "Interest-Rate-Risk Management; Policy Statement and Final Rule," *Federal Register* (Vol. 49, No. 129, July 3, 1984).

Franckle, Charles T. "The Hedging Performance of the New Futures Markets: Comment," *Journal of Finance* (December 1980), pp. 1273–79.

Franckle, Charles T., and Andrew J. Senchack, Jr. "Economic Considerations in the Use of Interest Rate Futures," *Journal of Futures Markets* (Spring 1982), pp. 107–16.

Hicks, J. R. *Value and Capital* (Oxford: Clarendon Press, 1939).

Hill, Joanne, Joseph Liro, and Thomas Schneeweis. "Hedging Performance of GNMA Futures Under Rising and Falling Interest Rates," *Journal of Futures Markets* (Winter 1983), pp. 403–13.

Jacobs, Rodney L. "Restructuring the Maturity of Regulated Deposits with Treasury-Bill Futures," *Journal of Futures Markets* (Summer 1982), pp. 183–93.

Kane, Edward J. "Market Incompleteness and Divergences Between Forward and Futures Interest Rates," *Journal of Finance* (May 1980), pp. 221–34.

Kaufman, George G. "Measuring and Managing Interest Rate Risk: A Primer," Federal Reserve Bank of Chicago *Economic Perspectives* (January–February 1984), pp. 16–29.

Koch, Donald L., Delores W. Steinhauser and Pamela Whigham. "Financial Futures as a Risk Management Tool for Banks and S&Ls," Federal Reserve Bank of Atlanta *Economic Review* (September 1982), pp. 4–14.

Kolb, R. W. *Interest Rate Futures: A Comprehensive Introduction* (Robert F. Dame, Inc., 1982).

Koppenhaver, G. D. "Selective Hedging of Bank Assets with Treasury Bill Futures Contracts," *Journal of Financial Research* (Summer 1984), pp. 105–19.

Parker, Jack W., and Robert T. Daigler. "Hedging Money Market CDs with Treasury-Bill Futures," *Journal of Futures Markets* (Winter 1981), pp. 597–606.

Pitts, Mark, and Robert W. Kopprasch. "Reducing Inter-Temporal Risk in Financial Futures Hedging," *Journal of Futures Markets* (Spring 1984), pp. 1–13.

Samuelson, P. A. "The Effect of Interest Rate Increases on the Banking System," *American Economic Review* (March 1944), pp. 16–27.

Santoni, G. J. "Interest Rate Risk and the Stock Prices of Financial Institutions," this *Review* (August/September 1984), pp. 12–20.

Stigum, Marcia. *Money Market Calculations: Yields, Break-Evens and Arbitrage* (Dow Jones-Irwin, 1981).

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http://fraser.stlouisfed.org/
Federal Reserve Bank of St. Louis

Toevs, Alden L. "Gap Management: Managing Interest Rate Risk in Banks and Thrifts," Federal Reserve Bank of San Francisco *Economic Review* (Spring 1983), pp. 20–35.

Zaslow, Jeffrey. "Some Thrifts and Other Concerns Find Hedging Against Rate Changes Costly," *Wall Street Journal*, November 5, 1984.

Appendix
Calculating the Hedge

Example 1: A Stack of 13-Week T-Bill Futures at Day 90

To calculate a hedge that insulates the present value of the portfolio, it is necessary to calculate the change in the present value of the portfolio for a small change in the interest rate. The estimate of interest elasticity can be used for this purpose. The interest rate is assumed to change by 5 percent (= .005 × 100/.10) in the table 1 example and interest elasticity, n_i, is estimated to be –3.811 (see panel C of table 1). Using this estimate of interest elasticity, the change in the present value of the portfolio can be computed given the change in the interest rate. From the example in table 1:

$$\%\Delta PV = n_i \times \%\Delta i = -3.811 \times 5 = -19.055$$
$$\Delta PV = -.19055 \times \$16.53 = -\$3.1497915.$$

This result indicates that, if the interest rate rises by 5 percent, the present value of the portfolio will fall by about $3.15. Notice that $3.15 is the difference between the present value of the streams of net receipts in panels A and B of table 1. This change in present value of the spot portfolio must be offset by an opposite change in the present value of the futures contract.

Using the above result, the future dollar amount, X, that the futures contract must generate at day 90 to offset the fall in the present value of the portfolio induced by the change in the interest rate is calculated as follows:

$$\$3.1497915 = X/(1.105)^{.25}$$
$$X = \$3.229404.$$

The face value of the futures contract, F, in 13-week T-bills that must be sold to generate $3.229404 for the given change in the interest rate is the difference between the amount the firm will receive upon delivery of the T-bills ($F/1.10^{.25}$) and the cost of covering the contract once the interest rate has risen ($F/1.105^{.25}$) or:

$$F(1/1.10^{.25} - 1/1.105^{.25}) = \$3.229404$$
$$F = \underline{\$2{,}918.6661}.$$

The contracted price of this futures contract appears in table 2 ($2,849.94 = $2,918.6661/1.10^{.25}$). This is the amount that the firm will receive upon delivery of the T-bills at day 90. As long as the firm has no expectation about the magnitude or direction of change in the interest rate, this hedge is optimal in the sense that the variance in the net present value of the portfolio is minimized for *any* variation in the interest rate.

It is not necessary that the stack be placed at day 90. By slightly modifying the calculation, an optimal hedge can be obtained for a stack of contracts on days 180, 270, 360, 210, etc. Even though it is possible to stack contracts on days other than the refunding dates, it still is necessary for the firm to settle the futures contracts on the refunding dates. This is required because interest rates may rise (fall) before the refunding date but fall (rise) between the refunding date and the delivery date of the futures contract.

Example 2: A Strip of 13-Week T-Bill Futures with Delivery Dates at Days 90, 180 and 270

The initial procedure in this calculation is the same as in the case of the stack. In both cases, it is necessary to calculate the change in the present value of the portfolio for a small change in interest rates. For a 5 percent increase in interest rates and the portfolio given in the table 1 example, this is –$3.1497915. This change in present value must be offset by an opposite change in the present value of the futures contracts.

In the case of the strip, there are assumed to be three contracts of equal face value but with delivery dates at days 90, 180 and 270. The future dollar amount, X, that must be received on these dates so that the present value of the stream is equal to $3.1497915 is:

$$\$3.1497915 = X/(1.105)^{.25} + X/(1.105)^{.50} + X/(1.105)^{.75}.$$

$$X = \$1.103447.$$

The face value of the three futures contracts, F, in 13-week T-bills that must be sold to generate $1.103447 at days 90, 180 and 270 is:

$$F(1/1.10^{.25} - 1/1.105^{.25}) = \$1.103447.$$
$$F = \underline{\$997.27175}.$$

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A Descriptive Analysis of Economic Indicators

Ronald A. Ratti

EACH month the U.S. Department of Commerce publishes a series of economic indicators, the most widely followed of which are the composite indexes of leading, coincident and lagging indicators.[1] The significance attached to these series is attested to by the promptness with which their month-to-month movements are reported and analyzed by the news media.[2] Economic agents monitor the behavior of these indexes because, historically, they have been thought to provide useful information on current and future changes in the economy.[3]

The objective of this paper is to describe how these indexes are constructed and revised, to provide a descriptive explanation for why they might provide information on future economic conditions, and to examine critically their usefulness.[4] In the final section of the paper, the difficulties inherent in using the index of leading indicators as a forecaster of future economic conditions are discussed. Emphasis is placed on the leading indicator index since it is the most widely reported and well known of the indexes considered.

A DESCRIPTION OF COMPOSITE INDEXES

Individual and composite indicators are used to predict downturns and upturns in the economy and to monitor the degree of strength or weakness in a recession or recovery. Analysts generally acknowledge that in order for individual indicators to provide useful information they should have the following characteristics: (1) they should represent and accurately measure important economic variables or processes; (2) they should bear a consistent relationship over time with business cycle movements and turns; (3) they should not be dominated by irregular and non-cyclical movements; and (4) they should be promptly and frequently reported.[5] These requirements ensure that the best indicators regularly provide timely economic information on the stages of the business cycle.

On the basis of these criteria, the Bureau of Economic Analysis has evaluated, and continues to evaluate, hundreds of economic time series. Only those series with a good overall performance that are avail-

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[1]Published monthly in *Business Conditions Digest* by the U.S. Department of Commerce.

[2]For example, an estimate of the behavior of the Index of Leading Indicators for August 1984 was released by the Department of Commerce on September 28. That same day, the *New York Times* carried a lengthy article with the headline "Economic Index Up by 0.5%" (Hershey [1984]). *United Press International* (1984) carried a story headed "Indicators Rise Slightly in August." On October 1, the *Christian Science Monitor* carried stories focusing on the behavior of the leading index for August 1984 (Cook [1984] and Nenneman [1984]), and *The Wall Street Journal* ran a story headed "Economic Index Eases Worries Over Slowdown" (Murray [1984]).

[3]For an authoritative discussion of the use of composite indicators for forecasting, see Zarnowitz and Moore (1982). On the use of the leading series for forecasting, see Hymans (1973), Stekler and Schepsman (1973) and Neftci (1979). For a summary of work on the use of the index of leading indicators for forecasting, see Gorton (1982).

[4]This work draws on the following basic sources: Zarnowitz and Boschan (1975a, 1975b), Moore (1984) and Zarnowitz and Moore (1982).

[5]If a series did not bear a consistent relationship over time with the business cycle, it would not be useful as an indicator of business cycle conditions. If a series was dominated by non-cyclical factors, it would not be possible to "read" cyclical developments from the behavior of the series. A series should be promptly and regularly reported in order to provide a steady stream of timely information. For a demonstration of the formal application of the criteria used for evaluating the usefulness of economic series as indicators, see Zarnowitz and Boschan (1975a).

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able monthly with a short time lag and are not subject to large revisions are candidates for inclusion in the three major composite indexes.

The composite indexes of leading, coincident and lagging cyclical indicators each measure the average behavior of series showing similar leading, coincident and lagging timing at business cycle turns. Components of the indexes are also chosen so as to represent as broad an array of diverse activities and sectors as possible. This requirement is meant to ensure that the composite indicators continue to monitor and closely shadow economic activity, even if the causes and nature of cyclical change vary over time and the performances of some individual indicators deteriorate. Since each business cycle has unique characteristics, individual series can be expected to perform better during some cycles than others. Without prior information on the causes of current economic change, it seems best to rely for information on groupings of series rather than individual series.

The Index of Leading Indicators

Table 1 lists the components of the three composite indexes. The leading index consists of individual components that might lead measures of economic activity.[6] For example, housing starts, new incorporations, contracts for construction and new orders for machinery and equipment are leading indicators, since they represent early commitments to future economic activity.

The inclusion of some other components in the leading index is less obvious and more involved. This is partly because there is no single well-developed theory linking each of the indicators to the business cycle. The economic series that make up the composite indicators are included primarily because they perform well statistically in relation to the cycle, not because they are the operational counterparts of variables in an economic theory of business cycles.

There is usually some economic rationale, however, for including each series in the index. An increase in average weekly hours worked, for instance, presumably leads the business cycle since it is easier for employers to move to higher output levels in the initial stages of an expansion by increasing the utilization of labor than by increasing the number of employees.

The remaining components of the index of leading indicators and the rationale for including them in the index are the following: Initial claims for unemployment insurance represent first claims filed by workers newly unemployed or claims for subsequent periods of unemployment. Slower deliveries, which inversely reflect the volume of business of firms supplying purchasing agents in the Greater Chicago area, has been found to precede changes in the actual volume of business.[7] The sum of changes in inventories on hand and on order are assumed to reflect changes in the desired stock of inventories. The desired stock of inventories is assumed to rise if the anticipated level of sales increases.

"Change in sensitive materials prices, smoothed" is based on indexes of crude and intermediate materials prices and spot market prices of raw industrial materials. Movements in these prices are assumed to reflect variations in demand relative to supply in the process of building up or drawing down raw material inventories. A rise in prices is taken to indicate increased demand for the output of the manufacturing and construction sectors. Stock price movements affect and measure the general state of business expectations about future profits. When prospects for profits deteriorate, investment plans are shelved and expansionary business operations are contracted.

The inclusion of money and credit indicators capture the impact of changes in real balances and the availability of credit on future activity. During the late stages of a boom, bank deposit creation is limited by the availability of reserves, and the rate of increase in consumer prices begins to accelerate. The opposite is true during a downturn. These effects cause the turning points in the rate of change in real M2 to lead the turning points in the business cycle. The change in business and consumer credit also is a leading indicator, since many economic actions require financial arrangements before their inception.

The Index of Coincident Indicators

The components of the Index of Coincident Indicators are measures of aggregate economic activity in the areas of employment, real income, production and

[6] A discussion of why the components of the Index of Leading Indicators lead the economy is provided in Moore (1984), chapter 21. A detailed discussion of the relative strengths of the components of the Index of Leading Indicators is given in Zarnowitz and Boschan (1975a).

[7] This is an ad hoc statistical criterion that seems in contrast to the "economic" reasoning behind other components. The use of this indicator is being questioned on the grounds that faster deliveries reflect better management rather than slack demand, especially in light of increasing computerization.

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Table 1

Standardization Factors and Weights for Composite Index Components

BEA Series Number and Title	Standardization factor[1]	Weight[2]
Leading index components		
1. Average weekly hours of production of nonsupervisory workers, manufacturing	0.467	1.014
5. Average weekly initial claims for unemployment insurance, State programs[3]	5.374	1.041
8. Manufacturers' new orders in 1972 dollars, consumer goods and materials industries	2.818	.973
32. *Vendor performance, percent of companies receiving slower deliveries	3.840	1.081
12. Index of net business formation	.996	.973
20. Contracts and orders for plant and equipment in 1972 dollars	6.194	.946
29. Index of new private housing units authorized by local building permits	5.064	1.054
36. *Change in manufacturing and trade inventories on hand and on order in 1972 dollars, smoothed[4]	2.530	.986
99. *Change in sensitive materials prices, smoothed[4]	.324	.892
19. Index of stock prices, 500 common stocks	2.633	1.149
106. Money supply M2 in 1972 dollars	.417	.932
111. *Change in business and consumer credit outstanding	2.627	.959
Coincident index components		
41. Employees on nonagricultural payrolls	.321	1.064
51. Personal income less transfer payments in 1972 dollars	.502	1.003
47. Index of industrial production	.924	1.028
57. Manufacturing and trade sales in 1972 dollars	1.021	.905
Lagging index components		
91. Average duration of unemployment in weeks[3]	3.587	1.098
77. *Ratio, manufacturing and trade inventories to sales in 1972 dollars	0.016	.894
62. *Index of labor cost per unit of output, manufacturing — actual data as a percent of trend	.557	.868
109. *Average prime rate charged by banks	.376[5]	1.123
101. Commercial and industrial loans outstanding in 1972 dollars	.901	1.009
95. *Ratio, consumer installment credit outstanding to personal income	.062	1.009

*First differences rather than symmetrical percent changes are computed for this series.
[1]Standardization factors are computed over the period 1948–81.
[2]The weight for a given series is the ratio of its performance score to the average score of all series in that index.
[3]Changes for this series are inverted; i.e., they are multiplied by –1.
[4]This series is a four-term moving average (weighted 1,2,2,1) placed on the terminal month of the span.
[5]This standardization factor is computed over the period 1966–81.
SOURCE: U.S. Department of Commerce, *Handbook of Cyclical Indicators* (1984).

real sales. The Index of Coincident Indicators, together with other coincident indicators, show how well the economy is faring and is used to identify and date the peaks and troughs in the business cycle. This identification and dating, however, can only be done after the turning points have occurred.

The Index of Lagging Indicators

The Index of Lagging Indicators is designed to confirm both downturns and upturns in business activity. Lagging indicators can also be useful for forecasting purposes, because their turns sometimes lead the opposite turns of the leading indicators. Lagging indicators, such as bank interest rates, unit labor costs, inventory holdings and outstanding debt are associated with the costs of doing business. Reductions in these items during a recession lay the basis for the subsequent upturn, as well as having an enhancing effect on such leading indicators as commitments to invest, inventory accumulation and new credit outstanding.

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Table 2
Index Standardization and Trend Adjustment Factors: 1948–81

Composite index	Average absolute change[1]	Index standardization factor[2]	Trend in raw index	Trend adjustment factor[3]
Leading index	0.496	0.582	0.132%	+0.139%
Coincident index	.852	1.000	.446	−.175
Lagging index	.602	.707	.253	+.018

[1]The average absolute change for each index is obtained as follows: (a) for each month, a weighted average of the standardized changes of all components in that index is computed; (b) a long-term (1948–81) average without regard to sign is calculated from these monthly averages.

[2]This measure is the ratio of the average absolute change in each index to the average absolute change in the coincident index.

[3]The trend adjustment factor is 0.271 minus the trend in the raw index.

SOURCE: U.S. Department of Commerce, *Handbook of Cyclical Indicators* (1984).

CONSTRUCTION OF COMPOSITE INDEXES

Construction of the composite indexes involves several statistical operations on both the individual data series that make up the indexes and on the indexes themselves. These steps are described in this section. The accompanying insert provides an illustration of how the indexes are constructed.

The first step in constructing the composite indexes involves standardizing the individual series. Standardization prevents the relatively volatile series from dominating movements in the composite index. If, for example, a series typically exhibits large percentage changes, a failure to standardize would cause this series to swamp the effects of series that typically change by more modest amounts.

For each individual series, the month-to-month percentage change is calculated. (For series already in percentage form or in ratio form the month-to-month difference is taken.) The percentage changes in a component series are then standardized by dividing them by the long-run average percentage change in that series without regard to sign (the standardization factor).[8] These standardization factors are shown in table 1.

A composite index is constructed by weighting the standardized changes of its components. The weight assigned each component is determined by the overall score each series receives on the basis of a number of economic and statistical criteria. The application of these criteria involves both objective and subjective evaluations of such factors as economic significance, timely recognition of business cycle turning points, degree of conformity to the stages of the business cycle, quality and availability of current data, and the importance of non-cyclical movements in the series.[9] The largest weights are attached to those components with the best overall performance on the basis of these criteria. The weights attached to the components of the composite indexes are shown in table 1. As can be seen, these weights do not vary between components by as much as the standardization factors do.[10]

The raw percentage changes in the leading and lagging indexes, given by the sum of the weighted standardized percentage changes of their components, are then adjusted so as to facilitate comparison with the coincident index. This is done by equating the cumulative sum over time of the absolute values of changes in the leading and lagging index with the sum of the absolute values of changes in the coincident index. The index standardization factors based on data over 1948–81 appear in table 2.

[8]The sum of the percentage changes of even a highly volatile series might be zero if large negative values are just as likely to be followed by large positive values as more negative values. For this reason, the sum of the absolute values of the percentage changes is used as a measure of volatility. This means that the standardization factor of a series that alternates in value between +1 and −1 is the same as the standardization factor of a series that has values of only +1.

[9]For a detailed explanation of the principles upon which the scoring system is based, see Zarnowitz and Boschan (1975a) and U.S. Department of Commerce (1984).

[10]Auerbach (1982) has argued that a simple average weighting scheme yields a leading composite index that is very similar to the official leading index and that elaborate procedures for determining weights are therefore unnecessary.

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Construction of Composite Indexes: An Example

The procedures for constructing composite indexes from the basic monthly data series are illustrated in the example below. In the example, the preliminary estimates of the leading coincident and lagging indicators are calculated for June 1984. The data, taken from the July 1984 issue of *Business Conditions Digest*, are presented in the table on the opposite page.

Note that data on several components — change in inventories, business and consumer credit, manufacturing and trade sales, the ratio of manufacturing and trade inventories to sales, and the ratio of consumer installment credit outstanding to personal income — were not available. These omissions and subsequent revisions in the original data will be sources of change in successive estimates of the three indexes.

The column headed "weighted and standardized percentage change" is obtained by dividing the percentage change in each component by its standardization factor, then multiplying by its weight, both of which are presented in table 1 and explained in the text.[1] The sum of the numbers in this column provide estimates of the movements during June in each of the indexes that have not yet been standardized for compatibility across the three indexes or detrended. For the leading, coincident and lagging indicators, these figures are –0.577, 0.888 and 0.398 percent, respectively. Dividing each of those numbers by the index standardization factors and then adding the trend factors, both of which are given in table 2, yields the following preliminary estimates of the changes in the three indexes for June:

Percentage change in

Leading Index = –(0.577/0.582) + .139 = –0.9;

Coincident Index = (0.888/1.000) – .175 = 0.7;

Lagging Index = (0.398/0.707) + .018 = 0.6.

[1]The numbers are also divided by the sum of the weights on the components included in an index. These sums are 10.005, 3.095 and 4.098 for the available components of the leading, coincident and lagging indexes, respectively.

In addition, a trend adjustment procedure is used to make the trends in the three major composite indexes equal to the average of the trends in the components of the coincident index. This is done by subtracting the trends in the leading, coincident and lagging indexes (0.132, 0.446 and 0.253, respectively) and adding in the average of the monthly trends in the components of the coincident indexes (0.271).[11] The trend adjustment facilitates the use of the three indexes as indicators of levels of activity. The trend adjustment factors are listed in table 2.

THE IMPORTANCE OF REVISIONS

A preliminary estimate of the performance of the composite indexes for a given month appears toward the end of the following month. The July issue of *Business Conditions Digest*, for example, carries a preliminary estimate of the composite indexes in June. The August issue of *Business Conditions Digest* will then carry a revised estimate of the June indexes. The second estimate typically differs from the first because data on some series were not originally available and because data that were originally available have been updated.

The net effect of these revisions is often a significant change in the estimate of the performance of the composite indicators. Table 3 illustrates that the absolute size of the first revision in the indexes of leading, coincident and lagging indicators averaged about 0.5, 0.3 and 0.3 percentage points, respectively, for the first nine months of 1984. These revisions appear to be substantial, given that the preliminary estimates of the monthly changes in these indexes have average absolute values of only about 0.7, 0.7 and 1.0 percentage points.

The sources of revisions in the three indexes vary from one month to the next. It appears, however, that for the monthly estimates during 1984 the subsequent availability of data on series *not available initially* ac-

[11]Details on trend adjustment can be obtained from U.S. Department of Commerce (1984).

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Construction of Composite Indexes: An Illustration

Index and BEA Series Number	Basic Data		Percentage Change	Weighted and Standardized Percentage Change[1]
	May 1984	June 1984	May to June 1984	May to June 1984
Leading Index Components				
1.	40.6	40.6	0	0.000
5.	348	350	−0.6	−0.012
8.	34.46	36.18	−5.9	−0.203
32.	70	66	−4	−0.112
12.	116.2	115.8	−0.3	−0.029
20.	17.11	15.59	−8.9	−0.135
29.	141	142.8	1.3	0.027
36.	34.26	NA	NA	NA
99.	0.27	−0.12	−0.39	−0.107
19.	156.55	153.12	−2.2	−0.095
106.	914	917.8	0.4	0.089
111.	26.2	NA	NA	NA
				−0.577
				−0.577/0.582
				+0.139
			Leading Index =	−0.9
Coincident Index Components				
41.	93.72	94.02	0.3	0.321
51.	1170.5	1177.3	0.6	0.387
47.	162.8	163.6	0.5	0.180
57.	177.35	NA	NA	NA
				0.888
				0.888
				−0.175
			Coincident Index =	0.7
Lagging Index Components				
91.	18.4	18.6	−1.1	−0.068
77.	1.52	NA	NA	NA
62.	86.6	86.2	−0.4	−0.152
109.	12.39	12.60	0.21	0.153
101.	114.20	116.19	1.7	0.465
95.	14.17	NA	NA	NA
				0.398
				0.398/0.707
				+0.018
			Lagging Index =	0.6

[1]Percentage change in component series is divided by the relevant standardization factors and multiplied by the relevant weight given in tables 1 and 2.

NA = not available

SOURCE: U.S. Department of Commerce, *Business Conditions Digest* (July 1984).

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Table 3

First and Second Estimates of Composite Indexes: 1984 (percent changes)

	Leading		Coincident		Lagging	
	First[1]	Second[2]	First	Second	First	Second
January	1.1%	1.0%	1.0%	1.4%	−0.9%	−0.9%
February	0.7	1.3	0.9	0.8	0.9	1.6
March	−1.1	−0.1	0.3	0.0	1.1	1.3
April	0.5	0.5	0.8	0.9	1.7	1.8
May	−0.1	0.4	0.5	0.9	1.0	1.7
June	−0.9	−1.3	0.7	0.9	0.6	0.9
July	−0.8	−1.8	0.8	0.1	0.9	1.2
August	0.5	−0.1	0.2	0.0	1.1	1.0
September	0.4	0.6	0.1	0.0	0.6	0.8
Average absolute revision	0.5		0.3		0.3	

[1]First estimate for a month is obtained from the issue of *Business Conditions Digest* for the following month.

[2]Second estimate for a month is obtained from the issue of *Business Conditions Digest* dated two months later.

SOURCE: U.S. Department of Commerce, *Business Conditions Digest*, various issues.

counts, on the average, for over two-thirds of the first revision in leading and lagging indexes and about one-half of the revision in the coincident index. The balance of the revisions are due to updated estimates of data *that were available* for the initial estimates.[12]

Estimates of the composite indexes are subject to revision for a period of 12 months. The first and last available estimates of the leading indicator from 1979 to 1983 appear in chart 1. As we can see, these estimates sometimes diverge by substantial amounts. In table 4, the average absolute values of successive revisions in estimates of changes in each composite indicator from 1979 to 1983 are presented. For purposes of comparison, the table also includes the average absolute value of selected estimates of the percentage change in each index. The average absolute value of the first revision (the difference between the first and second estimates) in the leading indicator is calculated to be 0.4, and the average absolute value of revisions subsequent to the first revision (the difference between the final and second estimates) in the leading indicator is found to be 0.5. Since the average absolute value of the total revision (the difference between the final and first estimates) in the leading indicator (0.6) is less than the sum of the individual revisions (0.9), it is apparent that successive revisions sometimes overshoot the final estimate. Given that the final estimates of the leading, coincident and lagging indicators have average absolute values of only 1.0, 0.7 and 0.9, respectively, errors in early estimates would seem to be substantial.

The difficulty created by error in early estimates can be illustrated by considering recent months during 1984. From table 3, it can be seen that the first estimate

[12]These observations are based on the following analysis. Let the first and second estimates of the rate of change in a composite index be x_{1t} and x_{2t}. The revision is given by $r_t = x_{2t} - x_{1t}$. The portion of the revision due to the updating of data series available for constructing x_{1t} can be calculated by estimating the change in the composite indexes assuming the continued nonavailability of data on series not originally available. If this estimate of the change in the composite indexes is denoted by e_t, the revision in the composite indexes due to updating data is given by $u_t = e_t - x_{1t}$. The portion of the revision in the behavior of the composite indexes due to using data on series not available for the initial estimate is given by $a_t = x_{2t} - e_t\ (= r_t - u_t)$. The relative contributions of updated data and increased data availability are defined to be

$$u = (\Sigma_t u_t\ (\text{sign of } r_t))/(\Sigma_t\ |r_t|),$$

and

$$a = (\Sigma_t a_t\ (\text{sign of } r_t))/(\Sigma_t\ |r_t|),$$

respectively. Clearly $u + a = 1$. For the new composite indexes defined in table 1, $u = .7$, .6 and .9 for the leading, coincident and lagging indexes for the period January 1984 to July 1984. Revisions seem to be mostly due to the use in later estimates of initially unavailable data, at least over the time period considered and for differences between the first and second estimates of the indexes.

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Chart 1

First and Final Estimates of Leading Index

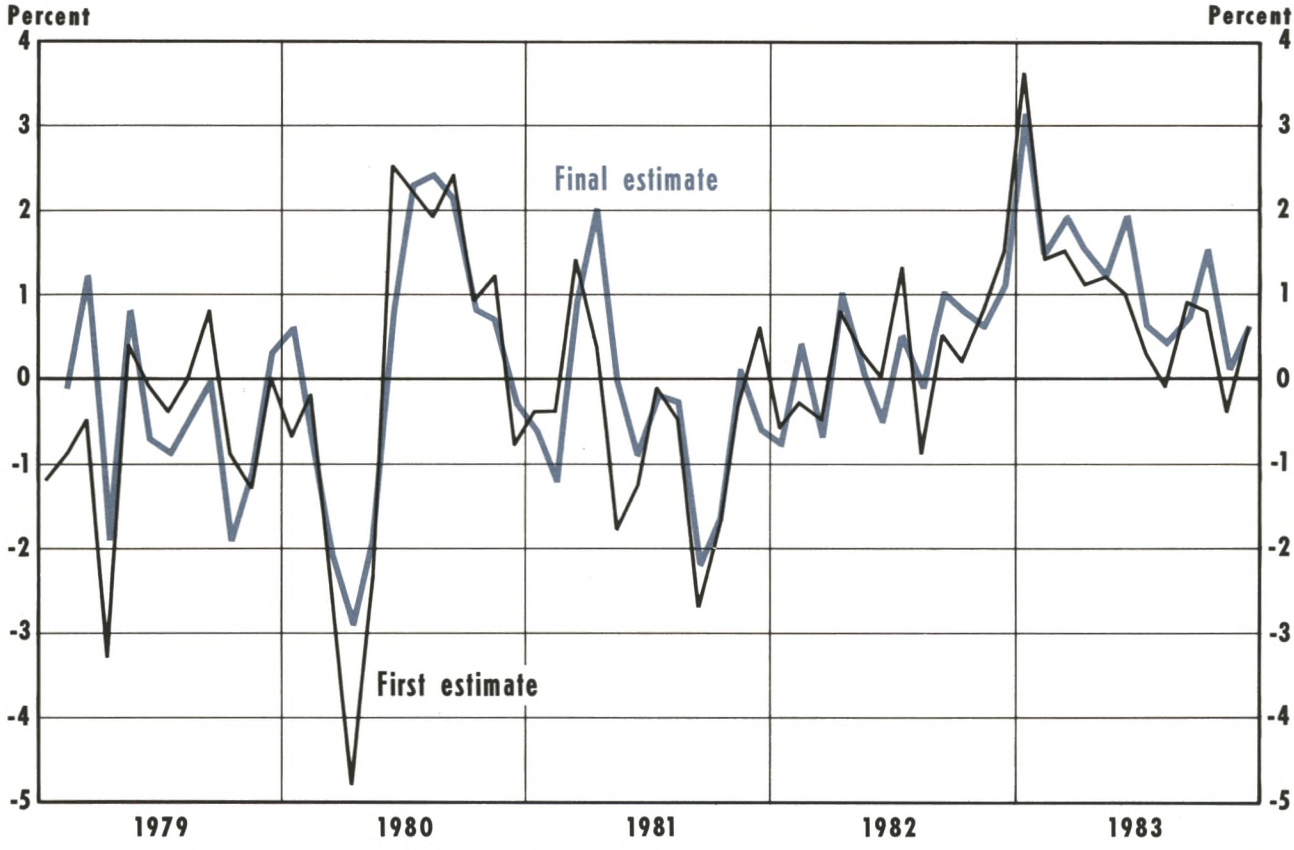

Table 4

Average Absolute Values of Estimates and Revisions of Composite Indicators: 1979–83

	Leading	Coincident	Lagging
First estimate	1.1	0.7	2.5
Second estimate	1.1	0.7	1.8
Final estimate	1.0	0.7	0.9
First revision	0.4	0.4	0.8
Revisions subsequent to first revision	0.5	0.2	1.2
Revision from first to final estimates	0.6	0.4	1.9

SOURCE: U.S. Department of Commerce, *Business Conditions Digest*, various issues.

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of the percentage change in the leading indicator in May was negative. The second and subsequent (not shown) estimates for May are positive. The first and subsequent estimates for June and July (as of the middle of December) are negative. This makes the behavior of the index during August of some interest. For August, the first estimate was positive (+0.5), the second negative (–0.1), and the third (available in November) positive (+0.1). A further illustration of the difficulties created for forecasting is taken up in the next section.

THE USEFULNESS OF THE INDEX OF LEADING INDICATORS IN FORECASTING

One way of evaluating the index of leading indicators is to examine its ability to predict the onset of a recovery or a recession. This is usually done by observing the number of consecutive monthly declines or increases in the index.[13] If the index has been rising steadily and the economy has been expanding, a fall in the index for several months heralds a recession. Likewise, if the index has been falling for several months and the economy has been depressed, a rise in the index over several months heralds a recovery.

This approach to forecasting the business cycle begins by specifying the number of successive months of reversal in the index's behavior necessary to predict a turning point in the cycle. In general, the method is more reliable the greater the number of consecutive months of decline or increase required to forecast a turning point. When the lead time in the forecast is increased, however, it reduces the number of consecutive months of reversal required to make a forecast.

Using both two and three months of consecutive movement in the index as a criteria for prediction, Wood (1984) has reported the reliability and lead time of using the leading index to forecast turning points in the economy's rate of growth. His observations are reported in table 5.

These data reveal that the index of leading indicators has forecasted every recession and growth recession (which occurs when the rate of growth in the economy slows down) since 1948.[14] A negative number indicates the number of months by which either a two- or three-month rule leads a peak or trough in the rate of growth. A positive number indicates the number of months by which the use of the rule lagged behind a turning point. For example, since the leading indicator declined for several months starting in August 1948, two- and three-month declines in the indicator lead the growth cycle peak in November 1948 by one and zero months, respectively.

Use of a two-month rule for forecasting a growth cycle peak gives a longer lead time than the three-month rule by more than one month for the recessions starting in both December 1969 and January 1980. This means that there were isolated consecutive monthly declines in the index in February and March 1969 and in November and December 1978, that is, declines that were not immediately followed by recession.

The lead times in table 5 refer to the forecasting performance of the final estimates of the leading indicator. In general, the final estimates are not the same as the initial estimates. These differences between early and final estimates of the indexes can sometimes create serious problems in forecasting turning points in the growth cycle. For example, table 5 indicates that three consecutive monthly declines in the leading indicator forecasted the onset of the 1980 recession by five months. These declines in the final estimate of the leading indicator, which occurred during June, July and August 1979, are shown in table 6. The problem with this analysis from a forecasting viewpoint is that the first and second estimates of the leading indicator did not register declines for August. The second estimate for August 1979, which became available at the end of October 1979, showed a positive rise in the leading indicator of 0.1 percent. As this example illus-

[13] For a discussion of an alternative criteria for forecasting turning points, see Zarnowitz and Moore (1982). Work by Zarnowitz and Boschan (1975b) suggests that the ratio of the coincident indicator to the lagging indicator would be a useful predictor of turning points. Moore (1969) first suggested the use of the ratio of the coincident to lagging indicators for forecasting purposes. For a history of the basic idea that lagging indicators might lead, see Moore (1984), chapter 23.

[14] A growth cycle is a fluctuation around the long-run trend in economic growth. Most business cycles contain, and coincide with, one growth cycle. The business cycle starting at the end of 1948 contained two growth cycles. The dates in table 5 indicate that economic growth slowed down from March 1951 to July 1952, then picked up again to peak in July 1953, at which time a recession began. The very long business cycle starting during 1960 contained three growth cycles, with slowdowns in growth starting immediately after May 1962 and June 1966, and upturns in growth starting in October 1964 and October 1967. A recession did not begin until December 1969. For a discussion of the concept of growth cycles, see Moore (1984), chapter 5.

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Table 5

Ex Ante Timing of the Leading Indicators During Growth Cycle Turning Points: 1948–82

Growth Cycle Peaks	Two Consecutive Monthly Decreases	Three Consecutive Monthly Decreases	Growth Cycle Trough	Two Consecutive Monthly Increases	Three Consecutive Monthly Increases
Nov. 1948	−1	0	Oct. 1949	−3	−2
Mar. 1951*	−4	−3	July 1952	−5	−4
July 1953	−1	0	May 1954	−5	−4
Aug. 1957	−19	−18	Apr. 1958	+1	+2
Apr. 1960	−9	−8	Feb. 1961	−8	−7
May 1962*	+1	+2	Oct. 1964	missed	missed
June 1966*	0	+1	Oct. 1967	−6	−5
Dec. 1969	−9	−5	Nov. 1970	+1	+2
Nov. 1973	−4	−3	Mar. 1975	+1	+2
Jan. 1980	−13	−5	July 1980	0	+1
July 1981	−6	−5	Dec. 1982	−7	−1
Average	−6	−4	Average	−3	−2

NOTE: *indicates that a growth recession followed. Negative numbers indicate a positive lead time.

Table 6

Estimates of the Leading Indicator: 1979 (percent changes)

	Final Estimate	First Estimate	Second Estimate
May 1979	0.8%	0.4%	0.3%
June	−0.7	−0.1	−0.3
July	−0.9	−0.4	−0.2
August	−0.5	0.0	0.1
September	0.0	0.8	0.2
October	−1.9	−0.9	−1.4
November	−1.1	−1.3	−1.2
December	0.3	0.0	−0.2

SOURCE: U.S. Department of Commerce, *Business Conditions Digest*, various issues.

trates, the likely magnitude of revisions in preliminary estimates of change in the composite indexes complicates the interpretation of signals in the short run.

Additional qualifications also need to be made concerning the forecasting ability of the index of leading indicators:[15]

(1) The leading index has falsely forecasted the onset of recession on at least three occasions. The index declined for three consecutive months in late 1960 and a recession didn't start until 17 months later. The index fell for two consecutive months in mid-1963 and mid-1971 and recessions did not begin until two or three years later.

(2) There is no clear a priori criteria as to whether declines in the index forecast a full-blown recession or merely a significant slowing in the economy. Consecutive monthly declines in the index preceded slowdowns, but not recessions, in economic growth in 1951, 1962 and 1966.

(3) The lead times by which the leading indicator predicts a turning point are highly variable. Indeed,

[15]These reservations also apply generally to the use of the ratios of the leading to coincident and coincident to lagging indexes that have also been suggested as predictors of economic activity.

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the three monthly declines in the index in December 1955, January and February 1956 were so far ahead of the business cycle peak that occurred in August 1957 that they can almost be regarded as a false signal. Given the historical tendency of the U.S. economy to exhibit cyclical fluctuations, a recession eventually will follow a decline (or any other movement for that matter) in the indicator. In order for the indicator to be a really useful forecaster, it also would need to forecast the timing of a recession within narrower bounds than it has since 1948.

(4) By using the most up-to-date version of the index, a favorable bias is introduced into this evaluation of the predictive performance of the leading indicator. The components of the index and the standardization, weighting and trend factors have been altered continually through the years. Currently, they are based on data from 1948–81. The current index has been designed so as to obtain as favorable an ex post record as possible. While this is the appropriate means for constructing an index that will lead future economic activity as reliably as possible, the application of the current index to historical business cycle data does not measure the forecasting performance of the leading indicator actually in use when the forecasts were made.

In summary, the usefulness of the index of leading economic indicators for forecasting would seem to be seriously circumscribed by the problem of the highly variable lags by which economic activity follows the index, and by the large revisions by which initial estimates of the index are adjusted.

REFERENCES

Auerbach, Alan J. "The Index of Leading Indicators: 'Measurement without Theory,' Thirty-five Years Later," *The Review of Economics and Statistics* (November 1982), pp. 589–95.

Cook, David T. "Fed Meets This Week Amid Fresh Signs of Slower Economy," *Christian Science Monitor,* October 1, 1984.

Gorton, Gary. "Forecasting with the Index of Leading Indicators," Federal Reserve Bank of Philadelphia *Business Review* (November/December 1982), pp. 15–27.

Hershey, Robert D. Jr. "Economic Index Up by 0.5%," *New York Times,* September 29, 1984.

Hymans, Saul H. "On the Use of Leading Indicators to Predict Cyclical Turning Points," *Brookings Papers on Economic Activity* (February 1973), pp. 339–84.

Moore, Geoffrey H. "Generating Leading Indicators From Lagging Indicators," *Western Economic Journal* (June 1969), pp. 135–44.

_____ . *Business Cycles, Inflation and Forecasting,* National Bureau of Economic Research Studies in Business Cycles No. 24, 2nd ed. (Ballinger Publishing Company, 1984).

Murray, Alan. "Economic Index Eases Worries Over Slowdown," *The Wall Street Journal,* October 1, 1984.

Neftci, Salih N. "Lead-Lag Relations, Exogeneity and Prediction of Economic Time Series," *Econometrica* (January 1979), pp. 101–13.

Nenneman, Richard A. "Latest Economic Data, Dip in the Prime Rate Look Good for the Economy," *Christian Science Monitor,* October 1, 1984.

Stekler, H. O., and Martin Schepsman. "Forecasting With An Index of Leading Series," *Journal of the American Statistical Association* (June 1973), pp. 291–96.

United Press International. "Indicators Rise Slightly in August," *N.Y. Journal of Commerce,* October 1, 1984.

U.S. Department of Commerce. *Business Conditions Digest,* various issues.

_____ . *Handbook of Cyclical Indicators,* 1984.

Wood, Steven A. "The Index of Leading Indicators: What is it Telling Us?" *Chase Econometrics* (September 1984), pp. A.24–A.33.

Zarnowitz, Victor, and Charlotte Boschan. "Cyclical Indicators: An Evaluation and New Indices," *Business Conditions Digest* (U.S. Department of Commerce, May 1975), pp. V–XIX.

_____ . "New Composite Indexes of Coincident and Lagging Indicators," *Business Conditions Digest* (U.S. Department of Commerce, November 1984), pp. V–XXI.

Zarnowitz, Victor, and Geoffrey H. Moore. "Sequential Signals of Recession and Recovery," *Journal of Business* (January 1982).

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