Inflation Expectations Surveys as Predictors of Inflation and Behavior in Financial and Labor Markets

Inflation expectations underlie many important decisions made in product, labor, and financial markets They contribute to the determination of nominal compensation gains and interest rates, and they even influence the future course of inflation itself. Among the surveys that report inflation expectations are the University of Michigan Institute for Social Research Survey (MICH), the Decision Makers Poll (DMP), and the Blue Chip Consensus (BCC) The surveys differ in their orientation MICH focuses on the expectations held by households, DMP attempts to capture the expectations of individuals active in financial markets, and BCC canvasses professional economists and industry-based forecasters as well as financial market participants This article examines whether these differing groups hold the same expectations and whether their inflation expectations, as reported in the surveys, are more closely related to future trends in inflation than is the recent behavior of actual inflation

We conclude that over the last decade inflation surveys have on the whole conveyed useful information about subsequent inflation developments Specifically, during this time period the inflation surveys possess a statistically significant forward-looking element and are more reliable than past inflation in predicting future inflation trends We also find, however, that although the surveys have performed well for the decade as a whole, their record since 1982 has been quite poor All three surveys overpredict consumer price inflation substantially, and this bias remains present, although to a smaller degree, even when the effects of fluctuations in food and energy prices are removed

The similarity in the forecasting performances of the inflation surveys in recent years reflects the strong correlations of the surveys with each other and with past inflation rates Despite these correlations, however, the forecasts produced by the different surveys are by no means identical At various times in recent years the surveys have given different indications of the level and the direction of inflation

Such differences might be interpreted as random variations without any economic significance, except that households and financial market participants appear to act on their different expectations More specifically, household inflation expectations, as revealed in MICH, appear to feed into future compensation growth, while financial market inflation forecasts, revealed in DMP, appear to feed into interest rate developments. The household inflation forecasts contain little information useful for interest rate determination, the financial market forecasts contribute relatively little to the explanation of nominal compensation growth

These results have several important implications First, inflation expectations can be consistently wrong for several years Partial explanations can be found for the errors, but ex post real interest rates can differ significantly and persistently from their ex ante expectations Given the continuing pattern of errors in recent years, high nominal interest rates caused by pessimistic financial market inflation expectations are likely to have produced unexpectedly higher real rates on an ex post basis To the extent that households viewed inflation prospects more optimistically, they would have viewed the higher nominal rates as higher real interest rates on an ex ante basis, and hence the higher rates would have been contractionary

Erroneous inflation forecasts also may affect the efficiency of capital accumulation and savings If financial markets and households have different inflation expectations, they may perceive different real returns to savings and costs of funds, with consequent effects on savings and investment decisions

Although not common, divergent inflation expectations appear to have contributed to movements in nominal interest rates on several occasions in recent years The first and most important instance began in mid-1983 and extended through the first eight months of 1984 The financial market expectation of inflation exceeded that of households by a percentage point or more through much of this period and was considerably higher than realized inflation as well. In another notable instance, during the first three quarters of 1987, financial market inflation expectations and interest rates rose sharply in anticipation of inflationary pressures which did not emerge, while household inflation expectations moved less pessimistically In recent months, inflation expectations have declined sharply in a number of published surveys. Both future economic performance and the appropriate stance of monetary policy depend on whether interest rate movements in response to such changing expectations are best interpreted as real interest rate movements or neutral nominal rate changes that on average correctly reflect future inflation rate trends

Our findings also possess some academic interest First, they represent yet another in a long line of empirical rejections of the rational expectations hypothesis [1] More important, they suggest that inflation expectations in specific markets can affect the relative prices determined within these markets Such heterogenous expectations may have a significant impact on economic activity because there is no immediate mechanism by which such expectations differences can be arbitraged away

The survey data

Three surveys of expected inflation over a one-year time horizon are examined The surveys evaluate the expectations of individuals who may interpret economic conditions and data differently DMP focuses on financial market expectations, the vast majority of respondents are equity or bond portfolio managers, chief investment officers, and financial officers MICH, by contrast, canvasses the inflation expectations of randomly selected households Although BCC overlaps to some extent in its coverage with the DMP, it is much more heavily weighted to economists, economic consultants, forecasters, and nonfinancial corporations, and probably reflects the views of professional forecasters to a greater degree than DMP These groups are clearly unlike in their perspectives and knowledge of economics Their differences may cause them to react to information and events differently and to hold diverse beliefs

Since February 1982, Richard Hoey, Chief Economist at Drexel Burnham Lambert, has published DMP on a regular basis The response group comprises anywhere from 190 to 400 institutional investment portfolio managers, economists, and executives in financial and investment institutions Respondents are not asked to forecast any specific inflation rate, but the pollers regard the consensus forecast as the sample's expectation of the one-year change in the consumer price index (CPI) Publication is rapid, so an expectation published in January 1983 is the expected change in the inflation rate from January 1983 to January 1984 DMP is issued every two or three months In order to have as many data points as possible for our statistical analysis, we linearly interpolate the missing values, using the data points on either side of the missing value.[2]

MICH is a monthly survey of over 1,000 randomly chosen households The households are asked their prediction of the change in the prices of the goods that they buy[3] The survey has changed over the years, prior to 1966, respondents were asked for only a quali-

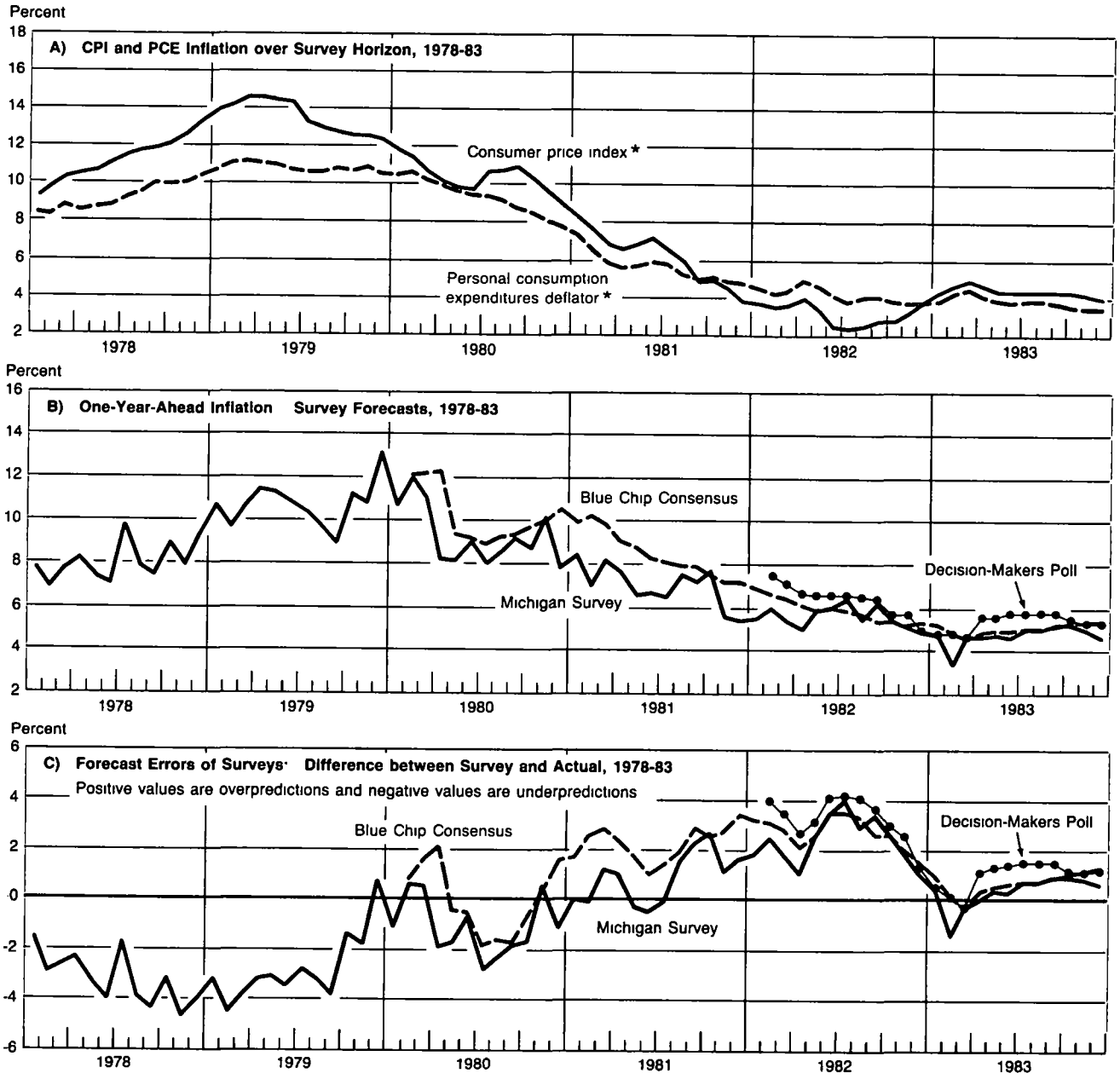
[1]Considerable effort has been devoted to determining whether survey expectations are rational The working paper version of this paper, A Steven Englander and Gary Stone, "Inflation Expectations Surveys as Predictors of Inflation and Behavior in Financial and Labor Markets," Federal Reserve Bank of New York, Research Paper no 8918, December 1989, cites many of the relevant sources A recent article treating the question is Adrian Throop, "An Evaluation of Alternative Measures of Expected Inflation," Federal Reserve Bank of San Francisco *Economic Review*, no 3 (Summer 1988), pp 27-43 Throop also analyzes the performance of surveys in relationships where inflation expectations are thought to be important His results differ from ours in that he finds in general that autoregressive or augmented autoregressive expectations outperform surveys in regression equations estimating such relationships Our approach differs in that we use only data that would have been available at the time of the forecast and we consider surveys that are relevant in specific markets For these reasons, Throop's procedure may be biased towards finding that surveys contain little information beyond what is available in autoregressions By contrast, a recent paper by Michael P Keane and David E Runkle, "Testing the Rationality of Price Forecasts New Evidence from Panel Data," Federal Reserve Bank of Minneapolis, Mimeo, November 1988, examines the performance of individual professional forecasters in the ASA-NBER survey and concludes that their forecasts are indeed rational

[2]Lagging the DMP to eliminate any possible effect from the interpolation procedure does not produce substantially different results, nor does removing the interpolated months

[3]For a more detailed discussion of the Michigan survey and a comparison with a survey of professional economists (Livingston Survey), see Edward M Gramlich, "Models of Inflation Expectations Formulation, A Comparison of Household and Economist Forecasts," *The Journal of Money, Credit and Banking*, vol 15, no 2 (May 1983), pp 155-73

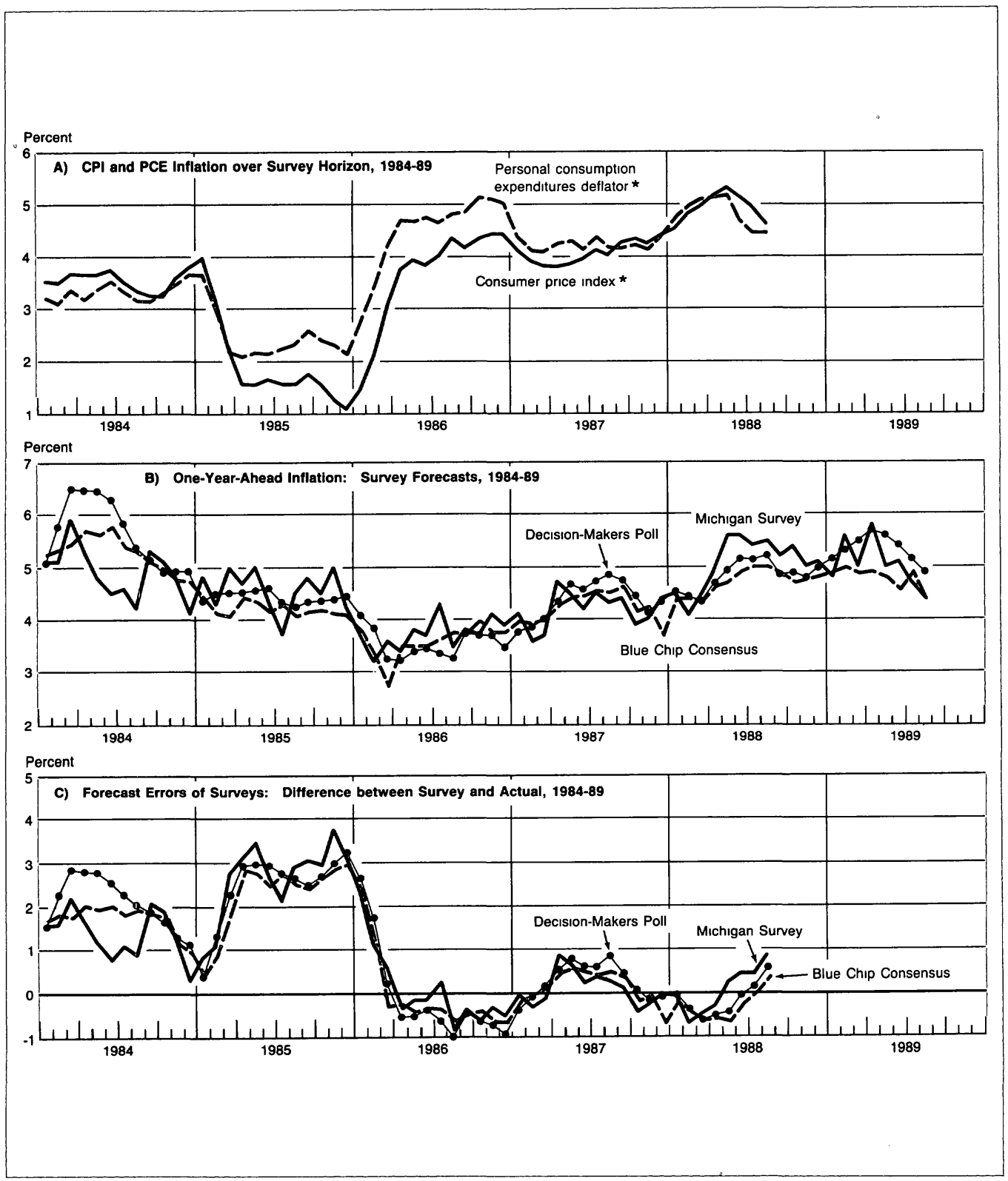
Chart 1

Comparisons of Inflation and Inflation Expectations



Sources Eggert Economic Enterprises, Blue Chip Economics Indicators, Drexel Burnham Lambert, Decision-Makers Poll, and Institute for Social Research, University of Michigan, Survey of Consumers

* The consumer price index (CPI) and the personal consumption expenditures (PCE) deflator are the actual inflation rates over the survey horizon


Percent
A) CPI and PCE Inflation over Survey Horizon, 1984-89
Personal consumption expenditures deflator *
Consumer price index *
6
5
4
3
2
1
1984
1985
1986
1987
1988
1989
Percent
B) One-Year-Ahead Inflation: Survey Forecasts, 1984-89
Michigan Survey
Decision-Makers Poll
Blue Chip Consensus
7
6
5
4
3
2
1984
1985
1986
1987
1988
1989
Percent
C) Forecast Errors of Surveys: Difference between Survey and Actual, 1984-89
Decision-Makers Poll
Michigan Survey
Blue Chip Consensus
5
4
3
2
1
0
-1
1984
1985
1986
1987
1988
1989

tative measure, but after 1966 they were asked for a quantitative measure on a quarterly basis. In the analysis below, we use data on MICH beginning in January 1978, when the survey switched to a monthly format.

The publication schedule of MICH is such that the reported number is actually the previous month's expectation of inflation over the following twelve months. We align the expectations so that they correspond to the month in which they were taken, not the month of publication Thus, the expectation reported in February 1978 is the expectation of the change in inflation from January 1978 to January 1979, and we treat it accordingly

In March 1980, Robert J. Eggert introduced the BCC, a survey reporting the forecasts of CPI growth made by banks, econometric forecasting companies, financial markets firms, and large nonfinancial companies. The forecasts are made at the beginning of the month in which the survey is published or at the end of the previous month.

The one-year-ahead expected inflation rate is constructed by taking the average of four consecutive annualized quarterly forecasts, beginning with the forecast following the current quarter. Although respondents are not asked to forecast inflation over a twelve-month horizon, as they are in the other surveys, the time profile of the quarterly forecasts is extremely flat, suggesting that respondents are providing their general sense of future inflation rather than period-dependent forecasts. Because only the BCC makes a specific reference to the CPI, the forecasting performance of all three surveys is compared to growth in both the CPI and the personal consumption expenditures (PCE) deflator. CPI and PCE deflator growth rates are similar in trends, although substantial differences appear in the magnitude of the changes in the inflation rate (Chart 1, panel A). The PCE neither increases nor falls as rapidly as the CPI. This reflects differences between a fixed-weighted index (CPI) and an implicit deflator (PCE), as well as the compositional differences in the two consumer price indicators.

Comparison of the survey forecasts

The broad movements in the survey forecasts are similar, but during some periods their predictions differ markedly. For example, the BCC forecast exceeded the MICH forecast from the beginning of 1980 until early 1982 (Chart 1, panel B). Subsequently, for extended portions of 1982, 1983, and 1984, the DMP forecast was substantially higher than those of either BCC or MICH. At intermittent periods since 1984, the MICH inflation forecast was above those of the other surveys (parts of 1985 and much of 1988), and the DMP forecast was higher than those of the other surveys (parts of 1987 and 1989) Since 1982, BCC generally has forecast lower inflation than the other surveys or taken an intermediate position between them.

A more formal statistical analysis reveals both similarities and differences among the surveys. As might be expected, the surveys are highly correlated with each other, although the association is greater between DMP and BCC than between MICH and the other two surveys. The adjusted R^2 from a regression of the DMP forecast on the BCC forecast is 0 88, as against about 0 61 for the regression of MICH on either BCC or DMP.

To some extent the correlations among the surveys reflect the correlation that each of the surveys has with past inflation. A distributed lag on past inflation can account for somewhat more than half of the variation in the surveys, ranging from 0 53 for BCC to 0.59 for MICH to 0.61 for DMP[4] These are higher correlations than exist in fact between future and past inflation, suggesting that survey respondents may be backward looking to a substantial degree.

Although the surveys show a fair degree of correlation with one another and with past inflation, some dissimilarities emerge when one looks a little deeper. If only those components of the surveys *not* related to past inflation are considered, the correlation between MICH and the other two surveys weakens considerably Only about a quarter of the variation in MICH that is independent of past inflation can be explained by the other two surveys. By contrast, even after the effects of past inflation are removed, BCC and DMP can explain more than 80 percent of the residual variation in each other. This suggests that BCC and DMP are correlated well beyond their common backward-looking components.

Inflation-forecasting performance

The forecast performance of MICH is quite respectable over the 1978-88 period It is virtually unbiased with respect to the CPI, has a moderate upward bias with respect to the PCE, and its root mean-squared errors (RMSEs, which measure the typical size of error irrespective of sign) are only about half the standard deviation of CPI and PCE inflation (Table 1, column 12). The performance is also strong relative to the naive forecast that just projects next year's inflation as equaling that of the past year. The RMSEs of MICH are quite a bit lower than those of the naive forecasts, although the upward prediction bias of MICH is slightly higher with respect to the PCE (Table 1, column 13).

The RMSE falls substantially when MICH is viewed as forecasting consumer price inflation excluding food

[4]The adjusted R^2 from such regressions changes with the sample period The standard errors remain relatively stable in the 0 45 to 0 65 range throughout the available sample

and energy Households appear to forecast the core component of consumer price growth better than they forecast food and energy price fluctuations

The performance since February 1980 (when BCC becomes available) is similar MICH remains better than the naive forecast, and its RMSEs are a good deal lower than the standard deviations of actual inflation (Table 1, columns 9 and 10) The performance of BCC in forecasting inflation as measured by growth in the overall CPI and the CPI excluding food and energy is much better than that of the naive forecast and slightly worse than that of MICH (Recall that BCC respondents are asked specifically to forecast CPI inflation)

When we evaluate the performance of all three surveys beginning in 1982, the year DMP became available on a regular basis, we find that the forecasting performance falls apart None of the surveys provides very good unconditional forecasts of one-year-ahead inflation over the period from February 1982 to August 1988 (Table 1, columns 1-3) The average overprediction ranges from one and three-tenths percentage points for DMP with respect to the CPI to eight-tenths of a percentage point for MICH with respect to the PCE deflator The errors have also been persistent, with only a few small instances of underprediction (Chart 1, panel C)

A comparison of forecast RMSEs with the standard deviation of actual inflation also illustrates the limited predictive success of the surveys in the mid and late 1980s The standard deviations of inflation since 1982 are less than half their post-1980 levels (Table 1, memo item) By contrast, the forecast RMSEs are virtually the same for MICH and only slightly lower for BCC across the two periods, despite the stability of inflation

Much of the bias in the forecasts can be explained by variations in food and energy prices For example, the average overpredictions of MICH and BCC fall from about one percentage point to about three-tenths of a percentage point if the surveys are viewed as projecting growth in the CPI excluding food and energy The bias in DMP falls as well, but remains high compared to the bias in the other two surveys

Table 1

Performance of Surveys in Forecasting Inflation

Inflation expectations measured by.	February 1982-August 1988				January 1984-August 1988				February 1980-August 1988			January 1978-August 1988	
	(1) DMP	(2) MICH	(3) BCC	(4) Naive	(5) DMP	(6) MICH	(7) BCC	(8) Naive	(9) MICH	(10) BCC	(11) Naive	(12) MICH	(13) Naive
Performance in predicting twelve-month growth in.													
Consumer price index													
Bias†	1 31	1 04	1 05	0 16	0 99	0 90	0 82	−0 08	0 79	1 10	1 00	0 06	0 27
RMSE	1 91	1 65	1 63	1 86	1 66	1 52	1 45	1 59	1 61	1 72	2 50	2 01	2 67
Personal consumption expenditures													
Bias†	1 12	0 84	0 85	0 16	0 78	0 69	0 61	−0 12	0 81	1 12	0 75	0 53	0 27
RMSE	1 77	1 43	1 46	1 34	1 65	1 44	1 42	1 43	1 42	1 70	1 83	1 38	1 84
CPI excluding food, energy													
Bias†	0 56	0 28	0 29	0 37	0 23	0 15	0 06	0 11	0 04	0 35	0 91	−0 29	0 25
RMSE	1 21	0 92	0 92	1 59	0 76	0 59	0 58	0 48	1 13	1 11	2 07	1 31	2 19
PCE excluding food, energy													
Bias†	0 68	0 41	0 42	0 36	0 39	0 30	0 22	−0 01	−0 25	0 70	0 63	0 52	0 25
RMSE	1 34	1 02	1 05	0 99	1 28	1 08	1 08	0 81	1 23	1 28	1 24	1 12	1 30
Memo standard deviation of twelve-month growth in													
CPI		1 04				1 13				2 37		3 80	
PCE		0 83				0 95				1 88		2 78	
CPI excluding food, energy		0 48				0 26				2 14		3 05	
PCE excluding food, energy		0 58				0 53				1 64		2 04	

Note Naive forecast assumes that inflation over the following twelve months will be the same as inflation over the previous twelve months

†Bias defined as average value of actual inflation less forecasted inflation A minus sign indicates that the survey underpredicted on average, a negative sign, that it overpredicted

The performance of the surveys improves over the period from January 1984 to August 1988, after the initial stages of the deceleration in inflation had ended This was a period of very stable inflation, however, and all three surveys are outperformed on the whole by the naive forecast, with RMSEs substantially higher than the standard deviation of actual inflation (Table 1, columns 5-8) Among the surveys, the DMP performs unambiguously the worst both in terms of bias and RMSE

Regression analysis generally supports the conclusions reached above For the 1982-88 period, when inflation rates were very stable except for food and energy price fluctuations, no meaningful information about future inflation is contained in any of the surveys or in past inflation itself (Table 2, columns 1-4) When the sample is extended back to 1980, the picture reverses Both MICH and BCC contain significant information about future inflation and more information than a distributed lag on past inflation That is, on average, changes in MICH or BCC are better guides to future inflation trends than the past patterns of actual price inflation (Table 2, columns 5-7)[5] The significance of the surveys in explaining future inflation remains even when they are entered simultaneously with lagged values on past inflation (Table 2, columns 8 and 9) If we go back to 1978, when only MICH is available, the margin by which that survey outperforms a distributed lag on past inflation increases substantially

[5]As might be expected with forecast horizons of twelve months, the errors possess a strong moving average component Although the moving average errors do not affect the consistency of the estimates, they do affect the consistency of the standard errors estimated by ordinary least squares regressions For discussions of this problem and proposed corrections see Halbert White, "A Heteroskedasticity-Consistent Covariance Matrix Estimator and Direct Test for Heteroskedasticity," *Econometrica*, vol 48 (1980), pp 817-38, and Lars P Hansen and Kenneth J Singleton, "Generalized Instrumental Variables Estimation of Non-Linear Rational Expectations Models," *Econometrica*, vol 50 (1982), pp 1269-86 The method proposed by Whitney K Newey and Kenneth D West, "A Simple Positive Semi-Definite Heteroskedasticity and Autocorrelation Consistent Covariance Matrix," *Econometrica*, vol 55 (1987), pp 703-8, was used to correct the estimated standard errors of the coefficients for eleventh-order moving average errors and heteroskedasticity

Table 2

The Inflation Surveys as Forecasts of Future Inflation: Regression Results†

Dependent Variable Growth rate in consumer price index over the next twelve months

	February 1982-August 1988				February 1980-August 1988					January 1978-August 1988		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)‡
Inflation expectations measured by:	DMP	MICH	BCC	Lagged Inflation	MICH	BCC	Lagged Inflation	MICH	BCC	MICH	Lagged Inflation	MICH
Coefficients.												
Intercept	3 61**	3 92**	3 14***	4 22*	−1 43	−0 55	1 76*	−0 52	−0 64	−2 86*	1 94*	−0.89
Inflation survey	−0 00	−0 07	0 10		1 12*	0 90*		0 75*	0 95*	1 45*		1 06*
Distributed lag on inflation				−0 19			0 56*	0 20***	−0 03		0 81	
Significance level of rationality test [a=0, b(+c)=1]	0 00	0 00	0 00	0 00	0 05	0 00	0 00	0 09	0 58	0 00	0 00	0 19
DW	0 99	0 10	0 10	0 10	0 39	0 16	0 12	0 25	0 17	0 55	0 13	0 56
SEE	1 05	1 04	1 04	1 03	1 40	1 32	1 49	1 39	1 34	1 72	2 37	1 27
ADJ R**2	−0 01	−0 01	−0 01	0 01	0 65	0 69	0 60	0 66	0 68	0 79	0 61	0 79

Notes Standard errors are corrected for eleventh-order moving average errors and heteroskedasticity See Newey and West, "A Simple Positive Semi-Definite Heteroskedasticity and Autocorrelation Consistent Covariance Matrix"

†Equation CPI12F = a+b inflation expectation (+c · lagged inflation), where CPI12F is the growth rate in the consumer price index over the next twelve months, and the lagged inflation term is an eighteen-month polynomial distributed lag on one-month annualized growth in the consumer price index with degree two and an endpoint constraint

‡Dependent variable is the growth rate in the personal consumption expenditures deflator over the next twelve months

*Significant at 1 percent

**Significant at 5 percent

***Significant at 10 percent

It is difficult to determine whether BCC or MICH contains the more significant information. Regression analysis indicates that BCC is marginally superior to MICH in general. When the two surveys are entered simultaneously, they both contribute significantly to explaining one-year-ahead inflation, although the coefficient size and statistical significance are greater for BCC. The existence of significant information on future inflation in both surveys indicates that the differences between the surveys are not random noise. Their forecasts are different but informative.

We can partially reconcile the poor performance of the surveys during 1982-88 with the much stronger performance when the sample period is extended backwards even a few years if we examine the sources of inflation fluctuations in the two periods. The surveys do poorly in periods when the primary sources of variation in inflation are food and energy prices, factors which are volatile and difficult to anticipate. By contrast, the surveys do better when the variation in inflation is largely due to fundamental labor market and business cycle pressures. The inflationary cycles caused by such forces extend over longer periods, and survey respondents may be able to assimilate them to a greater degree than the shorter lasting fluctuations caused by food and energy prices. Extending the sample backwards to 1980 introduces additional cyclical fluctuation and may account for the superior forecasting performance of the survey in the longer samples. Since 1982, the standard deviation of the CPI excluding food and energy has been less than half that of the overall CPI; for the post-1980 period as a whole, this share jumps to more than 90 percent (Table 1, memo item).

Although the longer term forecasting performance of the surveys is good, the survey forecasts are not clearly "rational" in the economists' sense of efficiently incorporating all available information. The standard form of this rationality test is provided at the bottom of Table 2. Over the shorter period the data strongly reject rationality, a result which is not surprising since all the surveys were strongly biased with respect to actual inflation. Over the longer periods the tests are close to accepting the hypothesis of rationality; indeed, over the 1978-88 period the tests on the coefficients easily accept the hypothesis that MICH rationally predicts PCE inflation. However, the persistence of over- and underpredictions for lengthy periods suggests that the surveys do not incorporate all available information (Chart 1, panel C).[6] Thus, the surveys are somewhat forward looking and may be useful in forecasting inflation, but the pattern of prediction errors suggests that the surveys do not correspond to economists' conception of rationality.[7]

[6]More formally, because the surveys are forecasting twelve months ahead, the autocorrelations of the errors should disappear after a lag of eleven months. In fact, they persist at a level of around 0.2, indicating that not all available information is used in the surveys since a better forecast could be made using the forecast error of twelve months earlier. The persistence of the autocorrelation alone warrants rejection of the rationality hypothesis.

Inflation expectations and compensation growth

The poor record of surveys in predicting inflation in recent years does not necessarily mean that they contain no information about future economic developments. Inflation expectations enter importantly into many economic decisions. The key question is whether individuals act on their expressed beliefs when they make these decisions.

To explore this question, we consider the relationship between inflation expectations and nominal compensation growth. In theory, nominal compensation growth ought to be strongly influenced by expectations of future inflation, with workers factoring an inflation markup into their real wage bargains. In practice, most econometric models assume that the expectations process can be modeled reasonably well by a distributed lag on past inflation rates, or alternatively, that this distributed lag reflects workers' willingness to "catch up" with past inflationary movements rather than base their wages on a forecast of future inflation. This section examines whether the putative inflation expectations component of nominal compensation growth is entirely related to past inflation, or whether the survey inflation forecasts contain a discernible forward-looking component.

The underlying model which we use is very simple. Workers contract for the year ahead on the basis of current labor market conditions and their expectations of future inflation. For each time period, the surveys are entered first individually, then in pairs, and finally in combination with distributed lags on past CPI and PCE inflation as candidate representations of inflation expectations.[8] Each inflation expectations proxy is

[7]Prior researchers have reached varied conclusions on the rationality of the Michigan survey. For example, James S. Fackler and Brian Stanhouse in "Rationality of the Michigan Price Expectations Data," *Journal of Money, Credit and Banking*, vol. 9 (November 1977), pp. 662-66, argue on the basis of their coefficient estimates that MICH is rational, but they do not discuss autocorrelation in errors. Edward M. Gramlich in "Models of Inflation Expectations" rejects the rationality hypothesis.

[8]For example, in the 1982-89 period, thirteen proxies for inflation expectations are entered: (1) DMP, (2) MICH, (3) BCC, (4) CPI, (5) PCE, (6) MICH, CPI, (7) MICH, PCE, (8) BCC, CPI, (9) BCC, PCE, (10) MICH, DMP, (11) BCC, DMP, (12) DMP, CPI, (13) DMP, PCE. In the above listing PCE and CPI represent an eight-quarter second-order polynomial distributed lag on past PCE or CPI inflation with an endpoint constraint.

evaluated according to its ability to contribute to the prediction of compensation growth over a one- and four-period-ahead horizon We use two models of nominal compensation determination — a basic model relating compensation growth to the prime age male unemployment rate and to inflation expectations, and a more elaborate model (E-L) that has been found to fit well and have stable parameters over long periods of time [9]

Because there are three time periods, two forecast horizons, and two compensation models, twelve "horse races" are being run In all, we estimate 108 regression equations to determine which combination of surveys and distributed lags on past inflation best explains future compensation growth

The results point in a common direction Equations with MICH or a combination of MICH and a distributed lag on either PCE or CPI inflation have the highest explanatory power (as measured by adjusted R^2) in ten of the twelve "horse races" (Table 3) In the other two instances, a distributed lag on past CPI inflation proves superior, although the margin is small over MICH

In all instances MICH contributes to explaining compensation growth over a four-period horizon, but it is outperformed by a distributed lag on CPI inflation in two instances of forecasting compensation growth over a one-quarter horizon This finding is of interest because our regressions suggest that the four-quarter horizon provides more reliable results The standard errors for the four-quarter-ahead equations are much less than one-half the size of the standard errors of the one-quarter-ahead equations, indicating that some of the one-quarter-ahead error is offset within a year (Where compensation growth rates are annualized, errors that are random on a quarter-by-quarter basis should produce standard errors in the four-quarter-ahead compensation equation that are one-half the size of those for the one-quarter-ahead equation) Thus, the survey in all cases contributes to explaining more stable medium-term trends, even though it misses some near-term fluctuations

In the period since 1982, MICH has done particularly well relative to both the other surveys In no case did including DMP or BCC improve the fit of an equation

[9] The model and its properties are discussed in A Steven Englander and Cornelis A Los, "The Stability of the Phillips Curve and Its Implications for the 1980s," Federal Reserve Bank of New York, Research Paper no 8303, February 1983 The model includes as explanatory variables not only inflation expectations and the prime-age male unemployment rate, but also the growth in the civilian labor force, the share of unemployment benefits paid under extended benefits programs, and the positive change in the prime age male unemployment rate

Table 3

Inflation Expectations Proxies Showing the Best Fit over Alternative Time Periods, Specifications, and Forecast Horizons

Time Period	Specification	Forecast Horizon	Coefficients of Best Fitting Inflation Expectations Proxy	Equation Adjusted R^2	Equation Standard Error
1982-II to 1988-III	E-L	Four quarters	i) MICH = 0 50** ii) CPI = 0 33*†	0 59	0 48
1982-II to 1988-III	Basic	Four quarters	i) MICH = 0 45*	0 54	0 51
1982-II to 1989-II	E-L	One quarter	i) MICH = 0 73*	0 14	1 41
1982-II to 1989-II	Basic	One quarter	i) CPI = 0 57*†	0 19	1 37
1980-II to 1988-III	E-L	Four quarters	i) MICH = 0 55* ii) PCE = 0 23**†	0 90	0 56
1980-II to 1988-III	Basic	Four quarters	i) MICH = 0 56* ii) PCE = 0 21*†	0 90	0 54
1980-II to 1989-II	E-L	One quarter	i) MICH = 1 16*	0 66	1 39
1980-II to 1989-II	Basic	One quarter	i) CPI = 0 52*†	0 65	1 41
1978-I to 1988-III	E-L	Four quarters	i) MICH = 0 52* ii) PCE = 0 23*†	0 95	0 59
1978-I to 1988-III	Basic	Four quarters	i) MICH = 0 58* ii) PCE = 0 23*†	0 94	0 61
1978-I to 1989-II	E-L	One quarter	i) MICH = 0 34*** ii) CPI = 0 36*†	0 78	1 34
1978-I to 1989-II	Basic	One quarter	i) MICH = 0 35*** ii) CPI = 0 40*†	0 76	1 39

Note The basic specification includes the prime age male unemployment and inflation expectations as explanatory variables for compensation growth The E-L specification is discussed in Englander and Los, "The Stability of the Phillips Curve and Its Implications for the 1980s " The significance levels of the inflation expectations coefficients in equations with a four-quarter horizon are based on Chi-squared tests after the standard errors are corrected for a fourth-order moving average process and heteroskedasticity See Newey and West, "A Simple Positive Semi-Definite Heteroskedasticity and Autocorrelation Consistent Covariance Matrix "

†Sum of coefficients in an eight-month polynomial distributed lag on one-month growth in either the consumer price index or the personal consumption expenditures deflator with degree two and an endpoint constraint

*Significant at 1 percent

**Significant at 5 percent

***Significant at 10 percent

containing MICH Indeed, in all cases the adjusted R^2s fell and the standard errors rose At least since 1982, MICH has been the survey most useful for forecasting compensation growth

When the sample is extended back to 1978, the results again suggest that MICH embodies a substantial portion of inflation expectations. The estimated effect of MICH is always of the same magnitude as, or greater than, the estimated effects of past inflation, although the significance level is sometimes relatively low. Taken as a whole, the data suggest that the inflation expectations process relevant to compensation growth can be well represented by MICH alone or by a combination of MICH and a distributed lag on past inflation None of the other surveys, whether by itself or in combination with past inflation or another survey, provides any additional information beyond what is embedded in MICH and past inflation

Finally, it is informative to make a comparison between the compensation-forecasting and inflation-forecasting equations, although the four-quarter horizon of the former differs slightly from the twelve-month horizon of the latter. The standard errors of the four-quarter-ahead compensation equation range from about five-tenths to six-tenths of a percentage point By contrast, the standard errors of the inflation-forecasting equations in Table 2 varied from about one percentage point to two and four-tenths percentage points depending on the time period and dependent variable. The much greater precision of the one-year-ahead compensation projection relative to that of inflation indicates that shocks to prices over the forecast horizon are not likely to be complemented by shocks to compensation growth [10] Otherwise the magnitude of the forecast errors would be similar, given that inflation expectations affect compensation growth on close to a one-to-one basis The large difference in precision suggests that surprise inflation or disinflation mainly affects real compensation as opposed to nominal compensation That is, nominal compensation growth does not seem to change fast enough in response to inflation shocks to maintain real wage growth at expected levels

In sum, the significance of MICH in compensation determination and the tight fit of the relationship are reasons to take the household survey seriously, at least as a partial indicator of underlying inflation expectations Even when the survey provides a relatively poor guide to future inflation, as in the mid-1980s, it appears to represent the beliefs on which households act

[10] To test these conjectures formally, we would have to convert the twelve-month-ahead inflation forecasting equations of Table 2 into four-quarter-ahead forecasting equations and correlate the residuals across equations For the reasons mentioned in the text and the fact that the residuals in the inflation-forecasting equations are much more autocorrelated than in the compensation equations (Durbin-Watson statistics of about 0 1 to 0 5 as against 1 2 for the compensation equations), unexpected inflation does not appear to have similar effects on inflation and compensation within a given year

Inflation surveys and interest rates

This section analyzes the relationship of the inflation surveys and interest rates to determine which survey, if any, represents the inflation expectation underlying interest rate movements. The approach parallels that of the previous section in that the surveys alone and in combination with distributed lags on past inflation are entered into nominal interest rate equations. The inflation proxy that best explains contemporaneous interest rate movements — as before, in terms of highest adjusted R^2 and minimum standard errors — is judged the best representation of the underlying inflation expectation. (The question whether causation runs from the inflation expectations surveys to interest rates or the reverse is addressed in the next section.)

The result also parallels that of the previous section in that one inflation survey is found to be better related than the others to the variable in question. In this case, the best fitting survey is the DMP, by a moderate but consistent margin. Movements in the DMP inflation forecast are more closely aligned with movements in interest rates than are those of either BCC or MICH. More important in light of the results on compensation growth, MICH is poorly related to interest rates, with a coefficient that is often small and insignificant.

Our model of interest rate determination relates nominal interest rates to expected inflation and to past data on inflation and interest rates [11] It can be written as

$$R_t = a + b\,\Pi_t^e + c\,R_{t-1} + d\,\Pi_{t-1}^e,$$

where R is the nominal one-year Treasury bill rate, Π^e is the expectation of inflation, and t and t-1 are time subscripts. With specific restrictions on the coefficients, the equation can be made consistent with a variety of interest rate models. a simple Fisher equation, $b=1$, $c=d=0$, a rational expectations cum Fisher equation, $b=c=-d$, $a=0$; a modified Fisher equation in which real rates deviating from the equilibrium level gradually adjust back to that level, $b=1$, $c=d<1$, $a=(1-c)\cdot r$, where r is the equilibrium real rate of interest; real interest rates that follow a random walk, $b=1$, $a=0$,

[11] The model is a variant of a model estimated by James D Hamilton in "Uncovering Financial Market Expectations of Inflation," *Journal of Political Economy*, vol 93, no 6 (1985), pp 1224-41, and others We do not make the assumptions on the error structure that Hamilton uses to identify his model

$c=d=1$, partial adjustment of nominal rates to inflation expectations, $d=0$, $b+c=1$ or $b+c+d=1$, or more general sets of coefficient estimates To explore the possibility that survey inflation expectations do not adequately reflect the expectations contributing to interest rate determination, lagged values of past inflation are included in some of the estimated equations Such a loose specification has the advantage of being based only on observable nominal inflation and interest rates rather than conjectured real interest rates, while allowing for patterns of coefficient estimates consistent with a wide variety of models

The regression results support three conclusions First, the equations in which DMP is entered have lower standard error and higher adjusted R^2 than do similar equations with MICH and BCC (Table 4, column 1 as compared with columns 2 and 3, column 5 as compared with columns 6 and 7) The DMP coefficient is generally larger and more significant than the coefficients of MICH or BCC Second, even when the sample is extended back to 1978, the significance level of the coefficient on MICH remains low as compared to the levels observed for the other surveys over a shorter time period (Table 4, columns 9-12) Third, including a variety of lagged inflation terms does not greatly alter the significance or size of the DMP coefficient (Table 4, column 1 as compared with column 4, column 5 as compared with column 8) Nor does introducing the other surveys simultaneously with DMP significantly improve the fit of the equation or reduce the level and significance of the DMP coefficient [12] Finally, introducing a second lag of the dependent variable or correcting for autocorrelation to eliminate the moderate but

[12]All of the results discussed in this paragraph and the next are presented in greater detail in the working paper version of this article

Table 4

Inflation Expectations and Interest Rates†

Dependent Variable Yield on actively traded one-year Treasury issues adjusted to constant maturities

	March 1982-August 1989								February 1978-August 1989			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Inflation expectations measured by.	DMP	MICH	BCC	DMP	DMP	MICH	BCC	DMP	MICH	MICH	MICH	MICH
Coefficients·												
Intercept(a)	−0 31	0 08	−0 45	−0 43	−0 13	0 27	−0 47	−0 41	−0 15	0 12	0 18	0 21
	(−1 29)	(0 23)	(−1 41)	(−1 84)	(−0 54)	(0 77)	(−1 47)	(−1 71)	(−0 43)	(0 35)	(0 69)	(0 60)
Inflation survey(b)	0 46	0 15	0 43	0 53	0 58	0 19	0 18	0 56	0 11	0 16	0 21	0 21
	(5 13)	(1 66)	(3 77)	(5 67)	(3 55)	(1 84)	(0 91)	(3 52)	(1 82)	(2 60)	(2 62)	(2 63)
Lagged interest rate(c)	0 82	0 92	0 84	0 83	0 83	0 92	0 80	0 83	0 92	0 90	0 93	0 90
	(22 41)	(27 32)	(21 35)	(20 07)	(19 98)	(30 45)	(19 69)	(19 05)	(27 85)	(25 90)	(34 66)	(25 91)
Lagged inflation(d)	−0 11	−0 04	−0 05	0 21					−0 06	0 05	−0 12	
	(−2 21)	(−0 65)	(−1 08)	(1 99)					(−0 14)	(0 33)	(−1 50)	
Lagged survey(d')					−0 25	−0 11	0 29	−0 46				−0 09
					(−1 41)	(−1 01)	(1 35)	(−0 25)				(−0 99)
Distributed lag on past inflation(e)‡				−0 40				−0 19		0 08		0 00
				(−3 40)				(−3 21)		(0 42)		(0 02)
DW	1 39	1 29	1 47	1 60	1 34	1 30	1 29	1 52	1 30	1 32	1 35	0 93
SEE	0 39	0 44	0 42	0 37	0 40	0 44	0 41	0 38	0 76	0 75	0 76	0 75
ADJ R**2	0 96	0 95	0 96	0 97	0 96	0 95	0 96	0 95	0 92	0 92	0 92	0 92

Note T-statistics in parentheses

†Equations $R_t = a+b \cdot survey + c \ R_{t-1} + d \ CPI12_{t-1} + e$ lagged inflation, and $R_t = a + b \cdot survey + c \cdot R_{t-1} + d' \cdot survey_{t-1} + e \cdot$ lagged inflation, where CPI12 is the twelve-month growth in the consumer price index and the lagged inflation term is the eighteen-month polynomial distributed lag on one-month annualized growth in the consumer price index with degree two and an endpoint constraint

persistent autocorrelation indicated by the low Durbin-Watson statistics barely alters the results Taken together, these results support the view that the DMP and, possibly to a lesser extent, BCC inflation forecasts contribute to the inflation expectations underlying interest rates

Variations on the basic regression equations produce essentially the same results In estimating the same relationships for interest rates with maturities of three and six months, one finds that both the size of the coefficients and their significance increase as the maturities lengthen The fact that the surveys uniformly contain more information for one-year Treasury bill rates than for shorter maturities suggests that respondents are correctly identifying their inflation rate expectation over that time and not just responding to short-term fluctuations Also, if one estimates equations for the change in interest rates (by constraining the coefficient of the lagged interest rate variable to equal one), the qualitative results do not change

The form of rational expectations embodied in the Fisher equation would demand that the effects of higher inflation be passed through to interest rates on a one-for-one basis This hypothesis is examined either directly or indirectly in most tests of rationality relating interest rates to inflation expectations The regression results show plausible estimates of the various coefficients but reject the coefficient of one on inflation expectations. Such tests implicitly assume that tax-induced distortions in the cost of borrowing or return to lending are insignificant or exactly offset each other, or that marginal borrowers and lenders are nontaxable As neither theoretical nor empirical analysis seems to support these hypotheses, it is not appropriate to make the hypothesis of rationality depend critically on a coefficient of uncertain theoretical magnitude [13]

Do financial market participants base their forecasts on interest rates?

Thus far we have assumed that financial market respondents hold independent views of inflation, which they then translate into interest rates An alternative assumption is that financial market participants, when questioned about inflation, take their cues from current interest rates When they observe a rise in rates, they may be inclined to attribute it to a rise in inflation expectations, whether or not expectations have in fact risen In this case, the interpretation of the empirical results would have to be substantially revised, because the causality would be reversed The reported inflation expectations would not determine interest rates. Rather, survey respondents would be formulating their stated expectations largely in response to current interest rates If this interpretation were correct, it would not be possible to base any inferences on the estimated relationships that use the inflation surveys While such a possibility seems very unlikely in the case of the household survey, it is more plausible in the case of DMP and, to a lesser extent, BCC The composition of the response groups suggests that all of the participants in DMP and many in BCC would pay careful attention to interest rates [14]

Several factors, however, support the interpretation that the surveys reflect actual inflation expectations First, the survey forecasts are highly correlated with past inflation, and the financial market forecasts are more highly correlated with past inflation than is the household forecast It may not be a good forecasting methodology for financial market participants to base their inflation forecasts on past inflation to this degree, but it is a plausible one

Second, the correlation of the inflation expectations survey and inflation is actually higher between the current survey and future (two-months-ahead) interest rates than between the current survey and current interest rates This relationship is true of BCC as well [15] More formally, DMP appears to Granger cause one-year Treasury bill rates (significance level 0 02), while Treasury bill rates do not Granger cause DMP (significance level 0 35) [16] If anything, interest rates appear to react to inflation expectations with a short lag

Finally, the characteristics of the survey forecasts match those of inflation much more closely than those of interest rates The variances of the inflation forecasts are quite close to the variance of inflation over the forecast horizon and much lower than the variance of interest rates If survey inflation expectations were derived by subtracting a relatively stable expected real interest rate from observed nominal interest rates, the variances of survey inflation expectations would more closely match the variance of interest rates Hence, our findings support the view that the inflation expectations

[13] See, for example, Lawrence H Summers, "The Nonadjustment of Nominal Interest Rates A Study of the Fisher Effect," in James Tobin, ed , *Macroeconomics, Prices and Quantities* (Washington, D C Brookings Institution, 1983)

[14] In the earlier sections, the issue of causality was not central because the surveys were being used to predict *future* compensation growth and inflation

[15] Over the sample available for all of the surveys, the correlation of the current one-year Treasury bill rate with DMP is 0 87, with BCC, 0 86, and with the Michigan survey, 0 66 For DMP and BCC the interest rate correlation is maximized with a two-month lead on interest rates, at 0 90 and 0 89, respectively The correlation between the Michigan survey and future interest rates is scarcely changed

[16] Four lags of each variable are included Even with DMP lagged two months, it still Granger causes one-year Treasury bill rates

surveys contain information independent of contemporaneously observed interest rates.

Assessing the differences in inflation expectations

The regression results indicate strongly that MICH is the inflation expectation relevant to future compensation growth, while DMP is the inflation expectation most relevant to interest rates. In theory, such differences of opinion should not exist — households and financial market participants have access to much the same economic data from which to form a view of future inflation trends. Nevertheless, it is inherently plausible that the survey of households would be most correlated with labor market developments and the survey of financial market participants most correlated with interest rates movements By small but persistent margins, expectations in labor and financial markets are shown to be most relevant to the determination of relative prices in these markets

To be sure, recognition of the existence and significance of such differences in expectations should not lead to an overstatement of their ongoing importance. The mean difference between the MICH and DMP surveys since 1982 is about three-tenths of a percentage point and the root mean squared difference about seven-tenths of one percentage point. Since the early 1980s, the range of forecasts has narrowed in line with the stabilization of actual inflation rates, as Chart 1 demonstrated Consequently, in recent years differences in household and financial market inflations expectations have led to different perceptions of real interest rates and real compensation growth only for limited periods. The gaps are likely to return to economically significant levels consistently only if the inflation outlook becomes more uncertain.

Conclusions

Surveys of inflation expectations contain useful information about future inflation on average, but they have proved to be unreliable in recent years. Even if the respondents' expectations are not realized, however, the surveys contain important information Correct or incorrect, the survey expectations appear to reflect the respondents' underlying beliefs about inflation, beliefs which contribute to nominal compensation growth and interest rate determination In other words, individuals appear to act on their stated beliefs, even when those beliefs are wrong

One of our major findings is that different groups act on different inflation expectations. The household survey contains significantly more information on future compensation developments than does the survey of financial market participants. The financial markets survey, by contrast, reveals much more about interest rates than does the household survey.

The differences in inflation expectations at particular times suggest that financial markets and households may have divergent views of the tightness of monetary policy and the real costs and returns to borrowing and saving. Differing perceptions of inflation premia may affect the behavior of both savers and investors To the extent that incorrect forecasts of accelerating or decelerating inflation affect interest rates and compensation growth, these forecasts may contribute unforeseen contractionary or expansionary impulses to the economy Somewhat paradoxically, the inflation surveys ought to be regarded as reliable indicators of the underlying beliefs of respondents but should be used cautiously as a guide to future inflationary trends

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