

**Examining the Credibility of Inflation Forecasts:
An Application of Cointegration Techniques**

Dipak Ghosh
Department of Accounting and Computer Information Systems
Box 4057
School of Business
Emporia State University
Emporia, KS 66801
USA

And

Swarna D. Dutt *
Department of Economics
Richards College of Business
State University of West Georgia
Carrollton, GA 30135
USA

*** Corresponding Author**

Abstract

In this study we examine the credibility of US inflation forecasts using the ASA-NBER survey data. A standard theoretical model of efficient/unbiased expectations is tested using actual and one year ahead inflation forecasts. Our nonstationarity tests confirm the presence of a single unit root in the levels of the series under consideration, paving the way for an application of cointegration techniques. The efficiency model is divided into weak form (cointegration) and strong form (cointegration and parameter restriction) tests. We use the “null of cointegration” approach to test for the presence of cointegration. Our results indicate that inflation expectations at the one year horizon are weak and strong form efficient.

1. Introduction

An integral part of formulating policy is accurate, credible and reliable forecasts of the major macroeconomic variables, and inflation forecasts rank at the top in terms of practical importance. Inflation expectations are an important part of the economic decision making process in the labor, product and financial markets. “Labor unions need inflation forecasts to help refine their wage demands, and firms planning for future expenses and expected revenues need to account for expected inflation. Government budget-making has perhaps an even greater need for accurate forecasts of inflation, given that Social Security payments are directly linked with the inflation rate measured by the CPI.”¹ Expected inflation will have an impact on the real interest rate and therefore on business investment. It will also have an impact on international capital investment (whether to invest at home or abroad) and therefore on exchange rates. It is an integral part of capital accumulation and savings decisions by households.

Forecasts of inflation (and any macroeconomic variable) can be obtained using a variety of methods. Econometric models, both structural and time-series, are widely used. In addition, survey data may also be used as a method of forecasting inflation. Since survey data involves the use of professional judgement (by the survey participants), one major criticism of surveys is the incentive to give accurate information, since the professional who is being surveyed does not have anything at stake. Particular surveys like the “Survey of Professional Forecasters” (whose data we use in this paper) do address this issue to some extent, though not entirely. Even with the drawback of surveys, they are, perhaps, the best way of directly measuring the forecasts of professionals (individuals who forecast for a living), and therefore provide an alternative to complex econometric models which may be time consuming and resource intensive.

Given the importance of forecasts, it is important to test the information contained in the forecasts. An examination of the credibility of major macroeconomic forecasts seems justified before they are actually put to use. Over the last two decades considerable research has been done on the reliability of the different inflation expectation surveys like the Decision Makers Poll, Blue Chip Consensus, Michigan Household Survey, Livingstone Survey, Money Market Survey, ASA-NBER Survey etc., but the results are far from unanimous.² Thomas and Grant (2000) have found that survey forecasts are approximately as good as structural models in forecasting inflation. Baghestani (1992) rejects the rational expectations hypothesis using survey data. Englander and Stone (1989, pg 22) find that “Surveys of inflation expectations contain useful information about future inflation on average, but they have proved to be unreliable in recent years, with substantial errors in all the surveys and especially in the DMP survey. Even if expectations are not realized, however, the surveys contain important information.” Cheung and Chinn (1999, pg 1) point out that “...given the weight placed by professional traders and policy makers on such judgement-based forecasts, it is important to know exactly what information is contained within these forecasts.”

Thus, given the widespread use and the increasing popularity of surveys of macroeconomic variables, we feel that a study of the accuracy and credibility of these surveys is essential, and that is what we propose to do in this paper. We will use data from the ASA-NBER survey. Cheung and Chinn (1999) also test for rationality in survey data, but they use the Johansen cointegration methodology to do so. Our single equation Hansen (1992) methodology not only allows us to test for cointegration, but also makes it easier for us to test for parameter restrictions, and also allows us to test for structural breaks in the model.³ We test for efficiency

through a sequential application of weak and strong form tests of unbiasedness, the former being a precondition to the latter.

This study is divided into six sections. In section two we briefly discuss the ASA-NBER data set, and in section three we outline the theoretical model. Section four discusses the unit root tests of the series under consideration, and section five is the application of the “null of cointegration” procedure to our data set. Section 6 contains our concluding remarks.

2. The ASA-NBER Data Set

The use of survey data such as the ASA-NBER data set is particularly suitable for examining market expectations since it provides us with a method of quantitatively estimating the market’s expectations. It includes a large number of major macroeconomic variables and has been continuously collected from 1968 (4th quarter) till date. It includes professional forecasts from business, finance, government and academics. We use quarterly data for actual inflation next year (S_{t+1}) and one year (S_{t+1}^e) ahead forecasts of expected inflation from 1981 (3rd quarter) - 2001 (4th quarter).⁽⁴⁾ For example, the actual inflation for 1st quarter of 1990 is matched with the forecast for inflation in the 1st quarter of 1990 which was made in the 1st quarter of 1989 (hence the use of the term “one year ahead forecast”).

This data set is subject to the same criticism as all other survey data sets, i.e., since the forecasters do not have anything at stake, they have no incentive to make accurate forecasts. However, this survey is anonymous, and this would increase the probability that they would express their true forecasts, since they will not be penalized for any mistakes. The anonymity also ensures that individuals do not necessarily have to agree with the official forecasts of their

employers. There is less pressure on individuals to go along with the market consensus due to the anonymity, and they can express their true opinions. Even though these factors will not necessarily outweigh the drawback of the absence of any consequences for poor forecasts, they do suggest that we cannot necessarily conclude, a priori, that survey forecasts are inaccurate. This should be judged based on econometric tests, which we perform in the following sections.

3. Weak and Strong Form Tests of Efficient Expectations

In this section we will examine the unbiasedness and efficiency of the experts' expectations formation process. This is weaker than rationality since it does not require the expectation process to match the stochastic process generating the actual series. It only requires the spot rate series to be cointegrated with the year ahead forecast and for the cointegrating regression to obey the necessary parameter restrictions and explained below. A standard expectation efficiency test consists of first estimating the model:

$$S_{t+k} = \beta_0 + \beta_1 s_{t+k}^e + u_{t+k} \quad \mathbf{1}$$

where s_{t+k} and s_{t+k}^e are the actual and expected inflation series k years ahead. In our data set $k=1$, which means that we consider the actual inflation one year from today (in period $t+1$) and the current expectation of inflation one year from today (inflation forecast for period $t+1$ made in period t). We assume that the error term u_t has mean 0, then a test of efficiency would first involve estimating equation (1), and then testing the error term for stationarity. A stationary error structure would imply that the actual spot rate and the experts' expectations move together over time. This is a necessary condition (weak form test) of efficient expectations. It is also a pre-condition to the strong form test of efficiency which is a test of the joint hypothesis of

coefficient restrictions $(\beta_0, \beta_1) = (0,1)$. McFarland et al. (1994) have tested for the market efficiency / unbiasedness hypothesis in foreign exchange markets using a similar set up. Cointegration was upheld for their entire sample of currencies, but the coefficient restrictions (the strong form model) was valid for less than half of the currencies. We use the null of cointegration approach to testing for the weak form of efficiency, as this is a necessary condition for the existence of the strong form of efficiency

4. Tests of Nonstationarity

A necessary condition for cointegration is the presence of nonstationarity (unit roots) in the variables. The augmented Dickey-Fuller (DF 1979, 1981), and the Phillips-Perron (PP 1988) tests are the most widely used in the literature. However, both these tests use the null hypothesis of unit roots (and the alternate hypothesis of stationarity). As Kwiatkowski et. al. (KPSS 1992) point out, the null hypothesis will not be rejected unless there is strong evidence against it. Even when the roots are near unity (but not exactly equal to one), the augmented Dickey-Fuller and the Phillips-Perron tests would indicate the presence of unit roots, even though in reality the roots are less than one. Therefore KPSS point out that a more appropriate procedure would be to formulate a test with a null hypothesis of stationarity (and an alternate hypothesis of an unit root). The alternate hypothesis of an unit root would not be accepted unless there is strong evidence against the null hypothesis of stationarity, and this procedure would also result in the acceptance of the null hypothesis of stationarity when the roots are near unity (which is an appropriate conclusion).

Therefore, we use the KPSS (1992) procedure to test for the presence of unit roots in our

data. The test statistic η_τ and η_μ in table 1 is the null of stationarity with and without a time trend respectively. Since in each case the test statistic is greater than the critical value, we reject the null of stationarity in favor of the alternative of unit roots for all the spot and forecasts series. ⁽⁵⁾

Table 1: Unit root tests KPSS test			
	Current Inflation	One year ahead Forecast	Critical Value
η_t	0.1545	0.1723	0.146
η_u	0.5635	2.9655	0.463

5. Weak and Strong Form Tests: Null of Cointegration Approach ⁽⁶⁾

Instead of using a VAR method for testing for cointegration, we propose to use the single equation method described in Hansen (1992). While the Johansen-Juselius VAR method has been widely used in the literature, a single equation method allows us to test for cointegration and parameter restrictions, and also for model stability over time. Cheung and Chinn (1999) examine the ASA-NBER data set also for cointegration, but they use the Johansen-Juselius method, and they do not examine the issue of stability of the model over time. This is an important issue due to the various changes and external shocks that have occurred during our sample period.

The Hansen (1992) procedure involves the estimation of equation 1 using the PH (1990) FM-OLS procedure, and then testing the residuals for nonstationarity using a null hypothesis of stationarity. Stationary residuals would imply that the actual inflation and the expected inflation

series are cointegrated. As explained in section 3, testing a series for stationarity yields more powerful results when we use a null hypothesis of stationarity. This therefore implies that we are using a null hypothesis of cointegration.. The test has a further advantage of allowing us to test for parameter stability over time.

The Hansen (1992) procedure is briefly described below:

$$y_t = A_t \chi_t + \Phi_t \tag{2}$$

The null hypothesis here is that A_1 in eq. (2) which is similar to eq. (1) is constant. The three test statistics specified here are Sup F, Mean F and L_c . The Sup F and the Mean F, statistics test the stability of the model over time. L_c is a test of cointegration of the two nonstationary variables. For cointegration to be present the model must be stable (SupF and MeanF must be insignificant) and L_c must also be insignificant. The results are in table 2.

Hansen Test		
Actual & F1Y	Test Statistic	Critical Value
Lc	0.1602 (0.2000)	p < 0.05
Mean F	2.1609 (0.2000)	p < 0.05
Sup F	8.6994 (0.2000)	p < 0.05
<p>Notes: Tabulated p-values in parentheses. Since all p-values are greater than 0.05, the model is stable. For Lc, p<0.05, thus spot rate (SR) and one year ahead forecast (F1Y) series are not cointegrated. SR and F1Y: is the cointegration regression between the spot and 1 year forecast series.</p>		

Since $p > 0.05$ for the Mean F and Sup F statistics, the model is stable over time. Since the L_c statistic is also insignificant ($p > 0.05$), the null hypothesis of series cointegration is accepted, and so is weak form efficiency.

A test of strong form efficiency would involve estimating the parameters from the cointegrating regression (equation 1) and testing the restriction that (β_0, β_1) is equal to $(0,1)$. The parameter estimates from the Hansen procedure are given in table 3.

	Parameter Value	T-statistic	
β_0	-0.7409	0.2188	
β_1	1.0518	-0.7924	
Chi-Square Statistic	3.7942		

β_0 is the constant and β_1 is the slope coefficient in equation 1. The t-statistic for β_0 tests whether β_0 is significantly different from 0, and the t-statistic for β_1 tests whether β_1 is significantly different from 1. The Chi-Square statistic tests whether (β_0, β_1) is jointly equal to $(0,1)$. The 5% critical value for the Chi-square statistic is 5.99, and the 1% critical value is 9.21.

The t-statistic for β_0 indicates that the constant term is insignificantly different from zero, and, and the t-statistic for β_1 indicates that β_1 is insignificantly different from 1. The Chi-Square statistic tests whether (β_0, β_1) is jointly equal to $(0,1)$. Since the Chi-square statistic is insignificant, we cannot reject the joint hypothesis that (β_0, β_1) is jointly equal to $(0,1)$. As a result of both individual and joint tests, we may conclude that (β_0, β_1) are equal to $(0,1)$.

Since the actual value of the one-year ahead inflation and the expected value are cointegrated and follow the necessary parameter restrictions, we can conclude that the expected future inflation rate is an unbiased and therefore efficient estimator of the actual inflation rate. This is also referred to as a “consistent” estimator by Cheung and Chinn (1999, pg 1) who also get

results similar to ours from the same data set.

The fact that the expected inflation is an unbiased and efficient estimator of the actual inflation indicates that new information is assimilated rapidly by financial markets. This is not surprising since the development of technology has made it possible for information to spread rapidly, and also for traders in various financial markets to react rapidly to any new information. This would imply, for instance, that bond traders with superior models would not be able to make abnormal profits.⁷

Our finding that inflation expectations are unbiased and efficient estimators of the future inflation rate does have some important implications. The first one is that the ASA-NBER survey does indeed provide credible forecast of the future inflation rate. This means that this survey data can be used for formulating policy. Labor unions can determine what the appropriate wage demand would be, indexed for inflation. The government can get an accurate estimate of future social security payments, since these payments are indexed for inflation. This is particularly important right now, given the concern over the viability of the social security trust fund. An accurate forecast of inflation will allow firms to calculate the cost of borrowings (by giving them an accurate estimate of the real interest rate). Moreover, the ASA-NBER data set contains forecasts of other macroeconomic variables too. Our result that the forecasts of inflation are credible, along with the results of Cheung and Chinn (1999) that the forecasts of other macroeconomic variables are credible would imply that business and the government could consider these survey forecasts in planning for the future. The impact of programs like the tax cut plan approved by Congress last year, and signed into legislation by President Bush, could be analyzed with a reasonable degree of accuracy.

6. Conclusion

Expected inflation is an important input in economic decision making, starting from savings and investment to production and resource allocation. The ASA-NBER quarterly surveys are used here to examine the efficiency of inflation forecasts. They are conclusively weak and strong form efficient since the spot and the one year ahead forecasts are cointegrated and also obey the necessary parameter restrictions. This is in line with the results of Cheung and Chinn (1999) and Baghestani (1992). This implies that surveys of professionals do yield accurate forecasts of macroeconomic variables, which can be used by businesses and governments to formulate economic policy.

An implication of this result is that policy makers may not have to spend the time and resources to come up with a complex econometric model to forecast inflation (and probably other macroeconomic variables). Use of surveys of professionals will yield reasonably accurate forecasts, which can be used by businesses and governments to formulate economic policy.⁸

References

- Baghestani, Hamid, (1992), "Survey Evidence on the Muthian Rationality of the Inflation Forecasts of US Consumers," *Oxford Bulletin of Economics and Statistics*, 54, 2, 173-186.
- Cheung, Yin-Wong, and Chinn, Menzie D., (1999) "Are Macroeconomic Forecasts Informative? Cointegration Evidence From the ASA-NBER Surveys," *NBER Working Paper Series*, Working Paper 6926, 1-24.
- Dickey, D.A. and Fuller, W.A. (1979) "Distribution of the Estimators for Autoregressive Time Series with a Unit Root," *Journal of American Statistical Association* 74, 427-31.
- , (1981) "Likelihood Ratio Statistics for Autoregressive Time Series With a Unit Root," *Econometrica*, 49, 1057-1072.
- Englander, Steven, and Stone, Gary, (1989) "Inflation Expectations Surveys as Predictors of Inflation and Behavior in Financial markets," Federal Reserve Bank of New York Research Paper No. 8918.
- Hansen, B. (1992), "Tests for the Parameter Instability in Regressions With I(1) Processes," *Journal of Business and Economic Statistics*, 10, 321-35.
- Johansen, Soren, and Juselius, K. (1990), "Maximum Likelihood Estimation and Inference on Cointegration - With Applications to the Demand for Money," *Oxford Bulletin of Economics and Statistics* 52, 169-210.
- Kwiatkowski, D., Phillips, P.C.B., Schmidt, P and Shin, Y. (1992), "Testing the Null Hypothesis of Stationarity Against the Alternative of a Unit Root, *Journal of Econometrics*, 54, 159-78.
- McFarland, J.W., McMahan, P.C. and Ngama, Y. (1995), "Forward Exchange Rates and Expectations during the 1920's: A Reexamination of the Evidence," *Journal of International Money and Finance*, 13, 627-36.
- Phillips, P.C.B. and Hansen, B.E. (1990), "Statistical Inference in Instrumental Variables Regression With I(1) Processes," *The Review of Economic Studies*, 57, 99-125.
- , and Perron, P. (1988), "Testing for a Unit Root in Time Series Regression," *Biometrika*, 75, 335- 46.
- Tallman, Ellis W., (1995), "Inflation and Inflation Forecasting: An Introduction," *Federal Reserve Bank of Atlanta Economic Review*, 80, 2, 13-27.
- Thomas, Lloyd B, and Grant, Alan P., (2000), "Forecasting Inflation --- Surveys Versus Other Forecasts," *Business Economics*, 35, 3, 9-18.

Notes

- 1) Tallman (1995), pg 13-14.
- 2) The work done in this area includes Thomas and Grant (2000), Cheung and Chinn (1999), Baghestani (1992), Englander and Stone (1989).
- 3) This was suggested by an anonymous referee.
- 4) Though most forecasts of macroeconomic variables are available from 1968 onwards, the CPI series was collected from 1981. The quarterly forecasts were obtained from the *Survey of Professional Forecasters* data set available on the web-site of the Federal Reserve Bank of Philadelphia. This survey was started in 1968 by the American Statistical Association and the National Bureau of Economic Research (ASA-NBER), and continued by the Federal Reserve Bank of Philadelphia from 1990. The actual inflation rate was obtained from the website of the Bureau of Economic Analysis.
- 5) We do not detail the tests since they are quite commonplace today. The results from the Augmented Dickey-Fuller and Phillips-Perron tests are available from the authors on request. These results are not mentioned in the paper due to reasons given in Section 3.
- 6) We do not detail any of the empirical tests as they are publicly available.
- 7) The authors would like to thank an anonymous referee for pointing this out.
- 8) An anonymous referee pointed out that we cannot be sure that the professionals are not influenced by the government's model-based forecasts, and therefore if the government stopped forecasting with the intention of using the survey forecast, this action might have an impact on the forecasts. There is perhaps no way we can be absolutely certain exactly what factors the professionals consider in coming up with their forecasts (the professionals cannot be asked since the surveys are anonymous). Even if the professionals are influenced by the government's forecasts, the surveys will still be useful to private industry.