Is it Really the Fisher Effect?

Paul A. Johnson*
Department of Economics
Vassar College
Poughkeepsie NY 12604

March 2005

Many researchers have used a cointegration approach to test for the Fisher effect. This note argues that the cointegration of the nominal interest rate and the inflation rate is consistent with any theory implying a stationary *ex post* real interest rate and so is not a sufficient condition for the Fisher effect to hold. The sufficient condition is the unpredictability of the inflation forecast error implied by the nominal interest rate and this condition may be tested using the signal extraction framework of Durlauf and Hall (1988, 1989).

JEL Classification: E43

Keywords: cointegration, Fisher effect, signal extraction

*Department of Economics, Vassar College, Poughkeepsie NY 12604-0708. Email: pajohnson@vassar.edu. Telephone: 845-437-7395. Fax: 845-437-7576. I thank Márcio Garcia, Christopher Kilby, Joy Lei and a referee for comments on an earlier draft. Lisa Wong and Ilian Georgiev provided efficient research assistance. Financial support from the Salmon Fund at Vassar College is gratefully acknowledged. All errors are mine.

A series of articles in this and its companion journals, including Atkins (1989), MacDonald and Murphy (1989), Bonham (1991), Moazzami (1991), Dutt and Ghosh (1995), Daniels, Nourzad and Toutkoushian (1996), Lee, Clark and Ahn (1998), Carneiro, Divino and Rocha (2002), and, Granville and Mallick (2004), have attempted to examine the role of the Fisher effect in determining nominal interest rates by testing for cointegration between nominal interest rates and inflation rates.[1] The broad conclusion from these studies seems to be that evidence of cointegration can be found using data over long time periods, especially if both the rising inflation periods of the 1960s and 1970s as well as the declining inflation periods of the 1980s and 1990s are included.[2] In this note I explain why the finding of cointegration between nominal interest rates and inflation rates is largely uninformative about the existence of the Fisher effect. I then describe an alternative approach that examines all testable implications of Fisher's theory and report the results of applications of that approach.

Let i_t be the time t one-period-ahead nominal interest rate and π_{t+1} be the inflation rate between periods t and $t+1$. Assume that both i_t and π_{t+1} obey stochastic processes that are integrated of order one. An obvious candidate cointegrating vector is $(1, -1)$ as this linear combination of i_t and π_{t+1} is the *ex post* real interest rate $r_t = i_t - \pi_{t+1}$. Conventional growth theory shows that long-run real interest rates are determined in the steady state of the economy and so the stationarity of r_t has no implications for the veracity of the Fisher effect. That

---

[1]Examples from other journals include Mishkin (1992), Wallace and Warner (1993), Mishkin and Simon (1995), Peláez (1995), Crowder and Hoffman (1996), Crowder (1997), Koustas and Serletis (1999), and, Fahmy and Kandil (2003).

[2]Using data sets ending in 1986, from the US, Belgium, Canada, and the UK, MacDonald and Murphy (1989) find little evidence that inflation rates and nominal interest rates are cointegrated. Employing subsequent advances in the econometrics of cointegrated time series, Dutt and Ghosh (1995) confirm this finding for the Canadian case. Bonham (1991) extends the work of MacDonald and Murphy (1989) by allowing for the possibility of an integrated *ex ante* real interest rate. He does so by proxying for the *ex ante* real interest rate using Huizinga and Mishkin's (1986) expected real interest rate variable and the earnings/price ratio, finding that both of these proxies and the inflation and nominal interest rates are cointegrated. Using quarterly US data from 1957 to 1992, Daniels, Nourzad, and Toutkoushian (1996) find that inflation rates and nominal interest rates are cointegrated. They also find that there is a long-run, one-to-one relationship between the two variables with unidirectional causality from the former to the latter. These results are consistent with those of Lee, Clark, and Anh (1998) who use Mishkin's (1992) monthly data set, which ends in December 1990. Using data from the UK over the last century, Granville and Mallick (2004) find evidence that the inflation rate is not integrated while the nominal interest rate is integrated of order one. Nonetheless, they find that a linear combination of the two variables is not integrated which they interpret as evidence in favor of the Fisher hypothesis.

stationarity is consistent with a host of theories of nominal interest rate behavior and therefore can, at most, be a necessary condition for the Fisher effect to hold.[3] Moreover, there can be just one cointegrating vector here, so the existence of any other stationary linear combination of i_t and π_{t+1} implies that r_t is not stationary – a possibility inconsistent with the idea of long-run real interest rates being determined in the steady state of the economy. Similarly, Rose (1988) argues that the finding of a unit root in the real interest rate process is inconsistent with the consumption CAPM.[4] An intregrated real interest rate is also inconsistent with Cochrane (1991)'s argument that interest rates are "almost certainly" not integrated because, if they are, the observed similarity in the values of interest rates now and in the distant past is an extremely low probability event.[5] Thus, if inflation and nominal interest rates are integrated, the Fisher effect implies, but is not implied by, their cointegration. Of course, if inflation and nominal interest rates are not integrated, no linear combination of i_t and π_{t+1}, including the real interest rate, is integrated. In either case, a finding of a stationary real interest rate is largely uninformative.

The sufficient condition for the Fisher effect to hold is that nominal interest rates embody an optimal inflation forecast – a condition that can be tested using the signal extraction approach for testing expectations-based models described in Durlauf and Hall (1988, 1989). To apply the Durlauf and Hall approach, note that the time t one-period-ahead nominal interest rate predicted by the rational expectations variant of Fisher's theory of interest, i_t^*, is given by $i_t^* \equiv \rho_t + E_t\pi_{t+1}$ where ρ_t is the one-period-ahead *ex ante* real interest rate at time t and $E_t\pi_{t+1}$ is the expectation of π_{t+1} conditional on information available at time t, Φ_t. The difference between i_t^* and the observed nominal interest rate, i_t, is the specification error in Fisher's theory given by $N_t \equiv i_t - i_t^*$. Durlauf and Hall refer to this error as "model noise" and show that all testable implications of Fisher's theory can be expressed as the hypothesis that $N_t = 0$.[6] Using the

---

[3]Miron (1991) makes the same point in the context of testing the expectations theory of the term structure.
[4]See also Rapach and Weber (2004).
[5]Cochrane's view alone renders the results of cointegration tests of the Fisher effect meaningless as, absent integration, the concept of cointegration is vacuous. I confess that Johnson (1994b) also tests the integration and cointegration properties of interest rate data but I do not further discuss the issue here.
[6]As i_t^* is the risk-free rate in the version of Fisher's theory discussed here so any role played by risk aversion in determining i_t will be reflected in the model noise.

definition of i_t^*, the model noise can be written as $N_t = i_t - \rho_t - E_t\pi_{t+1} = i_t - \rho_t - \pi_{t+1} + \epsilon_{t+1}$, where $\epsilon_{t+1} \equiv \pi_{t+1} - E_t\pi_{t+1}$ is the inflation forecast error satisfying $E_t\epsilon_{t+1} = 0$ by construction. The *ex post* real interest rate, $r_t = i_t - \pi_{t+1}$, can then be written as $r_t = \rho_t + N_t - \epsilon_{t+1}$. Under the maintained hypothesis that ρ_t is constant, and assuming that the time-series properties of r_t and X_t are such that the projection is well defined, Fisher's theory can be tested by projecting r_t onto any $X_t \subset \Phi_t$ containing a constant. Conditional on the choice of X_t, the variance of this projection can be shown to be the tightest possible lower bound on that of N_t.[7] The ratio of the variance of the projection to the variance of r_t is the R^2 from the regression of r_t on X_t and a test of Fisher's theory is thus given by the usual test of the hypothesis that $R^2 = 0$ in that regression. Moreover, the economic importance of any rejections may be gauged by the magnitude of R^2 as a small, but statistically significant value of R^2, while implying rejection of the theory, suggests that it is a close approximation to reality.

Garcia (1993) applies this approach to Brazilian data for the period 1973–1990 and, finding little model noise, concludes that the Fisher effect describes the data reasonably well. Johnson (1994a) applies the approach to monthly US data and finds that, while the Fisher's theory can be formally rejected, over the period 1953:01 to 1979:10 it provides a reasonably good description of interest rate behavior. The quality of this description after 1979:10 appears much worse but the small sample sizes prevent definitive conclusions. Johnson and Garcia (2000) relax the assumption of a constant *ex ante* real interest rate and test Fisher's theory after removing an estimate of ρ_t from the data.[8] They conclude that the 90-day US T-Bill rate over the period 1951:Q4 to 1991:Q4 "... can be well described as the sum of a rational forecast of inflation and an infrequently changing *ex ante* real interest rate" (p. 176).

By writing the *ex post* real interest rate as $r_t = \rho_t + N_t - \epsilon_{t+1}$ and maintaining the hypothesis of a constant *ex ante* real interest rate, $\rho_t = \rho$, the result that all testable implications of

---

[7]Durlauf and Hall (1988, 1989) show that all other linear tests are special cases of this approach. Garcia (1993) and Johnson (1994a) demonstrate this proposition for some of the tests of Fisher's theory in the literature by reinterpreting them in the signal extraction framework.

[8]If ρ_t were observable, Fisher's theory could tested by projecting $r_t - \rho_t = N_t - \epsilon_{t+1}$ onto any $X_t \in \Phi_t$.

Fisher's theory of interest are contained in the proposition that $N_t = 0$ shows that the strong testable implication of Fisher's theory is that r_t be orthogonal to Φ_t. This requires that r_t be stationary so if i_t and π_{t+1} are integrated they must be cointegrated. However, the issue of whether or not i_t and π_{t+1} can be integrated notwithstanding, the stationarity of r_t does not imply that r_t is orthogonal to Φ_t and is thus consistent with many models. The stationarity of r_t is thus only a necessary condition for the existence of the Fisher effect. Put another way, the cointegration of i_t and π_{t+1} implies only that the variance of the specification error is finite but the veracity of Fisher's theory requires that it be zero. The finding that interest rates and inflation rates are cointegrated is thus, at best, only mildly informative about the usefulness of Fisher's theory.

References

Atkins, F. J. (1989) "Co-integration, Error Correction and the Fisher Effect," *Applied Economics*, 21:1611-20.

Bonham, C S. (1991) "Correct Cointegration Tests of the Long-Run Relationship between Nominal Interest and Inflation," *Applied Economics*, 23:1487-92.

Carneiro, F G., J. Â. C. A. Divino, and C. H. Rocha (2002) "Revisiting the Fisher hypothesis for the Cases of Argentina, Brazil and Mexico," *Applied Economics Letters*, 9:95-98.

Cochrane, John H. (1991) "Comment," in *NBER Macroeconomics Annual 1991*, edited by Olivier Jean Blanchard and Stanley Fischer, MIT Press, Cambridge, pp 201-210.

Crowder, William J. (1997) "The Long-Run Fisher Relation in Canada," *The Canadian Journal of Economics*, 30:1124-42.

Crowder, W. and D. L. Hoffman (1996) "The Long-Run Relationship between Nominal Interest Rates and Inflation: the Fisher Equation Revisited," *Journal of Money, Credit and Banking*, 28:102-18.

Daniels, J. P., F. Nourzad, and R. K. Toutkoushian (1996) "Testing the Fisher Effect as a Long-Run Equilibrium Relation," *Applied Financial Economics*, 6:115-20.

Durlauf, S. N., and R. E. Hall (1988) "Bounds on the Variances of Specification Errors in Models with Expectations," mimeo, Stanford University.

Durlauf, S. N., and R. E. Hall (1989) "A Signal Extraction Approach to Recovering Noise in Expectations Based Models," mimeo, Stanford University.

Dutt, S. D. and D. Ghosh (1995) "The Fisher Hypothesis: Examining the Canadian Experience," *Applied Economics*, 27:1025-30.

Fahmy, Y. A. F., and M. Kandil (2003) "The Fisher Effect: New Evidence and Implications," *International Review of Economics and Finance*, 12:451-65.

Garcia, Márcio G. P. (1993) "The Fisher Effect in a Signal Extraction Framework: The Recent Brazilian Experience," *Journal of Development Economics*, 41:71-93.

Granville, B., and S. Mallick (2004) "Fisher hypothesis: UK Evidence over a Century," *Applied Economics Letters*, 11:87–90.

Huizinga, John, and Frederic S. Mishkin, (1986), "Monetary Policy Regime Shifts and the Unusual Behavior of Real Interest Rates," *Carnegie-Rochester Conference Series on Public Policy*, 24:231-74.

Johnson, P. A. (1994a) "Estimation of the Specification Error in the Fisher Equation," *Applied Economics*, 26:519-26.

Johnson, P. A. (1994b) “On the Number of Common Unit Roots in the Term Structure of Interest Rates,” *Applied Economics*, 26:815-20.

Johnson, P. A., and M. G. P. Garcia (2000) “A Regression Tree Analysis of Real Interest Rate Regime Changes,” *Applied Financial Economics*, 10:171-6.

Koustas, Z., and A. Serletis (1999) “On the Fisher Effect,” *Journal of Monetary Economics*, 44:105-30.

Lee, J-L., C. Clark and S. K. Ahn (1998) “Long- and Short-Run Fisher Effects: New Tests and New Results,” *Applied Economics*, 30:113-24.

MacDonald, R., and P.D. Murphy (1989) “Testing for the Long Run Relationship between Nominal Interest Rates and Inflation Using Cointegration Techniques,” *Applied Economics*, 21:439-47.

Moazzami, B. (1991) “The Fisher Equation Controversy Re-examined,” *Applied Financial Economics*, 1:129-33:

Miron, Jeffrey A. (1991) “Comment,” in *NBER Macroeconomics Annual 1991*, edited by Olivier Jean Blanchard and Stanley Fischer, MIT Press, Cambridge, pp 211-218.

Mishkin, Frederic. S. (1992) “Is the Fisher Effect for Real? A Reexamination of the Relationship Between in Infation and Interest Rates,” *Journal of Monetary Economics*, 30:195-215.

Mishkin, Frederic S. and John Simon, (1995) “An Empirical Examination of the Fisher Effect in Australia,” *Economic Record*, 71: 217-29.

Peláez, Rolando F. (1995) “The Fisher Effect: Reprise,” *Journal of Macroeconomics*, 17:333-46.

Rapach, David E. and Christian E. Weber (2004) “Are real interest rates really nonstationary? New evidence from tests with good size and power,” *Journal of Macroeconomics*, 26:409-430.

Rose, Andrew K. (1988) “Is the Real Interest Rate Stable?,” *Journal of Finance*, 43:1095-1112.

Wallace, Myles S., and Johns T. Warner, (1993) “The Fisher Effect and the Term Structure of Interest Rates: Tests of Cointegration,” *The Review of Economics and Statistics*, 75:320-324.