

**LONG (NOT PERFECT) MEMORY: FRACTIONAL INTEGRATION AND MODELS
OF GOVERNING PARTY SUPPORT IN BRITAIN**

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ABSTRACT**LONG (NOT PERFECT) MEMORY: FRACTIONAL INTEGRATION AND MODELS
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Controversies concerning factors driving the dynamics of party support are heated and longstanding. This paper utilizes statistical methods for analyzing long-remembered time series to address a number of these controversies in the British context. Estimates of the fractionally differencing parameter, d , reveal that governing party support, prime ministerial approval, and economic evaluations are long-remembered and nonstationary. Governing party support and prime ministerial approval are fractionally cointegrated. Multivariate fractional error correction models show that prime ministerial approval has important short- and long-run effects on governing party support. Both prospective and retrospective personal economic evaluations also are influential, but national economic evaluations are not significant. In the conclusion, we argue that individual-level heterogeneity is a likely source of the observed aggregate-level fractional integration in party support and other variables of interest. Specifying parsimonious models that incorporate theoretically meaningful heterogeneity is a challenging research frontier for political economists in Britain and elsewhere.

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The process of scientific advance often is characterized by a powerful synergy between methodological innovation and theoretical controversy. Since the publication of pioneering studies in the early 1970s (e.g., Goodhart and Bhansali, 1970; Miller and Mackie, 1973; Mueller, 1970), political scientists have vigorously debated factors governing the political economy of party and party leader support. In this paper, we employ recently developed statistical methods for analyzing long-remembered time series to address a number of these debates in the British context. After reviewing current controversies concerning the political economy of party support in Britain and other mature democracies, we introduce the concepts of long-memory and fractional integration, and consider why one might expect key variables in party support models to be fractionally integrated. Next, we discuss the concepts of fractional cointegration and fractionally integrated error correction mechanisms, and analyze the memory properties of British variables of interest. Multivariate fractional error correction models are used to investigate the determinants of governing party support, and encompassing tests are employed to address disputes about the explanatory efficacy of various kinds of economic evaluations. In the conclusion, we summarize major findings and discuss their methodological and theoretical implications for future studies of party support in Britain and elsewhere.

Continuing Controversies

Prior to the 1990s most studies of the dynamics of party support in Britain focused exclusively on the effects of objective economic indicators such as inflation and unemployment rates.¹ However, during the past decade, research has demonstrated the utility of employing measures of voters' judgments about their own and their country's financial well-being (e.g., Clarke and Stewart 1995; Sanders, 1991). Although there is now consensus that economic evaluations provide substantial explanatory leverage, sharp debates continue concerning which type of evaluation actually drives party support.

These debates have a lengthy intellectual lineage. Over three decades ago V.O. Key (1968) articulated his famous two-fold argument that voters are rational actors whose electoral decisions are guided by retrospective rather than prospective judgments of government performance. Key's thesis was consistent with a frequently articulated conventional wisdom that incumbents are rewarded or punished for the state of voters' pocketbooks in the recent past (Kiewiet, 1983: 5-7). According to this hypothesis (which we designate the PR model), personal retrospective economic evaluations are what matter for party support. However, claims also have been advanced on behalf of personal *prospective* judgments (the PE model). In Britain, these latter arguments gained considerable credence when Sanders (1991) used personal economic expectations as the linchpin in his two-stage forecasting model (the "Essex model") that predicted the widely unanticipated Conservative victory in the 1992 British general election an impressive 16 months before that event occurred.

There also are disputes between scholars such as Sanders who emphasize the importance of personal, or "egocentric," evaluations and those such as Kinder and Kiewiet (1981), MacKuen, Erikson, and Stimson (1992, 1996), Erikson, MacKuen and Stimson (2000) and Norpoth (e.g., 1996a, 1996b) who favor national, or "sociotropic," evaluations. The sociotropic camp, in turn, is deeply divided. In research on presidential approval in the United States, MacKuen et al. argue that national expectations (the NE model) outperform national retrospections (the NR model), whereas Kinder and Kiewiet and Norpoth make strong claims on behalf of the latter. Still others (e.g., Clarke and Stewart, 1994; Lewis-Beck, 1988) find that both national projections and

national retrospections are influential. In their British study, Clarke and Stewart (1995) report that national expectations perform as well as personal ones in analyses of governing party support, but that national retrospections outperform other types of economic evaluations as determinants of prime ministerial approval.

An additional controversy in British studies concerns the explanatory role of leader images in party support models (see, e.g., Butler and Stokes 1976; Clarke and Stewart, 1995; Clarke, Stewart and Whiteley, 1997; Crewe and King, 1994). In particular, the strong correlation between prime ministerial approval and governing party support has led some analysts to conclude that including the former variable in models of the latter one is tautological (see, e.g., Sanders et al., 1987). Clarke and Stewart (1995) respond that strong correlations do not necessarily indicate that the variables are measuring the same thing, and that powerful (causal) relationships between conceptually distinct variables are exactly what political scientists wish to discover. Moreover, multivariate analyses of cross-sectional survey data gathered in the British election studies (BES) consistently indicate that voters' images of party leaders and feelings about them have sizable effects on electoral choice.

This latter controversy has motivated interest in the concept of cointegration and the specification of error correction models that enable analysts to capture possible long-run relationships between party and leader support (e.g., Clarke and Stewart, 1995; Clarke, Stewart and Whiteley, 1997). Below, we show that the traditional cointegration assumption undergirding these models is too restrictive, and that the relationship between prime ministerial approval and governing party support is best described as *fractionally* cointegrated. Before doing so, we discuss what fractional dynamics are, how they can arise, and why one might expect the British time series data to exhibit this property.

Fractional Dynamics and Party Support

The concept of fractional integration generalizes the crucial distinction between stationary and non-stationary data. Until recently, time-series analysts have restricted themselves to making a "knife-edged" decision that their data are either stationary $I(0)$ or non-stationary $I(1)$, i.e., *unit-root*, processes (Box-Steffensmeier and

Smith, 1996). This decision is theoretically consequential. Choosing stationarity implies that one believes a series has a constant mean -- stochastic innovations (shocks) are gradually "forgotten," and the series is mean reverting.² In contrast, the unit-root choice entails the belief that a series has a perfect memory -- *ceteris paribus*, its value at time t is the same as its value at the previous period, $t-1$. However, because the data generating process (DGP) is stochastic, shocks occur and are not discounted over time. As shocks accumulate, the unit-root series can meander widely, and is said to exhibit a stochastic trend. In the case of party support, such behavior contradicts widely accepted theories concerning the homeostatic tendencies of party systems in mature democracies (see, e.g., Bartoloni and Mair, 1990; Butler and Stokes, 1976; Campbell et al., 1966; Epstein, 1967) -- theories that posit the existence of long-term forces that work to restore and maintain existing patterns of inter-party competition (e.g., Stokes and Iversen, 1966).

The stationarity-non-stationarity decision also has important consequences for empirical analyses of factors affecting party support. Opting for stationarity creates difficulties if the DGP does, in fact, involve a unit root. As is well known, the possibility of spurious regressions -- concluding that there is a statistically significant relationship between variables that are actually independent of one another -- increases dramatically when variables with unit roots are left in level form (Granger and Newbold, 1974). Recent research indicates that similar threats to inference obtain for near-integrated series, i.e., series for which the DGP is very strongly autoregressive (DeBoef and Granato, 1997, 2000).³ Assuming nonstationarity can cause problems as well. When diagnostics suggest the presence of a unit root, the conventional remedy is to difference the series. However, differencing is not a cost-free option because one will not be able to detect *long-run* relationships among the variables being analyzed (Smith, 1993). Over the past decade, analysts concerned about this latter possibility have adopted the practice of including error correction mechanisms (ECMs) in their models, typically asserting that the ECM specification is warranted by diagnostics indicating that variables of interest cointegrate (Engle and Granger, 1987).

In recent years, researchers have challenged the assumption that it is necessary for time series variables to have *integer* orders of integration. Influenced by pioneering theoretical work by Granger and Joyeux (1980)

and Hosking (1981), analyses of American time series data by Box-Steffensmeier and Smith (1996, 1998) and Lebo, Walker and Clarke (2000) indicate that variables such as presidential approval and party identification are *fractionally* integrated. Series exhibiting fractional dynamics may be analyzed by generalizing the familiar ARIMA models developed by Box and Jenkins (1970). In ARIMA notation, the DGP of a (fractionally) integrated series Y is given by:

$$\phi(B)(1-B)^d Y_t = \theta(B)\varepsilon_t \quad \text{where } \varepsilon_t \sim N(0, \sigma^2) \quad (1)$$

where B is the backshift operator such that $B^k \varepsilon_t = \varepsilon_{t-k}$, $\phi(B)$ represents a stationary autoregressive (AR) process, $\theta(B)$ represents an invertible moving-average (MA) process, and d , the fractional differencing parameter, measures the degree of integration of Y . If one assigns integer values to d , the traditional ARIMA framework is maintained. When $d = 0$, a series exhibits mean reversion, finite variance, and covariance stationarity, and it can be modeled using combinations of moving-average and autoregressive parameters in an ARMA $(p,0,q)$ specification. When $d = 1$, the variable is a unit-root process characterized by mean, variance, and covariance nonstationarity. In this case, the series can be rendered stationary by first differencing and then modeled using AR and MA parameters in an ARIMA $(p,1,q)$ format.

Fractionally integrated processes⁴ relax the assumption that d is an integer and permit its value to lie on the real number line between 0 and 1 (Baillie 1996; Beran, 1992). Series in this middle ground possess long memory with statistically significant correlations at long lags, and cease to be variance and covariance stationary when $0.5 \leq d < 1$ (Baillie 1996). It often is assumed that when $d \geq .5$, a fractionally integrated series remains mean reverting. Phillips and Xiao (1999:33-34) recently have pointed out that this is not true in a conventional sense, although shocks do eventually decay if $d < 1.0$. As in the unit-root case, a fractionally integrated series can be rendered $I(0)$ by differencing. For a fractionally integrated series, fractional- rather than integer-differencing is employed.

To illustrate the defining long-memory property imparted by fractional integration, we simulate a series with d value of .85, and calculate its autocorrelation function across 60 lags. To provide comparative perspective, we also calculate autocorrelation functions for a simulated random walk and a simulated stationary, first-order

autoregressive series.⁵ As Figure 1 shows, although the stationary series has a large AR1 coefficient ($\beta_1 = .85$), its autocorrelation function dampens quickly. In contrast, the random walk's autocorrelation function has extremely large values at low lags, and statistical significance is maintained over the first 56 consecutive lags. As intuition would suggest, the fractionally integrated series has intermediate (but decidedly nontrivial) persistence -- its autocorrelations are greater (in absolute value) than those for the stationary series through the first 36 successive lags, but they always are less than those for the random walk. Indicative of its long memory, the fractional series autocorrelations remain statistically significant through 33 consecutive lags -- nearly three years, if data were gathered on a monthly basis.

(Figure 1 about here)

Granger (1980) (see also Box-Steffensmeier and Smith, 1997) discusses ways by which a fractionally integrated series can be created, and demonstrates how aggregating individual-level heterogeneous behavior produces fractional dynamics. This heterogeneity exists with respect to varying autoregressive and moving average processes at the micro level. The aggregated series will long remember the behavior of individuals with strong auto-regressive tendencies while quickly forgetting the behavior of others. There are many political science time series variables that would seem to fit this characterization. Of particular interest here are British time series measures of party support, prime ministerial approval and subjective evaluations of national and personal economic conditions. These series are constructed by aggregating individual-level data from monthly national surveys.

Zaller's (1992) theoretical analyses of public opinion formation (see also Krause, 1998, 2000; Krause and Granato, 1988; Sniderman, Brody and Tetlock, 1991) suggest that in each such survey there will be persons with a diverse array of autoregressive tendencies. Specifically, Zaller's contention that political knowledge is normally distributed implies that voters respond differently to political and economic events. Poorly informed people may repeatedly change their opinions based on very little new information, whereas the opinions of more politically knowledgeable persons will vary less, barring some major event (e.g., the Falklands War, the ERM crisis). The distribution of these tendencies across the electorate will determine the degree of persistence in any particular

aggregated series. Some variables, such as prime ministerial approval, are likely to be dominated by voters with perfect memory (i.e. unit-root behavior) for whom long-term judgments about the country's leader are based on a simple aggregation of salient events involving that leader. In contrast, subjective economic evaluations are likely to be shorter memory as a vast majority of voters frequently update these evaluations. In general, these updating processes involve the ongoing acquisition of fresh information and the progressive discounting of previously acquired information. Since these processes vary in their particulars across the electorate and voters acquire varying combinations of data provided by "media, markets and mates," fractional dynamics will characterize aggregate economic evaluation series.⁶

These considerations prompt the conjecture that fractional dynamics of varying degree will characterize many of the series of interest to political economists. It bears emphasis that such series should not be treated as if they were "garden variety" stationary (i.e., $I(0)$) processes. In cases where $d \geq .5$, failing to account for fractional dynamics will lead to problems in regression analyses including biased standard errors and Durbin-Watson test statistics (Lebo, Walker and Clarke, 2000; see also Box-Steffensmeier and Tomlinson, 2000). The possibility of spurious regressions is significantly enhanced in these cases. How should analysts concerned about the possibility of fractional dynamics in their data proceed? Prior to developing and testing multivariate models, two steps analogous to those employed in a traditional ARIMA modeling exercise should be followed. First, rather than assuming variables are integrated at integer levels, e.g., $I(0)$ or $I(1)$, the memory characteristics of each series should be identified empirically. The identification process involves estimating the fractional differencing parameter d and its standard error for each series. Second, before employing the data for estimating the parameters in multivariate models, each series should be differenced by its estimated d value. In the next section, we describe the British data and estimate d for each series.

Data and d

We employ data from 210 consecutive monthly British Gallup polls spanning the July 1979 - December 1996 period. The variables are: governing (Conservative) party support,⁷ prime ministerial approval,⁸ and four

subjective economic evaluations -- personal expectations, personal retrospections, national expectations and national retrospections.⁹ Each variable is bounded (between 0 and 100 in the cases of governing party support and prime ministerial approval, and between -100 and +100 in the case of the economic evaluations) and each is an aggregation of individual-level data. These characteristics suggest that the series are fractionally integrated. Estimates of d for each series are consistent with this hypothesis.¹⁰

The value of d may be estimated using several techniques including, *inter alia*, semiparametric estimation (Geweke and Porter-Hudak 1983; Robinson 1995), approximate maximum likelihood estimation in the frequency domain (Fox and Taqqu 1986), exact maximum likelihood estimation in the time domain (Sowell 1992), Bayesian techniques (Koop, Ley, Osiewalski, and Steel 1995), and bootstrapping (Andersson and Gredenhoff 1998). Here, the d value for each of the British variables is estimated using both Robinson's and Sowell's estimators.¹¹ To determine the ARFIMA (autoregressive, fractionally integrated, moving average) model that best accounts for both short- and long-term dynamics of each series, d is estimated for each variable in a $(0, d, 0)$ model and in (p, d, q) models containing up to three autoregressive and three moving average parameters (at lags 1, 2 and 3). The Akaike Information Criterion and the Schwartz Bayesian Criterion (see, e.g., Franses, 1998:59) are employed to distinguish which of the 16 rival models per series is superior. According to both criteria, a $(0, d, 0)$ model is best for each of the six variables.

Table 1 presents the d estimates using both Robinson's semiparametric estimator and Sowell's full maximum likelihood estimator for these $(0, d, 0)$ models. The two procedures yield very similar results -- d does not equal zero for any of these series ($p < .05$), and it does not equal 1.0 for any series except possibly prime ministerial satisfaction. Although the point estimates for d of .96 and .91 for the latter variable indicate fractional integration, each is within two standard errors of 1.0. Thus, rejection of the unit-root hypothesis (with $p = .05$) is not possible. Based on these results, we conclude that fractional integration characterizes at least five of the six series. In the next section, we use these findings to help specify error correction models of the determinants of governing party support.

(Table 1 about here)

Fractional Cointegration and Fractional Error Correction Models

Just as the likelihood of finding fractional dynamics in political variables motivates a rethinking of the knife-edged distinction between stationarity and nonstationarity, the methodology of cointegration must likewise be rethought in light of the possibilities of long-memory equilibrium relationships between variables. Among the advantages of this new methodology is the ability to specify and estimate more precisely equilibrium relationships among variables of interest. Thus, along with ARFIMA modeling procedures, fractional cointegration techniques improve the chances of resolving longstanding controversies regarding rival models of the dynamics of important variables such as governing party support. The concept of fractional cointegration is most easily understood as a more general form of traditional cointegration.

Cointegration involves a long-term relationship between two or more variables (Granger 1981; Engle and Granger 1987, 1991). This relationship is one such that shocks to one variable at any time t are re-equilibrated at a constant rate in subsequent time periods. Standard operating procedure for diagnosing cointegration between two variables involves, first, determining if the original series are nonstationary ($I(1)$) and, second, determining if the residuals from a regression of one of the variables on the other are stationary ($I(0)$). Unit-root tests are employed to assess the order of integration of the individual variables and the regression residuals.

When one recognizes the low power of (non)stationarity tests (Maddala and Kim, 1998:ch. 4) and ceases to demand that d has an integer value, it is evident that the chances of finding potential candidates for cointegration in the conventional sense are drastically reduced (Barkoulas and Baum 1997; Dueker and Startz 1998). However, as Cheung and Lai (1993) observe, the requirement that the residuals of a cointegrating regression are $I(0)$ is unnecessary as it is sufficient that these equilibrium errors are not infinitely persistent. The key point is that despite being fractionally integrated, as long as the regression residuals are of a lower order of integration than are either of the initial variables, those variables can be said to be in equilibrium and to (fractionally) cointegrate. Hence, one may fuse the methodology of cointegration with the concept of fractional integration (Baillie and Bollerslev, 1994; Cheung and Lai 1993; Dueker and Startz 1998). Abadir and Taylor

(1998:6) redefine a bivariate cointegrating relationship as follows: two variables, Z_t and X_t where Z_t is $I(d)$ and X_t is $I(b)$ are fractionally cointegrated if there is a function $g(\cdot)$ such that $\eta_t = Z_t + g(X_t)$ is $I(s)$ and $s < d$. Thus, the existence of some function $g(X_t)$ that reduces the order of integration for Z_t establishes that Z_t and X_t are fractionally cointegrated (Abadir and Taylor 1998).

Extending the methodology of cointegration to include fractional cases enables one to generalize the concept of an error correction mechanism (ECM). Following Engle and Granger (1987), standard practice is to specify an error correction mechanism when two series cointegrate in the traditional sense, thereby enabling one to study long-run relationships among non-stationary variables. The ECM methodology assumes that the residuals of the cointegrating regression, and hence, the ECM, are $I(0)$. Relaxing this assumption as described above to allow for the possibility of fractional cointegration is a natural extension of this methodology. Rather than using (non)stationarity tests to decide whether the ECM is $I(0)$ or $I(1)$, estimating the d parameter for the ECM permits a more nuanced understanding of the nature of the equilibrium relationship. The range of possible behavior for the ECM is greatly increased -- defining an ECM as possessing long memory simply implies that shocks to one variable are re-equilibrated at a slower rate than the exponential decay of a conventional ARMA process.

The existence of a fractionally integrated ECM does present a problem to the multivariate modeler, however. If one wishes to include a fractionally integrated ECM as an independent variable in a larger equation, one should be wary of threats to inference generated by its long-memory characteristics. Monte Carlo analyses indicate that even when a dependent variable and other independent variables are $I(0)$, a single fractionally integrated independent variable can threaten inference, as both its coefficient estimates and standard errors are biased downwards (Lebo, 2000). Interpretation of an ECM's coefficient as a measure of the strength and significance of the adjustment mechanism will be flawed if one fails to account for fractional cointegration. Hence, it is important to remember the standard admonition and ensure that ECMs are $I(0)$ before including them in multivariate equations. As shown below for the case of British governing party support, this can be done simply by fractionally differencing the residuals of the cointegrating regression by their estimated value of d . A full multivariate ARFIMA model with an ECM specification thereby can be estimated without worrying about

threats to inference posed by the presence of a fractionally integrated component.

Prior to estimating such models with British data, prime ministerial approval and Conservative party support are tested for fractional cointegration. As noted above, previous studies of the relationship between public support for British parties and their leaders have employed an ECM to capture a long-run equilibrium relationship exists between the two variables. However, given the possibility of fractional cointegration, these studies may have over-estimated the rate at which leader approval and party support return to equilibrium following a shock. To investigate this possibility, a cointegrating regression is performed between Conservative party vote intentions and prime ministerial approval and the residuals are tested for stationarity. The d estimate is .59 (s.e.=.059). This is over four standard errors below the d values for either Conservative vote intentions or prime ministerial approval (see Table 2). Also, one cannot reject the hypothesis at the .05 level of probability that d is less than .5 and, hence, the residuals constitute a stationary series. Taken together, these results are consistent with the hypothesis that the two series are fractionally cointegrated.

The presence of mean-reverting long-memory in the residuals of the governing party support - prime ministerial approval regression tells us that a shock to one of these variables will persist longer than the geometric decay of a standard cointegrating system, but that the shock will dissipate as the variables eventually return to equilibrium. Hence, assuming a standard cointegrating ($d = 0$) relationship between prime ministerial approval and governing party support may over-estimate the speed with which the two variables return to their long-term equilibrium following a shock to one of them. The implication is that, despite the strong correlation between the two variables, voters clearly distinguish between the governing party and the prime minister and their opinion of the two can diverge for long periods. Next, we will show how accounting for this long-run relationship in a multivariate context can improve model specification and enhance confidence in empirical findings.

FEC Models: Specification and Estimation

We now specify and estimate fractional error correction (FEC) models of governing party support. To ensure that threats to inference are minimized, governing party support (Conservative vote intentions), prime

ministerial approval, and the four subjective measures are rendered $d = 0$ by fractionally differencing each by its own value of d (see Table 1).¹² To capture the long-term equilibrium relationship between Conservative support and prime ministerial approval, the error correction term (lagged one period) is included in the multivariate models. Before doing so, the ECM variable (the residuals of the cointegrating regression of Conservative support on prime ministerial approval) is fractionally differenced by its d estimate (.59). Other independent variables in the party support models include interventions for the Falklands War, the introduction of the poll tax, the replacement of Margaret Thatcher by John Major as prime minister, Major's reselection as Conservative leader, the ERM crisis and a summary variable to capture miscellaneous political events.¹³

The error correction model of governing party support is:

$$\text{GOVF}_t = \beta_0 + \beta_1 \text{PMF}_t + \beta_2 \text{EVALF}_t - \alpha \text{FECM}_{t-1} + \sum \beta_{3-k} \text{SHOCKS}_{t-i} + \varepsilon_t \quad (2)$$

where: GOVF = fractionally differenced governing party support; PMF = fractionally differenced prime ministerial approval; EVALF = fractionally differenced economic evaluations (personal prospective, personal retrospective, national prospective, national retrospective); FECM = fractional error correction mechanism estimated from first-stage regression of GOVF on PMF; SHOCKS = interventions (Falklands War, etc.); β , α = model parameters (to be estimated); ε = stochastic error term ($\sim N(0, \sigma^2)$).

Four separate analyses, using each of the subjective economic evaluations in turn, are performed.¹⁴ Column 1 of Table 2 shows prime ministerial approval, personal economic expectations, the error correction mechanism, and each of the intervention variables have statistically significant effects ($p \leq .05$). Column 2 shows a nearly identical pattern with personal retrospective economic evaluations being significant. However, columns 3 and 4 show that prospective and retrospective judgments of national economic conditions fail to achieve statistical significance (t ratios = 1.16, and 0.49) in their respective models. In the four models, the estimated coefficient for the ECM is properly (negatively) signed, and varies by only .01 (from -.272 to -.282), thereby indicating that shocks to governing party support are slowly eroded by the (fractionally) cointegrating relationship with prime ministerial approval. A variety of such shocks were at work in the period under consideration. As one would anticipate, the Falklands War, the replacement of Thatcher by Major, and Major's reselection as party

leader boosted the Conservatives' vote intention share, whereas the imposition of the poll tax and the currency crisis diminished it. Miscellaneous events also exerted significant effects.¹⁵

(Table 2 about here)

The vote intention analyses indicate that both personal economic expectations and personal economic retrospections exercise significant effects on governing party (Conservative) support. This finding, together with the failure of prospective or retrospective evaluations of the national economy to achieve statistical significance, are consistent with the Essex model's emphasis on the importance of personal economic judgments. It also contradicts -- for the British case at least -- the arguments of the many analysts who have advanced claims on behalf of national prospective or, more frequently, national retrospective economic judgments. But is one of personal economic evaluation models preferable to the other? As is the case for models based on standard cointegration methodology, one may address this question by performing encompassing tests to compare the performance of rival non-nested models (Charemza and Deadman, 1997:ch. 8). Empirically, a battery of encompassing tests (Davidson and MacKinnon, 1981; Mizon and Richard, 1986) show that neither personal economic evaluation model encompasses the other (Table 3). This result, in turn, suggests that although the FEC models show that personal economic evaluations perform better than national ones, the time horizon over which the former operate remains ambiguous.

(Table 3 about here)

One-Step Estimation: Recently, it has been argued that considerations of statistical efficiency make it preferable to estimate error correction model parameters using a one-step, rather than a two-step, procedure (e.g., DeBoef, 2000; see also Beck, 1992, 1993). The implicit assumption is that all variables, including those in the error correction mechanism, are stationary -- either as "supplied by nature," or by the application of suitable differencing procedures. As noted, when variables are fractionally integrated, stationarity can be achieved by filtering them using their estimated d values. Once governing party support, prime ministerial approval and the economic evaluations have been filtered by their d values, we may specify the one-step fractional error correction

model of governing party support as:

$$\text{GOVF}_t = \beta_0 + \beta_1 \text{PMF}_t + \beta_2 \text{EVALF}_t - \alpha(\text{GOVF}_{t-1} - \gamma \text{PMF}_{t-1}) + \sum \beta_{3-k} \text{SHOCKS}_{t-i} + \varepsilon_t \quad (3)$$

where GOVF, PMF, EVALF, SHOCKS and ε are as described above (p. 13), and β , α , and γ are parameters to be estimated.

Parameter estimates (see Table 4) for different variants of this model using the four economic evaluation variables are very similar to those for the two-step models. Personal economic expectations and personal economic retrospections have significant effects (t ratios = 2.173 and 1.752, respectively), but neither national economic expectations nor national economic retrospections achieve significance (t ratios = 1.089 and 0.352, respectively). Once more, encompassing tests fail to indicate that the personal expectations model is preferable to its personal retrospective rival or vice versa (data not shown). Also as in the two-step models, the adjustment parameters (α) are significant in each model ($p < .001$), as are various intervention variables. The γ coefficients capturing the fractional cointegrating relationship between governing party support and prime ministerial approval in the one-step models are significant as well.

(Table 4 about here)

The several coefficients in the one-step models all carry the same signs and are very similar in magnitude to their two-step counterparts. Adjustment parameters for the one-step models are slightly smaller than their two-step counterparts (by .045 on average), but Wald tests show that the differences are not statistically significant (e.g., $\chi^2 = 0.384$, $df = 1$, $p = .536$ for the personal expectations model). This also is true for the coefficients (γ 's) measuring the long-run fractional cointegrating relationships between governing party support and prime ministerial approval -- these coefficients are smaller (mean difference = .096) than that (.648) estimated in the two-step procedure, but the differences are not significant (e.g., $\chi^2 = 0.373$, $df = 1$, $p = .541$ for the personal expectations model). A more general test constraining all parameters in the one-step models to be equal to their counterparts in the two-step ones reveals that the differences are not significant (e.g., $\chi^2 = 1.530$, $df = 11$, $p = 1.000$ for the personal expectations model). Thus, alternative estimation procedures for rival models incorporating the fractionally integrated variables tell essentially the same story about the determinants of governing party

support in Britain.¹⁶ In the conclusion, we will reprise the highlights of this story, and suggest avenues for future research.

Conclusion: Resolving Controversies, Setting a New Research Agenda

The past decade has witnessed substantial theoretical and methodological innovation in studies of the dynamics of party support in Britain and other mature democracies. Sensitive to the serious threats to inference posed by nonstationary data, researchers have tested their data for unit-roots, and specified error correction models of the impact of economic evaluations and party leader images on vote intentions. Some critics have been slow to accept the results of these analyses, issuing caveats that unit-root tests have low statistical power, and that variables such as voting intentions, prime ministerial approval and economic evaluations are bounded (either by nature or construction) and, hence, cannot be truly nonstationary at the $I(1)$ level. In the present paper, we have argued that the concepts of fractional integration and fractional cointegration enable one to generalize the conventional integration-cointegration-error correction methodology to take account of these criticisms. Estimating the fractional differencing parameter d for key variables in a model of the dynamics of British governing party support reveals that threats to inference would arise if these variables were treated as stationary $I(0)$ processes. The d parameters indicate that all of the variables are fractionally integrated and nonstationary. Governing party support and prime ministerial approval are fractionally cointegrated.

These findings warrant the specification of models that generalize the error correction approach used in previous studies by relaxing the assumption of integer orders of integration and cointegration. Estimating the parameters in these new fractional error correction (FEC) models using either two- or one-step procedures documents the existence of a governing party vote intention-prime ministerial approval (fractional) error correction mechanism. The size of the ECM coefficient indicates that although these two variables travel in tandem in the long run, shocks caused by economic or political interventions can drive them apart for lengthy periods of time. Parameter estimates also reveal that evaluations of personal economic conditions are significant predictors of governing party support, but evaluations of the national economy are not significant.

The FEC model estimates thus help to resolve two longstanding controversies in the literature on party support in Britain. *Pace* the (perhaps mythical) era when social class "was everything" and "all else was embellishment and detail" (Pulzer, 1967), the FEC models forcefully testify that party leader images have been important elements in the calculus of party support in Britain since at least the late 1970s. Although the looseness of the (fractional) cointegrating relationship between prime ministerial approval and governing party support indicates that various economic and political interventions can have sizable short-term effects, it is equally clear that leader images matter a great deal. Model estimates testify that personal, not national, economic evaluations also matter -- at least in terms of direct effects on party support.¹⁷ However, this latter finding is not an unequivocal endorsement of the widely cited Essex model. Encompassing tests pitting personal expectations against personal retrospections are inconclusive, so therefore we caution that additional inquiry is in order.

When researchers conduct future studies of the dynamics of party support, fractional (co)integration methods will prove helpful. As demonstrated in this paper, these methods are easily implemented in the context of generalized versions of familiar ARIMA and error correction models, and they enable analysts to avoid the methodologically contentious and often theoretically unattractive assumption that important political and economic variables evolve through time with integer orders of integration. The concepts of fractional integration and fractional cointegration also have important heuristic value in that they encourage researchers to offer conjectures concerning micro-level processes responsible for fractional aggregate-level phenomena. As Granger (1980) and, more recently, Box-Steffensmeier and Smith (1997) have emphasized, individual-level heterogeneity is a likely source of aggregate-level fractional integration. Specifying such heterogeneity in the context of parsimonious, theoretically attractive, models of party support poses an interesting and important challenge to political economists in Britain and elsewhere.

ENDNOTES

1. For reviews of this extensive literature, see Clarke et al. (1992); Lewis-Beck (1988); Norpoth, Lewis-Beck and Lafay (1991).
2. A weak or wide-sense stationary series has a constant mean, a constant variance and a constant covariance for any lag k , i.e., $E(y_t) = \mu$; $E[(y_t - \mu)^2] = \gamma_0$; $E[(y_t - \mu)(y_{t-k} - \mu)] = \gamma_k$ for all t and k (Franses, 1998:68). The simplest unit-root series is the random walk: $Y_t = 1.0 * Y_{t-1} + \varepsilon_t$, where $\varepsilon_t \sim N(0, \sigma^2)$. Recursive substitution shows that the random walk may be expressed as $Y_t = Y_0 + \sum \varepsilon_i$ where Y_0 is the initial value of Y and $\sum \varepsilon_i$ is the sum of all shocks from time 1 through time t .
3. An example of a near-integrated process is: $Y_t = \beta_1 Y_{t-1} + \varepsilon_t$ where $\varepsilon_t \sim N(0, \sigma^2)$, $\beta_1 = 1.0 + \zeta$, and ζ is a small negative number, e.g., $-.01$. See DeBoef and Granato (2000).
4. The simplest fractionally integrated process is fractional Gaussian noise, i.e., $(1 - B)^d Y_t = \varepsilon_t$, where $\varepsilon_t \sim N(0, \sigma^2)$. $(1 - B)^d$ can be expanded (infinitely) as $1 - dL - (1/2)d(1 - d)B^2 - (1/6)d(1 - d)(2 - d)B^3 - \dots - (1/j!)d(1 - d)(2 - d)\dots((j - 1) - d)B^j - \dots$. See Franses (1998:79).
5. The three series were simulated using RATS 4.3, with the fractional series being created using Rob Schoen's ARFSIM.PRG procedure.
6. For example, variation in extent of concern with different aspects of the macroeconomy, e.g., inflation versus unemployment for middle- and working-class persons respectively, is a possible source of heterogeneity in economic evaluations. See, e.g., Hibbs (1982a, 1982b). Similarly, as Sanders (1991) observes, one would expect concern with interest rates to vary according to whether a voter is a mortgage holder or a tenant.
7. The Gallup vote intention questions are: (a) "If there were a General Election tomorrow, which party would you support?" (b) [If "don't know"] "Which party would you be most inclined to vote for?" Conservative vote intentions are calculated as the sum of the percentages of respondents answering "Conservative" to (a) or (b).
8. The Gallup prime ministerial approval question is: "Are you satisfied or dissatisfied with [name] as Prime Minister?" Prime ministerial approval is measured as the percentage saying they are "satisfied."
9. The subjective economic evaluation questions are: (a) personal prospections - "How do you think the financial situation of your household will change over the next 12 months?" (b) personal retrospections - "How does the financial situation of your household now compare with what it was 12 months ago?" (c) national prospections - "How do you think the general economic situation in this country will develop over the next 12 months?" (d) national retrospections - "How do you think the general economic situation in this country has changed over the last 12 months?" The response categories are: "get(got) a lot better," "get a little better," "stay the same," "get a little worse," "get a lot worse." The economic evaluation variables are constructed by subtracting the percentage offering negative responses from the percentage offering positive ones.
10. Our diagnoses of the dynamic properties of the time series data also included a battery of unit-root tests. Although there are many such tests, each has limited power in the face of fractional alternatives, and different tests can produce contradictory results (see Maddala and Kim, 1998:ch. 9). Illustrative of the latter point, the Dickey-Fuller test (Dickey and Fuller, 1979) indicates that party support is nonstationary. However, the variance ratio test (Cochrane, 1988) rejects the hypothesis that d equals 1.0, and the KPSS test (Kwiatkowski et al., 1992) rejects the hypothesis that d equals 0.0. The unit-root tests speak more consistently when prime ministerial approval and the economic evaluation series are analyzed. For prime ministerial approval, the Dickey-Fuller and

variance ratio tests fails to reject the null hypothesis of nonstationarity, and the KPSS test rejects the null of stationarity. For economic evaluations, the story is just the opposite; the Dickey-Fuller and variance ratio test reject the null hypothesis of nonstationarity, whereas the KPSS test fails to reject the null of stationarity. In sum, restricting one's choice to the traditional $d = 0$ or $d = 1$ dichotomy, unit-root tests suggest that prime ministerial approval is $I(1)$, economic evaluations are $I(0)$, and governing party support is indeterminate.

11. Robinson's estimator is calculated using the RATS RGSE.SRC procedure; Sowell's estimator is calculated using an OX routine written by Jurgen Doornik. An alternative maximum likelihood procedure is the ARIMA.FRACDIFF module in SPLUS 4.5.

12. The series are filtered using the RATS FIF.SRC procedure.

13. The Falklands war, replacement of Thatcher by Major, the ERM crisis and Major reselection interventions are coded as 1 for the month in which the intervention occurred and 0 otherwise. Since the poll tax implementation is hypothesized to exert a temporary one-month effect, it is scored 1 for the month it occurred, -1 for the next month, and 0 otherwise. The miscellaneous intervention variable is scored +1 for months in which there was an intervention hypothesized to increase Conservative support, -1 for months in which there was an intervention hypothesized to decrease Conservative support, and 0 for other months. A list of interventions is available upon request.

14. The party support models are estimated using the OLS regression program in MICROFIT 4.0. MICROFIT 4.0 is selected for this purpose because it provides an extensive battery of regression diagnostics, as well as encompassing tests for rival non-nested models.

15. With the exception of normality of residuals, all regression diagnostic tests are statistically insignificant. Thus, there is no evidence of residual autocorrelation (first-order or general), heteroscedasticity (ARCH or general) or functional form misspecification. Also, CUSUM and CUSUM squared tests (not shown) are consistent with the hypothesis of parameter constancy.

16. Since prime ministerial approval enters the Conservative support model without a lag, the possibility of simultaneity bias is investigated. Test results for both the two-step and one-step estimates of the party support models are consistent with the hypothesis that prime ministerial approval is weakly exogenous to Conservative vote intentions and, hence, it is possible to perform single-equation estimation of the parameters in the Conservative support model. For example, for the two-step estimates, adding the ECM to a model of the determinants of prime ministerial approval (personal expectations variant) shows that the ECM is statistically insignificant ($t = 1.096$). Adding the residuals of the prime ministerial model to the Conservative support model (personal expectations variant) also yields an insignificant coefficient ($t = 1.295$). On weak exogeneity tests in the context of error-correction models, see Charemza and Deadman (1997:ch.7). Details re: the prime ministerial approval models are available upon request.

17. There is evidence that retrospective judgments regarding national economic conditions have significant *indirect* effects on party support via their influence on prime ministerial approval. Encompassing tests applied to models of prime ministerial approval developed to determine if prime ministerial approval is weakly exogenous to governing party support show that a model incorporating national retrospections encompasses models using other types of national and personal economic evaluations. Details available upon request. See also Clarke, Stewart and Ho (2000).

REFERENCES

- Abadir, Karim M. and A. M. Robert Taylor. 1998. "On the Definitions of (Co-)Integration." Unpublished manuscript. York: University of York.
- Andersson, Michael K. and Mikael P. Gredenhoff. 1998. "Robust Testing for Fractional Integration Using the Bootstrap." Stockholm School of Economics Working Papers Series in Economics and Finance No. 218.
- Bartolini, Stefano and Peter Mair. 1990. Identity, Competition and Electoral Availability 1885-1985. Cambridge: Cambridge University Press.
- Baillie, Richard T. 1996. "Long Memory Processes and Fractional Integration in Econometrics." Journal of Econometrics 73:5-59.
- Baillie, Richard T. and Tim Bollerslev. 1994. "Cointegration, Fractional Cointegration, and Exchange Rate Dynamics." The Journal of Finance 79:737-45.
- Barkoulas, John C. and Christopher F. Baum. 1997. "Fractional Differencing Modeling and Forecasting of Eurocurrency Deposit Rates." Journal of Financial Research 20:355-72.
- Beck, Nathaniel. 1992. "Comparing Dynamics Specifications: The Case of Presidential Approval." In James A. Stimson, ed., Political Analysis, vol. 3. Ann Arbor: University of Michigan Press.
- Beck, Nathaniel. 1993. "The Methodology of Cointegration." In John R. Freeman, ed. Political Analysis vol. 4. Ann Arbor: University of Michigan Press.
- Beran, Jan 1994. Statistics For Long Memory Processes. New York: Chapman and Hall.
- Box, G. E. P. and G. M. Jenkins. 1970. Time Series Analysis: Forecasting and Control. San Francisco: Holden Day.
- Box-Steffensmeier, Janet M. and Renée M. Smith. 1996. "The Dynamics of Aggregate Partisanship." American Political Science Review 90:567-80.
- Box-Steffensmeier, Janet M. and Renée M. Smith. 1997. "Heterogeneity and Individual Party Identification." Paper presented at the Annual Meeting of the Midwest Political Science Association. Chicago, April 1997.
- Box-Steffensmeier, Janet M. and Renée M. Smith. 1998. "Investigating Political Dynamics Using Fractional Integration Methods." American Journal of Political Science 42:661-89.
- Box-Steffensmeier, Janet M. and Andrew R. Tomlinson. 2000. "Fractional Integration Methods in Political Science." Electoral Studies 19:63-76.
- Butler, David and Donald E. Stokes. 1976. Political Change in Britain. 2nd College Edition. New York: St. Martin's Press.
- Campbell, Angus, Philip E. Converse, Warren E. Miller and Donald E. Stokes. 1966. Elections and the Political Order. New York: John Wiley & Sons, Inc.

- Charemza, Wojciech W. and Derek F. Deadman. 1997. New Directions in Econometric Practice. Aldershot: Edward Elgar.
- Cheung, Yin-Wong and Kon S. Lai. 1993. "A Fractional Cointegration Analysis of Purchasing Power Parity." Journal of Business and Economic Statistics 11:193-12.
- Clarke, Harold D., Euel W. Elliott, William Mishler, Marianne C. Stewart, Paul F. Whiteley and Gary Zuk. 1992. Controversies in Political Economy: Canada, Great Britain, the United States. Boulder, CO: Westview Press.
- Clarke, Harold D., and Marianne C. Stewart. 1994. "Prospections, Retrospections, and Rationality: The 'Bankers' Model of Presidential Approval Reconsidered." American Journal of Political Science 38:1104-23.
- Clarke, Harold D., and Marianne C. Stewart. 1995. "Economic Evaluations, Prime Ministerial Approval and Governing Party Support in Britain: Rival Models Reconsidered." British Journal of Political Science 25:145-70.
- Clarke, Harold D., Marianne C. Stewart and Paul F. Whiteley. 1997. "New Models for New Labour: The Political Economy of Labour Party Support, January 1992-April 1997." American Political Science Review 92: 559-75.
- Clarke, Harold D., Marianne C. Stewart and Karl Ho. 2000. "Major's Lesser (Not Minor) Effects: Prime Ministerial Approval and Governing Party Support in Britain Since 1979." Electoral Studies 19:255-74.
- Cochrane, J. H. 1988. "How Big is the Random Walk in GNP?" Journal of Political Economy 96:893-920.
- Crewe, Ivor and Anthony King. 1994. "Did Major Win? Did Kinnock Lose? Leadership Effects in the 1992 Election." In Anthony Heath et al., eds., Labour's Last Chance? The 1992 Election and Beyond. Dartmouth: Aldershot.
- Davidson, R. and J. MacKinnon. 1981. "Several Tests for Model Specification in the Presence of Alternative Hypotheses." Econometrica 49:781-93.
- DeBoef, Suzanna. 2000. "Modeling Equilibrium Relationships: Error Correction Models with Strongly Autoregressive Data." Unpublished paper, Department of Political Science, Pennsylvania State University.
- DeBoef, Suzanna, and Jim Granato. 1997. "Near-Integrated Data and the Analysis of Political Relationships" American Journal of Political Science 41:619-40.
- DeBoef, Suzanna and Jim Granato. 2000. "Testing for Cointegrating Relationships with Near-Integrated Data." Political Analysis 8:99-117.
- Dickey, David A., and Wayne A. Fuller. 1979. "Distribution of the Estimators for Autoregressive Series with a Unit Root." Journal of the American Statistical Association 74:427-31.
- Dueker, Michael and Richard Startz. 1998. "Maximum-Likelihood Estimation of Fractional Cointegration with an Application to U.S. and Canadian Bond Rates." The Review of Economics and Statistics 80:42-26.
- Engle, Robert F. and Clive W. J. Granger. 1987. "Co-integration and Error Correction: Representation, Estimation and Testing." Econometrica 55:251-76.

- Engle, Robert F. and Clive W. J. Granger. 1991, eds. Long-Run Economic Relationships: Readings in Cointegration. Oxford: Oxford University Press.
- Epstein, Leon D. 1967. Political Parties in Western Democracies. New Brunswick, N.J.: Transaction Books.
- Erikson, Robert S., Michael B. MacKuen and James A. Stimson. 2000. "Bankers or Peasants Revisited: Economic Expectations and Presidential Approval." Electoral Studies 19:295-312.
- Fox, R and M.S. Taqqu. 1986. "Large Sample Properties of Parameter Estimates for Strongly Dependent Stationary Gaussian Time Series." Annals of Statistics 14:517-32.
- Franses, Philip Hans. 1998. Time Series Models for Business and Economic Forecasting. Cambridge: Cambridge University Press.
- Geweke, John and Susan Porter-Hudak. 1983. "the Estimation and Application of Long Memory Time Series Models." Journal of Time Series Analysis 4:221-38.
- Goodhart, Charles, A. E. and R. J. Bhansali. 1970. "Political Economy." Political Studies 18:43-106.
- Granger, Clive W. J. 1980. "Long Memory Relationships and the Aggregation of Dynamic Models." Journal of Econometrics 14:227-38.
- Granger, Clive W. J. 1981. "Some Properties of Time Series Data and their Use in Econometric Model Specification." Journal of Econometrics 16:121-30.
- Granger, Clive, W.J. and R. Joyeux. 1980. "An Introduction to Long-Memory Models and Fractional Differencing." Journal of Time Series Analysis 1:15-39.
- Granger, Clive W.J., and Paul Newbold. 1974. "Spurious Regressions in Econometrics." Journal of Econometrics 2:111-20.
- Hibbs, Douglas A. 1982a. "Economic Outcomes and Political Support for British Governments Among Occupational Classes: A Dynamic Analysis." American Political Science Review 76:259-79.
- Hibbs, Douglas A. 1982b. "The Dynamics of Political Support for American Presidents among Occupational and Partisan Groups." American Journal of Political Science 26:312-32.
- Hosking, J. R. M. 1981. "Fractional Differencing." Biometrika 68: 165-76.
- Key, V.O. 1968. The Responsible Electorate: Rationality in Presidential Voting, 1936-1960. New York: Vintage Books.
- Kiewiet, D. Roderick. 1983. Macroeconomics & Micropolitics: The Electoral Effects of Economic Issues. Chicago: University of Chicago Press.
- Kinder, Donald R. and D. Roderick Kiewiet. 1981. "Sociotropic Politics: The American Case." British Journal of Political Science 11:129-61.
- Koop, Gary, Eduardo Ley, Jacek Osiewalski and Mark F. J. Steel. 1995. "Bayesian Analysis of Long Memory and Persistence Using ARFIMA Models." Journal of Econometrics

- Krause, George A. 1998. "Voters, Information Heterogeneity, and the Dynamics of Aggregate Economic Expectations." American Journal of Political Science 41:1170-1200.
- Krause, George A. 2000. "Testing for the Strong Form of Rational Expectations with Heterogeneously Informed Agents." Political Analysis 8:285-305.
- Krause, George A. and Jim Granato. 1998. "Fooling Some of the People Some of the Time? A Test of Weak Rationality With Heterogeneous Information Levels." Public Opinion Quarterly 62:135-51.
- Kwiatkowski, D., P.C.B. Phillips, P. Schmidt, and Y. Shin. 1992. "Testing the Null Hypothesis of Stationarity Against the Alternative of a Unit Root." Journal of Econometrics 54:159-78.
- Lebo, Matthew. 2000. "Fractional Integration and Political Modeling." Unpublished paper, Cambridge, MA.: Harvard-MIT Data Center.
- Lebo, Matthew, Robert Walker and Harold D. Clarke. 2000. "You Must Remember This: Dealing With Long Memory in Political Analyses." Electoral Studies 19:31-48.
- Lewis-Beck, Michael S. 1988. Economics and Elections: The Major Western Democracies. Ann Arbor, MI: University of Michigan Press.
- Lo, Andrew W. 1991. "Long Term Memory in Stock Market Prices." Econometrica 59:1279-1313.
- MacKuen, Michael B., Robert S. Erikson, and James A. Stimson. 1992. "Peasants or Bankers?: The American Electorate and the U.S. Economy." American Political Science Review 86:597-611.
- MacKuen, Michael B., Robert S. Erikson, and James A. Stimson. 1996. "Comment." Journal of Politics 58:793-801.
- Maddala, G.S. and In-Moo Kim. 1998. Unit Roots, Cointegration, and Structural Change. Cambridge: Cambridge University Press.
- Miller, William L. and William M. Mackie. 1973. "The Electoral Cycle and the Asymmetry of Government and Opposition Popularity." Political Studies 21:263-79.
- Mizon, G. and J. Richard. 1986. "The Encompassing Principle and its Application to Testing Nonnested Models." Econometrica 54:657-78.
- Mueller, John E. 1970. "Presidential Popularity From Truman to Johnson." American Political Science Review 64:18-34.
- Norpoth, Helmut. 1996a. "Presidents and the Prospective Voter." Journal of Politics 58:776-92.
- Norpoth, Helmut. 1996b. "Rejoinder." Journal of Politics 58:802-05.
- Norpoth, Helmut, Michael S. Lewis-Beck and Jean Dominique Lafay. 1991. eds. Economics and Politics: The Calculus of Support. Ann Arbor, MI: University of Michigan Press.

- Phillips, Peter C. B. and Zhijie Xiao. 1999. "A Primer on Unit Root Testing." In Michael McAleer and Les Oxley, eds., Practical Issues in Cointegration Analysis. Oxford: Blackwell Publishers Ltd.
- Pulzer, Peter. 1967. Political Representation and Elections in Britain. London: Allen & Unwin.
- Robinson, P.M. 1995. "Gaussian Semiparametric Estimation of Long Range Dependence." Annals of Statistics 23:1630-61.
- Sanders, David. 1991. "Government Popularity and the Next General Election." @ Political Studies 62:235-61.
- Sanders, David, Hugh Ward and David Marsh (with Tony Fletcher). 1987. "Governmental Popularity and the Falklands War: A Reassessment." British Journal of Political Science 17:281-313.
- Smith, Renée M. 1993. "Error Correction, Attractors, and Cointegration: Substantive and Methodological Issues." In John R. Freeman, ed., Political Analysis, vol. 4. Ann Arbor: University of Michigan Press.
- Sniderman, Paul M., Richard A. Brody and Phillip E. Tetlock, eds. 1991. Reasoning and Choice: Explorations in Political Psychology. Cambridge: Cambridge University Press.
- Sowell, F. 1992. "Maximum Likelihood Estimation of Stationary Univariate Fractionally Integrated Time Series Models." Journal of Econometrics 53:165-88.
- Stokes, Donald E. and Gudmund R. Iversen. 1966. "On the Existence of Forces Restoring Party Competition." In Angus Campbell et al. eds., Elections and the Political Order. New York: John Wiley & Sons, Inc.
- Zaller, John. 1992. The Nature and Origins of Mass Opinion. New York: Cambridge University Press.

Table 1

Estimates of Fractional Differencing Parameter d

| | Sowell's d estimate | Standard Error | Robinson's d estimate | Standard Error | t-ratio ^a ($d=0$) | t-ratio ^a ($d=1$) |
|----------------------------|--------------------------|-------------------|----------------------------|-------------------|-----------------------------------|-----------------------------------|
| <i>Variables</i> | | | | | | |
| Governing Party Support | 0.82 | 0.058 | 0.85 | 0.059 | 14.32** | -2.53* |
| Prime Ministerial Approval | 0.91 | 0.060 | 0.96 | 0.059 | 16.18** | -0.67 |
| Economic Evaluations: | | | | | | |
| Personal Expectations | 0.72 | 0.059 | 0.70 | 0.059 | 11.80** | -5.06** |
| Personal Retrospections | 0.77 | 0.051 | 0.84 | 0.059 | 14.16** | -2.70** |
| National Expectations | 0.61 | 0.060 | 0.63 | 0.059 | 10.62** | -6.24** |
| National Retrospections | 0.83 | 0.057 | 0.83 | 0.059 | 13.99** | -2.86** |

N = 210

* - $p < .05$ ** - $p < .01$ ^a based on Robinson's estimates.

Table 2

ARFIMA Error Correction Models of Governing Party Support,
Two-Step Estimates, September 1979 - December 1996

Models

| <i>Predictor Variables</i> | <u>Personal Expectations</u> | | <u>Personal Retrospections</u> | | <u>National Expectations</u> | | <u>National Retrospections</u> | |
|----------------------------------|------------------------------|-------------|--------------------------------|-------------|------------------------------|-------------|--------------------------------|-------------|
| | <u>b</u> | <u>s.e.</u> | <u>b</u> | <u>s.e.</u> | <u>b</u> | <u>s.e.</u> | <u>b</u> | <u>s.e.</u> |
| Constant | 0.140 | 0.134 | 0.138 | 0.134 | 0.131 | 0.134 | 0.129 | 0.135 |
| Δ PM approval | 0.378*** | 0.038 | 0.384*** | 0.038 | 0.383*** | 0.039 | 0.392*** | 0.040 |
| Economic Evaluations: | | | | | | | | |
| Δ Personal Expectations | 0.056* | 0.028 | x | x | x | x | x | x |
| Δ Personal Retrospections | x | x | 0.056* | 0.033 | x | x | x | x |
| Δ National Expectations | x | x | x | x | 0.016 | 0.013 | x | x |
| Δ National Retrospections | x | x | x | x | x | x | 0.007 | 0.014 |
| ECM: | | | | | | | | |
| Adjustment parameter | -0.272*** | 0.058 | -0.274*** | 0.059 | -0.282*** | 0.058 | -0.281*** | 0.059 |
| Falklands War | 6.625*** | 1.887 | 6.891*** | 1.889 | 6.795*** | 1.896 | 6.751*** | 1.912 |
| Poll Tax | -3.174** | 1.327 | -3.825** | 1.338 | -3.368** | 1.330 | -3.473** | 1.331 |
| Major Replaces Thatcher | 4.980** | 1.912 | 4.765** | 1.923 | 4.941** | 1.926 | 4.989** | 1.932 |
| Currency Crisis (t-3) | -3.373* | 1.867 | -3.292* | 1.870 | -3.198* | 1.876 | -3.125* | 1.881 |
| Major Reselection(t-1) | 5.641*** | 1.881 | 5.620*** | 1.889 | 5.904*** | 1.887 | 5.931*** | 1.892 |
| Miscellaneous Events | 1.520*** | 0.288 | 1.500*** | 0.288 | 1.518*** | 0.291 | 1.504*** | 0.294 |

Diagnostic Statistics

| | | | | |
|--------------------|-----------|-----------|-----------|-----------|
| Adjusted R2 | .586 | .583 | .581 | .578 |
| S.E.E. | 1.859 | 1.864 | 1.871 | 1.876 |
| Durbin Watson d | 1.949 | 1.952 | 1.933 | 1.944 |
| Serial Correlation | 8.980 | 10.168 | 8.765 | 7.880 |
| Functional Form | 0.063 | 0.005 | 0.059 | 0.067 |
| Normality | 13.066*** | 19.168*** | 17.313*** | 19.774*** |
| Heteroskedasticity | 0.482 | 0.357 | 0.271 | 0.380 |
| ARCH (1) | 0.207 | 0.014 | 0.053 | 0.029 |

a - $p \leq .001$; b - $p \leq .01$; c - $p \leq .05$; one-tailed test.

x - variable not included in model.

Note: all predictor variables modelled as operating at time t except as indicated.

Table 3

Encompassing Tests of Rival Personal Economic Expectations (PE) and
 Personal Retrospective Economic Evaluation (PR) Models,
 Two-Step Fractional Error Correction Estimates

| <i>Encompassing Tests</i> | <u>PE Model v. PR Model</u> | <u>PR Model v. PE Model</u> |
|---------------------------|-----------------------------|-----------------------------|
| N-Test | -1.127 (p = .260) | -2.200 (p = .028) |
| NT-Test | -0.523 (p = .601) | -1.207 (p = .228) |
| W-Test | -0.522 (p = .602) | -1.199 (p = .230) |
| J-Test | 0.811 (p = .418) | 1.295 (p = .195) |
| JA-Test | 0.811 (p = .418) | 1.295 (p = .195) |
| F Test | 0.657 (p = .419) | 1.677 (p = .197) |

Table 4

ARFIMA Error Correction Models of Governing Party Support,
One-Step Estimates, September 1979 - December 1996

Models

| <i>Predictor Variables</i> | <u>Personal Expectations</u> | | <u>Personal Retrospections</u> | | <u>National Expectations</u> | | <u>National Retrospections</u> | |
|----------------------------------|------------------------------|-------------|--------------------------------|-------------|------------------------------|-------------|--------------------------------|-------------|
| | <u>b</u> | <u>s.e.</u> | <u>b</u> | <u>s.e.</u> | <u>b</u> | <u>s.e.</u> | <u>b</u> | <u>s.e.</u> |
| Constant | 0.197 | 0.136 | 0.228 | 0.143 | 0.216 | 0.143 | 0.212 | 0.144 |
| Δ PM approval | 0.364*** | 0.039 | 0.367*** | 0.039 | 0.367*** | 0.041 | 0.377*** | 0.041 |
| Economic Evaluations: | | | | | | | | |
| Δ Personal Expectations | 0.063* | 0.029 | x | x | x | x | x | x |
| Δ Personal Retrospections | x | x | 0.061* | 0.035 | x | x | x | x |
| Δ National Expectations | x | x | x | x | 0.015 | 0.014 | x | x |
| Δ National Retrospections | x | x | x | x | x | x | 0.005 | 0.015 |
| ECM: | | | | | | | | |
| Adjustment parameter | -0.235*** | 0.060 | -0.227*** | 0.062 | -0.233*** | 0.062 | -0.232*** | 0.062 |
| PM Approval(t-1) | 0.555*** | 0.153 | 0.529*** | 0.163 | 0.567*** | 0.160 | 0.556*** | 0.161 |
| Falklands War | 6.797*** | 1.917 | 7.098*** | 1.945 | 7.000*** | 1.955 | 6.985*** | 1.972 |
| Poll Tax | -3.207** | 1.349 | -3.943** | 1.381 | -3.448** | 1.372 | -3.552** | 1.373 |
| Major Replaces Thatcher | 4.805** | 1.945 | 4.400* | 1.988 | 4.626** | 1.992 | 4.675** | 1.999 |
| Currency Crisis (t-3) | -4.571** | 1.908 | -4.531** | 1.939 | -4.403* | 1.946 | -4.329*** | 1.952 |
| Major Reselection(t-1) | 6.032*** | 1.933 | 6.120*** | 1.970 | 6.384*** | 1.972 | 6.438*** | 1.978 |
| Miscellaneous Events | 1.580*** | 0.298 | 1.660*** | 0.314 | 1.664*** | 0.317 | 1.650*** | 0.321 |

Diagnostic Statistics

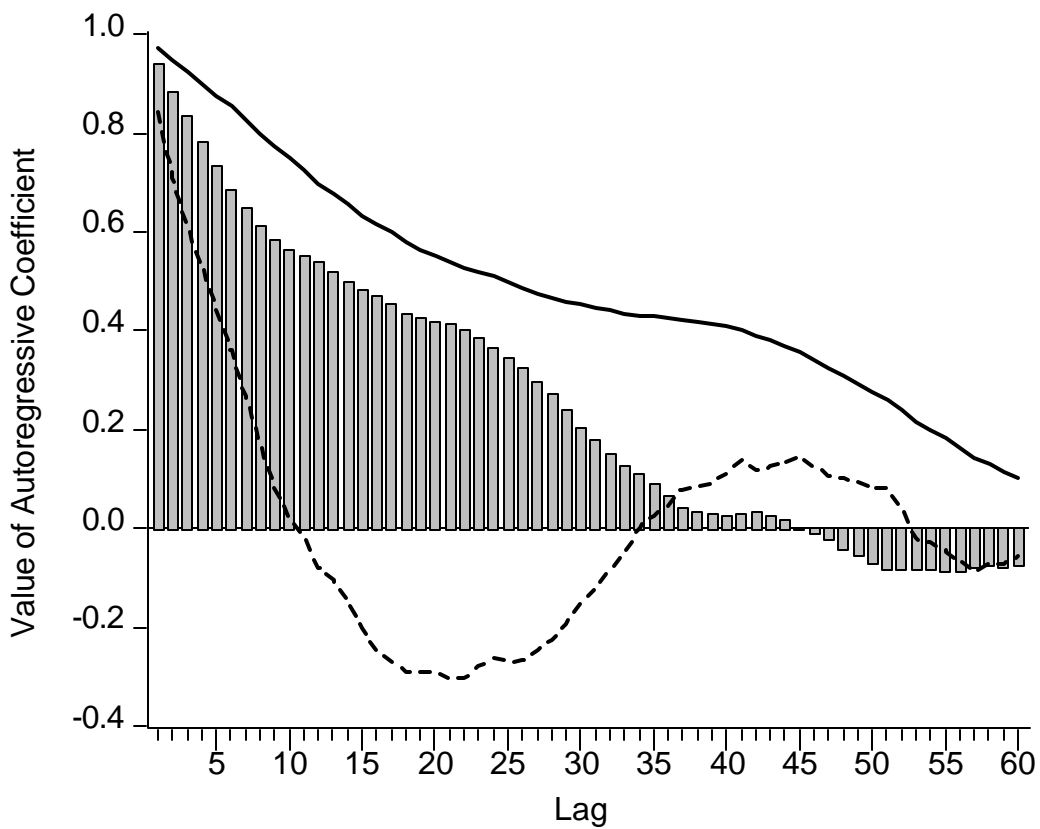
| | | | | |
|--------------------|--------|---------|---------|---------|
| Adjusted R2 | .575 | .576 | .572 | .570 |
| S.E.E. | 1.888 | 1.918 | 1.928 | 1.933 |
| Durbin Watson d | 1.984 | 1.993 | 1.978 | 1.987 |
| Serial Correlation | 9.428 | 11.098 | 8.946 | 8.235 |
| Functional Form | 0.048 | 0.113 | 0.280 | 0.282 |
| Normality | 9.558* | 13.555* | 12.942* | 14.866* |
| Heteroskedasticity | 0.007 | 0.010 | 0.012 | 0.001 |
| ARCH (1) | 0.145 | 0.050 | 0.020 | 0.020 |

a - $p \leq .001$; b - $p \leq .01$; c - $p \leq .05$; one-tailed test.

x - variable not included in model.

Note: all predictor variables modelled as operating at time t except as indicated.

Figure 1. Autocorrelation Functions for Fractionally Integrated, Random Walk and Stationary First-Order Autoregressive Processes



■ Fractionally integrated, $d = .85$ — Random walk - - - - Stationary AR1, $B1 = .85$

