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Rational Learning and Partisan Attitudes

*Rational Learning and Partisan Attitudes**

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Theory: Characterizing voters as rational actors who update their party affiliations based on a Bayesian assimilation of new information, Achen (1992) showed that a revisionist model of party identification generates, among its empirical implications, stable partisanship among adults. The model further implies that susceptibility to partisan change declines with age. The significance of Achen's model for the study of party identification leads us to examine more closely its underlying assumptions and the empirical ramifications of this and other learning models.
Method: This essay develops a more general learning model, based upon the Kalman filter, that encompasses the Achen model as a special case.
Results: We show that the Achen assumption of a fixed party benefit level leads to implausible implications about how voters learn from the history of party performance. When party benefit levels are allowed to vary over time, models of voter learning no longer imply that partisan attitudes, even among the older segments of the population, remain stable in the wake of new information about the parties. We conclude by discussing the empirical viability of our revised learning model and its implications for the study of partisan attitudes.

In the field of public opinion and electoral behavior, no explanatory variable is more pervasive than party identification. Decades after its formulation by Belknap and Campbell (1952) and refinement by Campbell et al. (1960), the idea that voters commonly express some form of attachment to parties has become more or less universal. Scholars debate whether party identification's influence on electoral choice has waned since the publication of *The American Voter* (1960), but few take exception to the claim that partisanship remains a powerful predictor of vote choice (Keith et al. 1992; Miller and Shanks 1996).

At the same time, the nature and origins of party identification remain the subject of ongoing dispute. The traditional view of partisanship emphasizes the strength of the psychological bond that links citizens to political parties. Partisans come to see themselves as members of social groups (e.g., Democrats, Republicans), in much the same way that certain people incorporate religious, regional, or ethnic groups into their self-conceptions. Alter-

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Replication Note: Data and programs used to generate the results reported in this essay may be found on the website http://pantheon.yale.edu/~gogreen/achen/. The American National Election Study data were obtained from ICPSR.

ing one's self-concept, particularly when it involves repudiating once admired groups and symbols, is disquieting, so that once partisan or other social identifications take root in young adulthood, they tend to persist even amid changing political circumstances. To be sure, social identifications can be disrupted beyond age 30. Party attachments, for example, have been found to shift when party organizations emerge that pit linguistic, ethnic, and regional identities against preexisting party identities (Schickler and Green 1997) or in party systems such as contemporary Italy in which party labels change (Converse and Pierce 1985). But under ordinary circumstances, the distribution of partisanship is expected to adjust slowly to swings in political or economic fortunes and shift appreciably only when short-term forces favor one party for a sustained period of time. Party identification, as Converse (1966) argues, functions as ballast in an electoral system, stabilizing party competition amid shifting political currents.

The alternative perspective on partisanship, associated with scholars such as Downs (1957) and Fiorina (1981), views party identification as a "running tally" of evaluations of party platforms and performance in office. From this vantage point, party identification is more analogous to presidential approval than to religious affiliation. Continually updated in light of current information, partisanship may undergo considerable change as events alter public confidence in each party or as changes in party leadership alter the perceptions of the parties' policy stances.

In the ensuing empirical disputes between the two perspectives, debate centered on the apparent stability of party identification. Some early studies seemed to show that partisanship was susceptible to change (Brody and Rothenberg 1988; Fiorina 1981; Franklin and Jackson 1983; Jackson 1975; Page and Jones 1979), but by the early 1990s, these findings came under attack on methodological grounds. Revisionist claims were dealt a series of setbacks as new evidence emerged showing partisanship among adults to be highly stable over time (Green and Palmquist 1990, 1994) and only modestly affected by changing perceptions of party platforms or performance in office (Green and Palmquist 1990; Schickler and Green 1994).

In the early 1990s, however, the terms of debate shifted. Characterizing voters as rational actors who update their party affiliations based on a Bayesian assimilation of new information, Achen (1992) showed that a revisionist model of party identification generates, among its empirical implications, stable partisanship among adults. The model further implies that susceptibility to partisan change declines with age. Achen's important paper strengthened the revisionist case, allowing it to sidestep the issue of partisan stability, while at the same time supplying a mechanism for life-cycle effects that had previously been attributed to maturation (Alwin and Krosnick 1991). Far from being empirically inadequate, the revisionist view now seemed to explain a wide range of known facts about party identification (Achen 1992, 204-6).

The significance of Achen's model for the study of party identification leads us to examine more closely its underlying assumptions and the empirical ramifications of this and other learning models. This essay develops a more general learning model, based on the Kalman filter, and investigates its implications for the dynamics of partisan attitudes. In section 1, we provide an overview of Achen's learning model, drawing attention to certain pivotal assumptions. Achen, for example, assumes that the average "benefits" a party provides remain constant over time and equates party identification with prospective evaluations of party performance. Both premises turn out to play an important role in shaping the empirical implications of this model. In section 2, we show that the Achen model is a special case of a more general formulation of the voter's inference problem. In section 3 we show that Achen's assumption of a fixed party benefit level leads to implausible implications about how voters learn from the history of party performance. When party benefit levels are allowed to vary over time, models of voter learning no longer imply that partisan attitudes, even among older segments of the population, remain stable in the wake of new information about the parties.

The frequent and abrupt changes in the public's evaluations of the parties suggest that citizens are attentive to current information. If party identification is equated with prospective performance evaluations, however, its stability over long stretches of time is consistent with a model of rational updating of expected performance only under very special circumstances. This theoretical tension, coupled with the manifest differences between prospective performance evaluations and party identification, suggest that one must model the two constructs differently. In the concluding section, we sketch an alternative model of party identification.

1. Overview of the Model

In two recent papers, Achen develops a Bayesian model of how voters use information they observe about the political parties to form judgments about the relative abilities of the parties to deliver benefits (Achen 1989, 1992). Extending earlier work by Zechman (1979) and Calvert and MacKuen (1985), Achen depicts voters as rational and forward looking.[1] Voters use the laws of probability to "update" their prior beliefs about the parties, which are based initially on information they infer from their parents' political views, by using the additional political information they receive over their own lifetimes. Voters are rational in the sense that this updating process extracts an

[1]For other work using a Bayesian model of voter learning, see Bartels (1993) and Husted, Kenny, and Morton (1995). These authors do not examine party identification. Like Achen (1992), they consider voter learning for the special case where the political variables of interest are assumed to be fixed over time.

optimal amount of information from preexisting beliefs and news about the political environment. Citizens then base their voting decisions on their assessments of which party they expect to provide greater benefits. Achen generates a formula which captures how voters optimally combine their initial beliefs with new information, and then he details what this formula implies about the evolution of a voter's party identification and voting decisions. Further, his work also generates some important implications for how we might change the way we specify empirical models that attempt to explain how people vote.

Achen contends that many important empirical findings about party identification are consistent with a simple model of learning, but the implications of his model follow from the fact that he analyzes a special case, namely, a "stable two party system." The statistical expectation of the benefits that each party provides to each group in society is assumed to be set at some unobserved level. This level remains constant over time, which is to say, the parties never change their policy positions, competence in economic management, or skill in managing foreign affairs. Rather, the two parties

> offer benefits to voters that oscillate over time around a fixed but unknown mean. . . . The benefits vary independently from one term of office to the next around a central tendency. Thus, the parties may oscillate left or right by chance, but they do not drift steadily in any one direction. In effect, the model describes a stable period between realignments. (1992, 199).

Citizens form their party identifications by estimating the underlying party benefits differential and siding with the party that offers the greatest utility. The process involves acquiring information about the actual benefits that each party provides each period, which constitutes a noisy measurement of this constant mean benefit level provided by each party. The voters' inference problem is to update their initial opinion about the parties, making guesses about the true party mean benefit level using a lifetime of observations of the actual benefit levels provided by the parties (e.g., the constant mean benefit level plus noise, where the noise term each period is i.i.d. normal).[2] We will refer to the model of voter learning when the relative benefit level of the parties is fixed as the "static party" model.

[2]Achen's model of party identification shows that current party identification is a function of the voter's initial prior beliefs and the voter's personal experience. As a result, the model looks "retrospective" even though the voters are entirely prospective. Achen states that "In fact, the retrospective appearance (of the party identification equation) is an accident of the special case considered here, in which party benefit streams are constant over time. If the model were applied to the period of a realignment or to parties whose platforms and appeals are changing, it would cease to be retrospective" (1992, 202). As we point out below, however, only in the most extreme case would voter learning cease to look retrospective.

Using the assumption that parties are a fixed quantity, Achen shows that a rational learning model can produce a number of interesting theoretical results about how citizens learn over time. He proves that, for example, as citizens accumulate experience observing the parties, the value of additional information declines. As a result, all things equal, we should observe that older citizens place less weight on recent performance than younger citizens. Similarly, Achen shows that judgments about the parties become more precise as time passes and citizens acquire information, the result being that party identification becomes increasingly stable over a voter's lifetime.

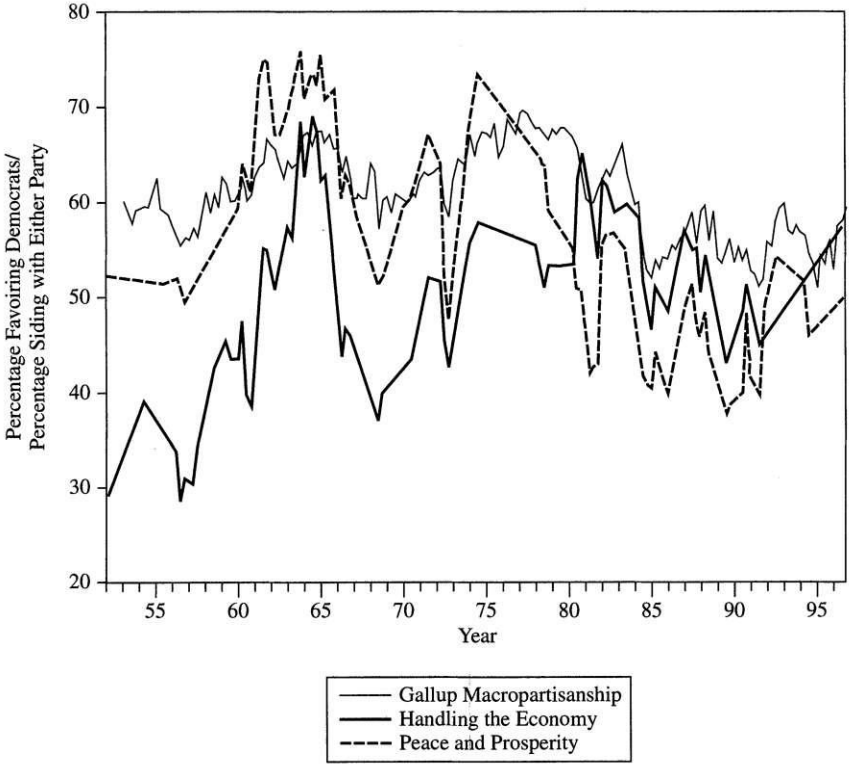
How do the implications of the learning model change when the party benefits differential is no longer assumed to be unchanging over time? As we demonstrate below, allowing the parties to change—even to a minor degree—alters Achen's central finding, that citizens acquire so much information about the parties that they cease to assimilate new information into their partisan attitudes. Our more general model suggests that current information continues to be important, even when voters have a great deal of experience with the parties. Achen's model implies stable partisan attitudes because it presupposes perfectly stable parties.

Before proceeding with our generalization of Achen's model, it is important to call attention to the fact that for Achen, party identification is nothing more than the voter's "current estimate of the benefit differential between the parties" (1992, 202). Achen does not make explicit what he has in mind by "benefits," but at various points alludes to favorable economic performance and ideologically attractive policies. Self-conceptions, social identities, and the like play no apparent role in this definition. When Achen speaks of party identification, he seems to have in mind what is ordinarily termed prospective evaluations of party performance.

The distinction between whether voters identify with supporters of a given party (ordinarily termed party identification) and how they assess what parties would do in office (prospective performance evaluation) has important empirical ramifications, particularly as we try to link theoretical predictions with observed regularities. One of the most striking facts about partisan attitudes is that prospective performance evaluations can swing wildly as party fortunes wax and wane without much impact on the distribution of party identification. Consider, for example, the aggregate distribution of party identification and performance evaluations, as assessed by Gallup polls during the period 1952-96 (Figure 1). Following MacKuen, Erikson, and Stimson (1989), we chart the percentage of all party identifiers (Democrats and Republicans, with Independents excluded) who call themselves Democrats.[3] For the sake of comparability, we score the pro-

[3]Gallup switched from in-person to telephone interviews in early 1988, and the partisanship data have been adjusted to account for the Republican bias in the Gallup telephone samples. For further discussion of these data, see Green, Palmquist, and Schickler (Forthcoming).

Figure 1. Marcopartisanship and Prospective Evaluations of Party Performance on the Economy and Foreign Affairs



spective evaluations in a similar manner. That is, we ignore respondents who see no difference between the parties and plot the percentage who see the Democrats as likely to do a better job. One performance series asks which party will do a better job of keeping the country prosperous; the other, which party will keep the nation out of war.[4]

[4]Two similar versions of the prosperity item were used. The first reads "Looking ahead for the next few years, which political party do you think will do a better job of keeping the country prosperous—the Republican Party or the Democratic Party?" The other is similar: "Which political party—the Republican, or the Democratic—will do a better job of keeping the country prosperous?" The war questions come in three formats: "Looking ahead for the next few years, which political party do you think would be more likely to keep the United States out of war—the Republican Party or the Democratic Party?" An earlier version reads "Looking ahead for the next few years, which political party do you think would be more likely to keep the United States out of World War III— the Republican or the Democratic Party?" A variant of the WWIII reference reads "Which political party do you think would be more likely to keep the United States out of World War III—the Republican Party or the Democratic Party?"

The most noteworthy feature of Figure 1 is the speed and frequency with which evaluations of the parties have changed. Between 1957 and 1958, the Democratic rating on economic performance shot from 51% to 68%; another surge occurred between 1960 and 1961, where the rating climbed from 60% to 75%. These gains dissipated rapidly a few years later, as the 71% ratings typical of 1965 gave way to ratings of 61% in 1966. Nixon's reelection campaign pushed the Democratic rating down from 68% in 1971 to just 47% by the end of 1972. Swings of more than 10 points in the span of a year or two occur periodically from that point on: 1972-74, 1978— 80,1980-81,1981-82,1983-84,1991-92. No less dramatic swings punctuate the series prospective evaluations based on the criterion of keeping the country out of war. It seems clear, then, that the public, however inattentive it may be, adjusts its assessments of the parties rapidly in the wake of changing national or international conditions (cf. Page and Shapiro 1992).

While it is apparent from Figure 1 that Democratic gains in party identification coincide with surging public confidence in the Democratic party, party identification has changed much more gradually over time. The dramatic improvements in assessments of Democratic competence between the late Eisenhower and early Johnson administrations (which saw economic evaluations shift by 25 percentage points and peace and prosperity ratings by 45) and sharp declines during the Reagan era (economic ratings dropped from the mid 60s under Carter to the low 40s at the end of 1984), corresponded with 10-15 percentage point shifts in party identification. When we consider the 60 quarters during which data for all three series are available, the standard deviations for party identification, economic evaluations, and peace and prosperity ratings are 4.7, 11.4, and 9.5, respectively.

Much the same conclusion comes through when we trace individuals' attitudes over successive waves of a panel study. In the 1990-91-92 NES Panel, respondents were asked to rate the parties in terms of economic and foreign policy stewardship. Table 1 presents the correlations between responses to these questions at each point in time. Because the prospective performance evaluations have just three response categories, we report the polychoric correlations (Joreskog and Sorbom 1993), which correct for the ordinal nature of the data. For the sake of comparability, polychoric correlations for the party identification measures were based on the 3-point categorization of Democrats, Independents, and Republicans. Applying a Heise (1969) model of over-time stability to these data, so as to allow for the possibility of measurement error (see Green and Palmquist 1994), we find that party identification is substantially more stable than prospective evaluations of party performance. Corrected for measurement error, the R^2 when 1991 attitudes are regressed on 1990 is 1.0 for party identification, .92 for economic evaluations, and .87 for foreign policy evaluations. The same ordering holds when 1992 is regressed on 1991: .92 versus .70 and .76.

Table 1. Stability of Individual-Level Party Identification and Prospective Performance Evaluations

Polychoric Correlations			
Three Point Party Identification: 1990	1.000		
Three Point Party Identification: 1991	0.888	1.000	
Three Point Party Identification: 1992	0.852	0.836	1.000
Which Party will Better Handle the Economy: 1990	1.000		
Which Party will Better Handle the Economy: 1991	0.669	1.000	
Which Party will Better Handle the Economy: 1992	0.559	0.580	1.000
Which Party will Better Handle Foreign Affairs: 1990	1.000		
Which Party will Better Handle Foreign Affairs: 1991	0.536	1.000	
Which Party will Better Handle Foreign Affairs: 1992	0.466	0.487	1.000

Results from a Heise (1969) Model of Over-Time Stability Weighted Least Squares Estimates

	R^1, wave 2	R^2, wave 3	Reliability
Party Identification	1.000	.920	.872
Economic Evaluations	.928	.698	.694
Foreign Affairs Evaluations	.914	.755	.561

Data are from the 1990-91-92 National Election Study Panel. N = 942.

The manifest differences between party identification and prospective performance evaluations suggest that the power of rational learning models may vary depending on which facet of partisan attitudes one considers. Achen contends that his model accounts for certain key empirical regularities associated with party *identification*; but those regularities differ from what we find when looking at *prospective performance evaluations*, despite the fact that Achen equates the two conceptually. This point will be important to bear in mind as we generalize Achen's model, because it will turn out that relaxing his assumption about stable party benefits will imply that citizens are more responsive to current information than Achen's model suggests. Given the rapid swings that occur in public evaluations of the parties, it may be said that a more general learning model anticipates the dynamics of prospective evaluations but cannot, by itself, account for the more limited change characteristic of party identification. This is a point to which we will return in the concluding section of this paper.

2 Rational Learning Model

Voters begin life with some ideas about the political parties and some sense of how sure they are about their views. Following Achen, we assume that each voter begins with some prior belief about the party "differential," which is the difference between the benefits the voter expects from the Demo-

crats minus the benefits expected from the Republicans. Associated with this prior belief, which is denoted a_0, is a variance P_0, which captures the voter's level of uncertainty about his or her initial beliefs about the parties. (Readers may find it convenient to refer to Table 2, which summarizes the notation used in this model.) The voters observe the behavior of the parties over time and get some additional information about the party differential. Suppose the true party differential at time t is α_t. At time t the voters observe:

$$y_t = \alpha_t + \in_t, \qquad [1]$$

where $\in_t$ is an error term, independently distributed N(0, h), with positive h. Following Achen, we will assume that the voters need only worry about estimating the relative party benefits, and the properties of the error term, such as its distribution and variance, are known.[5] Equation [1] says that each period's observation is a noisy reading of the true party differential at the time of the observation. If the true party differential is correlated over time, voters can use information from today's performance to make inferences about what the parties will be offering next period. Suppose the party differential changes over time according to the rule:

$$\alpha_t = \gamma\alpha_{t-1} + \eta_t, \qquad [2]$$

where γ is a positive constant, less than or equal to 1, and η_t is an error term, independently distributed N(0, q). One special case of equation [2], $\gamma = 1$ and $q = 0$, implies that the true party differential stays constant over time. Alternatively whenever $q > 0$, the ideological positions, relative skill, or attractiveness of the party leaders may vary over time.

Voters combine their prior beliefs and what they observe to estimate the party benefit differential. We assume that rational voters use the best possible method for combining their prior beliefs and current information. The

[5]In some previous theoretical work on voter learning the voters also had to infer the variance of the error term, and so their updated beliefs followed a *t* distribution, instead of a normal distribution (Calvert and MacKuen 1985). Throughout our analysis, we will assume that the voters know the process by which the information they observe is generated (i.e., the distribution of the error terms, the equation linking what they observe each period to the underlying parameter they wish to estimate) but do not know the values the errors take on and so therefore must use what they observe to make statistical estimates of what they are interested in. In principle, over time all the parameters we assume the voters know could be estimated using the data the voters observe. We will not analyze how our results might differ when the voters must also estimate those additional parameters, though it seems intuitive that, after an initial period of learning, the situation will approximate that when the parameters are known from the beginning.

Table 2. Summary of Notation Used in the Kalman Filter Model

Symbol	Explanation
y_t	observed benefit differential, period *t*
α_t	actual benefit differential, period *t*
$\in t$	measurement error in observed benefit differential, period *t*
η_t	random component of change in actual benefit differential, between period *t* - 1 and period *t*
h	variance of $\in_t$
q	variance of η_t
a_0	initial voter beliefs about actual benefit differential
P_0	variance of voter initial beliefs
a_t	voter estimate of benefit differential at period *t*
P_t	variance of voter estimate of benefit differential at period *t*

optimal estimate of α_t,where optimal means minimizing the expected square error, will be denoted by a_t. This estimator is:

$$a_t = (1 - K_t)\,\gamma a_{t-1} + K_t(y_t) = \gamma a_{t-1} + K_t(Y_t - \gamma a_{t-1}), \qquad [3]$$

where $K_t = (\gamma^2 P_{t-1} + q) \mid (\gamma^2 P_{t-1} + q + h)$, and P_{t-1} is the variance of a_{t-1}. The variance of the estimator at is Pt, where

$$P_t = hK_t$$

These equations are known as the Kalman filter algorithm. A more extensive description of the Kalman filter, along with demonstrations of its properties, is contained in Harvey (1989) and Beck (1989). Under the assumption of normality of the errors, the Kalman filter is the estimator that gives the voter the lowest mean squared error. Under this assumption the Kalman filter algorithm can be derived using Bayes' rule (see Meinhold and Singpurwalla 1983). The Kalman filter therefore represents a generalization of Achen's model of Bayesian learning, which now permits us to relax the assumption that party benefits remain constant. We demonstrate later in the paper that Achen's model is a special case of our more general model. If the normality assumption is relaxed, the Kalman filter remains the optimal estimator among all linear estimators.

While the exact formula used to combine new and old information is relatively complicated, the properties of the Kalman filter are quite intuitive. The estimate of todays party difference [eqn. 3] is a weighted average of what we had expected the party difference to be and an "error correction" which adjusts our estimates according to how far off today's actual observation, y_t, is from our expectation based on previous observations, After observing y_t, our revised estimate of α_t captures all the information we have and forms the basis for next period's expectation, which is then revised again if there is a further prediction error. The amount of weight placed on this period's observation y varies according to how much information is contained in the new observation. When h is large, the amount of noise contained in each new observation of party performance is large, and so there is a relatively small revision of our beliefs about the parties in response to a surprising value of y. When h is small, y is a very good reading of where the parties are, and so the voters will put a lot of weight on recent performance. When q is small, the parties do not move around very much, and so old observations, which are imbedded in last period's estimate of the party differential, contain a lot of useful information about the current party differential. As a result, the amount of weight placed on new information will be small. On the other hand, if q is large, and therefore the true underlying party differential moves around a lot, the voters will ignore the past and place more value on the current observation. As q approaches extreme large values, all weight is placed on the new information, and nothing can be learned from earlier periods.

The Kalman filter algorithm is "started" using the voter's priors; a_0 is the voter's best guess for α_0, and P_0 is the variance of this estimate. After voters observe y_1, they revise their estimates of the party positions and also calculate the variance of their new estimates.

$$a_1 = \gamma a_0 + K_1(Y_1 - \gamma a_0), \qquad [3]'$$

$$P_1 = hK_1. \qquad [4]'$$

where $K_1 = (\gamma^2 P_0 + q) / (\gamma^2 P_0 + q + h)$. The process of updating based on new information continues next period and beyond, using the new values of a, P, and the new value of y.

An interesting feature of the Kalman filter is that, as of time t, all the useful information from the past is embodied in a_{t-1}, the voter's best estimate of the party differential in period t - 1. The specific values of y and a_0 that led up to this judgment about the party differential can be "forgotten" without any loss. As in the special case of Bayesian learning when the party

differential is constant over time, preserving a running tally of the parties' qualities is, from the standpoint of the rational voter, as good as memory based processing, even if there is no cost to storing memories.

The Kalman filter model is a generalization of previous work on Bayesian learning by voters. It is easy to show that, for the special case where the parties do not change, the Kalman filter estimator for the party differential is equivalent to the expected value of the party differential produced by the more familiar Bayesian updating formula employed by Achen and others. The first iteration is shown as an example. Let q = 0 and $\gamma = 1$, then the Kalman filter algorithm simplifies to:

$$a_1 = a_0 + K_1(y_1 - a_0) = (1 - K_1)a_0 + K_1 y_1, \quad [5]$$

where $K_1 = (P_0)/(P_0 + h)$. This can be rewritten in a more familiar form:

$$\alpha_1 = [ha_0 + P_0 y_1]/(P_0 + h) = [(1/P_0)a_0 + (1/h)y_1]/[(1/P_0) + (1/h)], \quad [6]$$

where 1/h is the precision of y_1 and $1/P_0$ is the precision of the prior. This is directly analogous to Achen's equation 5 (1992, 202). Thus, the Kalman filter model encompasses Achen's as a special case.

3. Some Characteristics of Voter Learning

The Kalman filter provides the optimal prospective evaluation of the relative benefits offered to the voter by the parties. As noted above, Achen equates this quantity with the voter's party identification. To maintain comparability with earlier work, we refer to the prospective evaluation as the voter's "party identification" in this section.

Proposition 1.
Suppose that the voter's priors about the parties represents the influence of parental experience (Achen 1989). The effect of parental experience on their children's current party identification is positive, but declines over time.

Proof. First, we show a lemma:
The optimal estimator a_t can be written as a linear function of a_0:

$a_t = c_t a_0 + f_t(Y_t)$, where f_t is a row vector, Y_t is a *t* element column vector $(y_{1,} \ldots y_t)$, and

$$C_t = \prod_{i=1}^{t} (1 - K_i)\gamma^t$$

The linear form of a_t follows directly from the form of the Kalman filter. The exact value of c_t can be shown by induction. From [3]' $a_1 = \gamma a_0 + \mathbf{K_1(y_1} - \gamma a_0)$, and so $c_1 = (1 - K_1)\gamma$. $a_N = C_N a_0 + f_N(Y_N) \cdot$ Using [3], $a_{N+1} = \gamma a_N + K_{N+1}(y_{N+1} - \gamma a_N)$. Substituting, $a_{N+1} = (1 - K_{N+1})\gamma [c_N a_0 + f_N(Y_N)] + K_{N+1} y_{N+1}$, which implies that $c_{N+1} = (1 - K_{N+1})\gamma c_N$. Since $K < 1$ and $\gamma \leq 1$, the weight placed on the prior estimate of the party differential always fails.

Proposition 1 shows that as time passes the initial conditions get less and less weight in the voter's estimates of what the party will now do. Before moving on, let us consider what this means for the transmission of party identification from parents to children. Achen suggests that children take as their initial priors the evaluations of their parents. Both his model and ours imply that these parental evaluations will become increasingly uninformative to offspring as they acquire experience with the parties. In the limit, parental evaluations contribute nothing to the evaluations of the offspring. Any correlation between parent and child evaluations is the by-product of similarities in their preference schedules and the fact that each may have observed similar party differentials over time.

The next proposition deals with the relative importance of recent observations in the voter's evaluation of the parties. The following definition will be useful in explaining how this varies across different situations.

Definition: Suppose $Y(t) = B(t)X(t)$. The effect of X on Y is said to "stabilize" at B, if B is the limit of $B(t)$ as t goes to infinity. The duration of each time period is, of course, arbitrary, but it should be borne in mind that the empirical results charted in section 1 suggest that voters update their beliefs significantly over a matter of several months.

Proposition 2.

A. The effect of recent experience on voter beliefs stabilizes at a unique value:

$$K = \frac{-[c + (1 - \gamma^2)] + \sqrt{[c + (1 - \gamma^2)]^2 + 4c\gamma^2}}{2\gamma^2}$$

where c = q/h.

B. Assume voters begin life with sufficiently diffuse priors. ($P_0 > hK$). Then
1. the effect of new observations decreases over time.
2. the effect of new information decreases at a decreasing rate.

Proof.

A. $K_t = P_t/h$, so behavior of P_t implies behavior of K_t. $P_t = g(P_{t-1})$, a non-linear difference equation. To find the steady state solve $P = g(P)$. Next, we

show that the steady state is unique. In the Appendix we show that $|g'(x)| < 1$ for all x. This implies both that x converges to the steady state and that there can be at most 1 equilibrium value of x.

B. 1. Using the definition of K_t, $K_t < K_{t-1}$ iff $P_t < P_{t-1}$. Since $1 > g'(x) > 0$ (see Appendix), x does not oscillate around the steady state. Therefore if the initial variance is greater than the steady state variance (hK), the variance must fall over time toward the steady state variance. Alternatively, using the definition of P_t, the variance falls over time whenever:

$$P_t = \frac{h(\gamma^2 P_{t-1} + q}{(\gamma^2 P_{t-1} + q + h)} < P_{t-1}$$

This condition holds iff $P_{t-1} > hK$. It can easily be shown that, as long as $P_t > hK$, $P_{t+1} > hK$. Therefore if $P_0 > hK$, the weight on new information strictly decreases over time.

B. 2. Since P_t falls over time, K_t falls over time at a decreasing rate if the derivative of $d(K_t - K_{t+1})/dP_t > 0$. This derivative can be rewritten as $hd(P_t - P_{t+1})/dP_t > 0$, which is shown in the Appendix.

Why does the weight assigned to new information stabilize at some positive value? Initially, voters are very unsure of the parties' relative benefit levels and revise their views relatively quickly when they receive new information about the parties. During this initial phase the voters begin to accumulate some recent information about the parties. Since the parties do not remain fixed over time, however, the amount of useful knowledge contained in past observations diminishes as time passes. The rate at which old information loses its value varies with q, which captures how fast party positions and other attributes change. For any particular value of q, there is some point in the past beyond which observations contain very little useful additional information, and so the weight placed on these observations goes toward zero. Once the voters have enough observations that the weight placed on observations before a certain part of their lives nears zero, the voters' learning rule approaches the "steady state" updating formula. At this point the voters' assessment of the parties is a weighted average of the current observation and past observations, with the weight on the current observation equal to K.

Exactly how much weight should the voters place on today's observation versus past observations? The formula for K shows when the weight on the current observation will be highest. K is increasing in c = q/h, the "signal to noise" ratio. As q increases, the parties are changing quickly, and so old information is less useful in figuring out where the parties are today. Intuitively, when q is high voters should place more weight on what they see today, which raises K. The optimal use of past performance is also affected by the size of h. As h increases, today's observation of the party differential is a less

and less precise measurement of where the parties really are. As a result, voters should react less to any one observation. On the other hand, when h is very low, the voters can (almost) observe where the parties currently are from this period's observation alone. In contrast, the older data have two sources of noise when h is very low; a small amount of measurement error and the error caused by the movement of the parties. Voters should therefore discount the older information and rely on the much more precise estimate of the parties' current location contained in this period's performance evaluation. The past should be completely disregarded when $h = 0$.

Lastly, what does the static party model say about the use of past versus current information about the parties? In the static party model $q = 0$, and so the steady state value of $K = 0$. Comparing this with the more general model we present, the restricted model predicts that the weight placed on new information will fall as time passes, and then stabilize at 0 weight placed on new information. This extreme result follows from the assumption that the party differential is fixed. When $q = 0$ no old observations are ever discarded as useless, and eventually the voters have the parties completely pinned down. In fact, throughout life voters will place equal weight on all the information they receive, *no matter how old that information is.* Taken literally, the model implies that the voters can learn as much about the current party differentials from last year's observation as from observations taken decades earlier. Since the voters accumulate more information over time, the weight placed on each piece of information must fall, until the voters place an arbitrarily small amount of weight on each individual observation. Eventually, experienced citizens cease to learn about the party differential.

In contrast, when $q > 0$ the past can tell voters only so much about the present; since the parties are changing, recent observations always provide new information about where the parties are today. As a result, the more general model predicts that early in life voters will place a lot of weight on new information, but that the weight placed on new information will decline over time and then stabilize at some amount greater than zero. How much greater than zero will depend on how much confidence the voters have in their ability to infer the parties' positions from their current observation and how quickly they think parties move around over time.

Table 3 illustrates some different learning patterns assuming diffuse priors ($P_0 = 10$, $h = 1$) and different values of c, the voter's signal to noise ratio. One noteworthy feature of the table is the fact that K, the weight assigned to newly observed information, remains sizable even when c is quite small. For example, when the signal to noise ratio is just .05 and $\gamma = 1$, new information is assigned a weight of .2. Thus, *even when the underlying party differential changes very little over time (in comparison to random fluctuations in observed party performance), rational learning nonetheless involves placing considerable weight on contemporaneous information*. By the same to-

Table 3. Effect of Recent Experience on Party Evaluations Once the Updating Process has Reached a Steady State

Table entries are weights (K) given to the most recent period's observation of party performance

	Autoregressive Coefficient (γ) Linking the Party Differential At time *t*-1 to the Party Differential at time *t*			
	.10	.50	.90	1.00
1.00	.501	.531	.597	.618
.50	.335	.372	.468	.500
Signal to Noise Ratio .25	.201	.246	.347	.400
(c = q/h) .05	.048	.061	.141	.200

Table entries are number of periods that must elapse before weights are within 10% of the steady state value of K

	Autoregressive Coefficient (γ) Linking the Party Differential At time *t*-1 to the Party Differential at time *t*			
	.10	.50	.90	1.00
1.00	1	2	2	2
.50	2	2	2	3
Signal to Noise Ratio .25	2	3	4	4
(c = q/h) .05	2	4	8	7

ken, this scenario implies that older observations gradually become uninformative: a prior that is weighted .8 in period 1 carries a weight of just .11 in period 10.

We may now summarize what the Kalman Filter model implies about the persistence and change in partisan attitudes. Equation [3] can be rewritten to state the voter's estimate of the time *t* party differential in terms of the voter's estimate of the party differential at time *t*-1. Following Achen and equating a voter's prospective evaluation of the relative benefits from each party with the voter's party identification, we can write today's party identification as a function of yesterday's party identification and today's party performance:

$$a_t = (1 - K_t)\gamma a_{t-1} + K_t y_t \qquad [7]$$

Proposition 3.

The effect of lagged party identification on this period's party identification:

The effect of lagged party identification on current party identification:

a. rises over time, if priors are sufficiently diffuse ($P_0 > hK$).

b. stabilizes at $(1-K)\gamma$, where K is as defined in Proposition 2.

Proof. The properties of K_t and the definition of K are provided in Proposition 2.

Proposition 4.

The effect of performance surprises.

1. Party identification changes only when benefits in the current period are unexpectedly high or low relative to the last period's current party ID; the effect of innovations diminishes over time.
2. The effect of innovations stabilizes at K.

Proof. This follows directly from Proposition 2.

Note that when q > 0, innovations will affect the voter's perceptions of the parties, regardless of how late in life such innovations occur. What is more, after a certain point, the effect of innovations will become constant and greater than zero. When q = 0, innovations will have less and less effect on the voters, and will eventually be ignored.

A chief selling point of Achen's analysis is the guidance it provides for empirical work on party identification. Achen critiques linear regression analysis, with party identification on the left-hand side and the kitchen sink on the right-hand side; he goes further and proposes a relatively simple nonlinear alternative suggested by his model of voter learning. Specifically, Achen's analysis suggests a regression of the form:

$$PID_t = \frac{\beta_1 y_t + (\beta_2 + \beta_3 n)(PID_{t-1})}{\alpha + n}$$

where a represents the ratio h/P_0.[6]

Given our analysis, is the econometric form suggested by Achen still the best choice? Our work suggests a very different form for the regression. As in Achen's specification, the relative weight placed on lagged party identification and current evaluations should vary over time, and the weights are complicated nonlinear functions (the sequence of K_ts). After a while, however, the weights stabilize. In the regression model Achen proposes, by contrast, the effect of current events is forced to decline over time, and will continue to fall until its effect on party identification becomes zero.

[6]The theoretical analysis leading up to Achen's equation 8 actually suggests a different econometric specification. An easy way to confirm this is that, while Achen's theoretical work implies that as N approaches infinity the weight on lagged party identification approaches 1, in the econometric model as N approaches infinity, the coefficient on lagged party identification approaches β_3/a, which is not subject to any restriction. More generally, if the theoretical model Achen spells out is taken seriously, there are important restrictions implied by the theory that should be imposed on the regression equation but which are left out of equation 8.

Based on our theoretical work, the best approach would be to try to estimate the exact equations specified by the Kalman filter. A simpler, though somewhat inferior, approach was suggested by simulations we conducted which indicated that, for a very wide range of signal to noise ratios, the Kalman filter algorithm weights became very close to their steady state values after only a few periods (see Table 3). This suggests that we should divide up the voter's life into two segments, an early period where the weights are changing, followed by a period where the weights are constant. Further, we expect to observe a decreasing weight on current events, increasing weight on lagged party identification for the first years of the voter's life, and then no further decline with additional experience. This pattern could be approximated by a simple regression. Specifically, one might regress party identification on lagged identification and new information (e.g., current ratings of party competence), with an interaction between these independent variables and a series of dummy variables for different age categories. The Kalman filter suggests that the effects of new information will be larger for younger citizens and that once the effects of new information stabilize there will be no further interaction with age.

As Achen points out, the problem with such models is the difficulty of assembling a statistical analysis that attends to the nuisances of measurement error and categorical dependent variables. Grappling with these assorted estimation problems would take us too far afield from the central purpose of this paper, so we will confine our empirical observations to a very simple test. Table 4 presents rates of opinion change for different age groups, drawing upon data from the 1990-91-92 and 1992-93-94 NES Panel Studies. Each table entry represents the average amount of (absolute) change in opinion from one survey to the next. In other words, for each individual the survey response at time 1 was subtracted from the response at time 2; an absolute value was taken; and the average of these absolute values appears in the table. Three survey items are examined: 7-point party identification, 3-point prospective evaluations of which party will better handle the economy, and 3-point prospective evaluations of how the parties will handle foreign affairs.

The expectation based on a Kalman filter model is that rates of change will be highest among the youngest cohort, but other cohorts should look more or less the same. The Achen model, on the other hand, implies that rates of change will diminish steadily with age. In ten of twelve instances, the youngest cohort (ages 18-29) shows the greatest movement over time. No consistent ordering holds for the older cohorts, although there is some indication, consistent with other studies, that attitude stability deteriorates among the oldest cohort possibly because their life circumstances change with retirement (Alwin and Krosnick 1991). This empirical

Table 4. Mean Absolute Change in Party Identification, Economic Evaluations of the Parties, and Evaluations of Which Party Will Better Handle Foreign Affairs, by Age Cohort, 1990-92 and 1992-94

	Age Cohorts				
	18-29	30-39	40-49	50-64	65-
1990-91					
Party ID	.79	.55	.58	.49	.61
Economic Evaluations	.42	.37	.29	.35	.31
Foreign Affairs	.50	.40	.40	.36	.38
(N)	(197)	(222)	(171)	(176)	(176)
1991-92					
Party ID	.93	.70	.64	.81	.80
Economic Evaluations	.59	.51	.39	.50	.43
Foreign Affairs	.61	.53	.46	.55	.53
(N)	(197)	(222)	(171)	(176)	(176)
1992-93					
Party ID	.77	.75	.58	.78	.43
Economic Evaluations	.44	.39	.40	.40	.45
Foreign Affairs	.58	.47	.42	.48	.40
(N)	(84)	(167)	(106)	(114)	(103)
1993-94					
Party ID	.79	.53	.51	.60	.54
Economic Evaluations	.48	.44	.34	.36	.35
Foreign Affairs	.61	.47	.31	.44	.47
(N)	(84)	(167)	(106)	(114)	(103)

Sample sizes in parentheses. Party identification is measured using a 7-point scale. Both prospective party evaluation items are measured using 3-point scales.

test, though crude, suggests the potential value of the Kalman filter modeling approach.

Discussion

The Kalman filter offers an intuitive and parsimonious model of learning that is at the same time more flexible than Achen's static party model. Whereas Achen draws a rigid distinction between periods of realignment and periods of stable two party politics, our model accommodates both situations within a common analytic framework. In effect, our model permits voters to be on the lookout for signs of change in party competence. Even when voters are aware that such changes seldom occur, the *possibility* of change alters the way in which they would optimally update their beliefs about party capabilities. In the static model, citizens eventually reach a point where they have watched the parties for so long that their current observa-

tions cease to be informative. In the Kalman filter model, by contrast, new information is accorded considerable weight by experienced observers, even when the rate of party change is quite gradual.

From an empirical standpoint, the Kalman filter model seems to capture certain basic features of how the public updates its prospective performance evaluations. At the aggregate level, such evaluations can change rapidly with changes in party leadership or economic conditions; at the individual level, the interaction between age and current information is confined to those under 30.

Defending the empirical adequacy of this model means confronting the myriad challenges to Bayesian learning models in general. In their review of this literature, Lodge and Taber (1997) point out that efficient assimilation of new information fails to occur when learners have low motivation, issues are complex, prior convictions are strong, time constraints are pressing, and so forth. Lau and Sears (1986, 349) argue more broadly that "even when information is plentiful and there is no reason to suspect motivational biases, there are so many errors and inconsistencies in human cognition that . . . information processing is itself normally flawed." The empirical challenges to Bayesian learning models come from two sources. The first comprises studies (e.g., Birnbaum and Mellers 1983) which show that experimental subjects tend to be poor intuitive statisticians when confronted with quantitative updating problems. The second hearkens back to cognitive consistency theory to argue that partisanship functions as a perceptual screen. Rational updating based on new information is undone by "subtle processes of perceptual adjustment by which the individual assembles an image of current partisanship consistent with his partisan allegiance" (Stokes 1966, 127; see also Campbell et al., 1960, 133).

The first group of studies seems convincing enough: undergraduates in these experiments do no better at solving statistics problems than they do in statistics classes. But is the processing of quantitative information during a lab experiment analogous to citizens' ongoing evaluation of qualitative information in the political environment? The external validity of these experiments is a matter of dispute, so the question becomes whether cognitive biases surface in nonexperimental data as well. Here it turns out that evidence of selective attention and learning is surprisingly thin. The most frequently cited instance of perceptual bias is the fact that Republicans and Democrats tend to think their party's candidate prevailed in presidential debates, but this is to be expected given the distinctive tastes of the two partisan groups. When these tastes are held constant and we examine evaluations across political debates, we find, for example, the Democrats, Republicans, and Independents were each more likely to claim that Reagan prevailed over Mondale after their second debate than after Reagan's dismal performance in their first encounter (CBS/*New York Times*, 1987).

Table 5. Prospective Economic Evaluations of the Parties, by Party Identification in the Initial Wave of Each Panel Study (Entries are percentage of each partisan group saying that the Democratic Party does a better job of handling the economy.)

1990-91-92 Panel Study

	Party Identification in 1990		
	Democrat	Independent	Republican
Economic evaluations 1990	39.0	13.2	3.5
Economic evaluations 1991	37.7	14.4	3.5
Economic evaluations 1992	63.2	31.2	11.5
N of cases	(405)	(319)	(261)

1992-93-94 Panel Study

	Party Identification in 1992		
	Democrat	Independent	Republican
Economic evaluations 1992	64.2	27.9	7.8
Economic evaluations 1993	44.3	17.2	7.3
Economic evaluations 1994	29.4	15.5	2.2
N of cases	(201)	(233)	(179)

1994-96 Panel Study

	Party Identification in 1994		
	Democrat	Independent	Republican
Economic evaluations 1994	31.9	11.6	1.1
Economic evaluations 1996	55.6	27.0	10.4
N of cases	(232)	(215)	(182)

The limitations of the perceptual bias argument become even more apparent when we follow party evaluations over time. Table 5 presents the results from three panel studies that track Democrats, Republicans, and Independents over two year periods. Entries to the table are the percentages of each partisan group who indicate that the Democratic Party does a better job of handling the economy. Naturally, when asked to make this sort of judgment, Republicans play the Cassandra to the Democrats' Polyanna. What is interesting is the extent to which the three partisan groups move together from one survey wave to the next as the political fortunes of the parties change. None of the groups move between 1990 and 1991; all become more pro-Democratic from 1991 to 1992 and 1994 to 1996; all become more pro- Republican from 1992 to 1994. When we perform a logistic regression to test whether partisan groups in each panel move at different rates from one survey wave to the next, as would be expected if one group of partisans were resisting discordant information, we cannot reject the null hypothesis that all three groups move at the same rate ($\chi^2 = -2(L_0 - L_1) = 13.38$, df = 10, $p > .10$). Much as our learning model would suggest, perceptual bias seems

not to prevent partisans from updating their evaluations in light of new information.

Whatever its merits as a model of performance assessments, the Kalman filter model has difficulty accounting for the stability of party identification. It may be tempting to turn to Achen's static party model for this purpose, but given the extent to which older citizens adjust their performance evaluations, one cannot assume that they believe the parties to be unchanging—the central premise of the static party model.

Typical of the difficulties of applying rational learning models to party identification is the fact that any such model must account for the "period effects" that stamp different generations with distinctive partisan coloration. Voters who came of age during the 1920s remained distinctively Republican; those during the 1930s, distinctively Democratic (Campbell et al. 1960). While party-switching has occurred among white Southerners, at least half of the aggregate shift to the Republican Party since 1965 has been the result of generational replacement (Green and Schickler 1996). Learning models that stress the influence of contemporaneous information have difficulty explaining the persistence of early formative experiences. Granted, one may attribute cohort differences to the distinctive tastes formed by their experiences early in life. While there might be something to the notion that different cohorts harbor different values as a result of their material circumstances in young adulthood (Inglehart 1977), it seems doubtful that this explanation could account for the fact that older, more conservative Southern Whites have tended to be more Democratic than their younger counterparts.

If party identification is more tenacious than a Bayesian learning model would suggest, perhaps the difficulty lies with the way in which we have characterized the learning process. Following Achen, we have focused entirely on the consequences of observing the parties' performance in office for purposes of making prospective judgments of performance. Party *identification*, however, concerns the way in which people *think of themselves.* ("In general, when it comes to politics, do you think of yourself as a Democrat, Republican, Independent, or what?") What matters is one's image of the social groups "Democrat," "Republican," and "Independent" and whether one includes oneself among them. Party performance doubtless contributes to the esteem in which partisan groups are held, such that Republicans are a less attractive object of identification in 1964 than 1984, but the fortunes of the Republican Party can change without much altering what comes to mind when people think of rank-and-file Republicans. The stability of partisanship, in other words, may reflect the persistence of citizens' images of Democrats and Republicans.

If this speculation is correct, then the appropriate model is quite a bit more complex than the one presented above. Citizens learn about which

sorts of social, economic, or ideological groups affiliate with each party, while at the same time sorting out which group labels properly apply to themselves. Party performance evaluations may also affect the attractiveness of the rank-and-file partisan groups, Democrats and Republicans. Partisan instability among the young, by this account, results from the fact that they acquire a great deal of reference group information and are somewhat more susceptible to change in their prospective evaluations of party performance. In time, however, voters acquire a sense of who Democrats and Republicans are and whether these social group labels describe themselves.

In and of itself, this model need not imply stability. A voter's perceptions of which social groups affiliate with each party could change, as could the esteem in which those groups are held. One might argue, however, that perceptions of which groups affiliate with the parties evolve very slowly, since, barring a dramatic secular realignment, it is difficult for citizens not employed by polling firms to update their impressions about the social bases of partisanship. By the same token, one might argue empirically that feelings toward social groups—as opposed to political figures or institutions— tend to be quite stable over time. Putting both conjectures together suggests that the dynamics of party identification might be approximated by a tipping model. People maintain their partisan identities as long as their image of the partisan groups remains intact. But when secular realignment is afoot (e.g., the 1980s, after decades of generational replacement have eroded the ranks of Southern White Democrats), the public image of the partisan groups shifts, which in turn produces a shift in party identification and perhaps further alters perceptions of partisan groups. It remains to be seen whether this speculation is empirically sustainable in light of more discriminating tests, but, unlike the learning models considered here, a model focusing on the evolution of social group perceptions holds out the possibility of accommodating both the gradual manner in which party identification typically changes and occasional secular realignments.

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APPENDIX

1. Proposition 1 Claim: $|g'(x)| < 1$ for all x.

Proof.

In steady state

$$P = h(\gamma^2 P + q) / (\gamma^2 P + q + h) = g(P).$$

Note that $dg(x)/dx$, after simplification, equals $\left[\left(\frac{h\gamma}{\gamma^2 P + q + h}\right)\right]^2$, which is

greater than 0. This quantity is also less than 1: $dg(x)/dx<1$ can be written as $(h\gamma) < (\gamma^2 P + q + h)$, since all the variables are nonnegative. Further, $(h\gamma) < (\gamma^2 P + q + h)$can be simplified to $(\gamma - 1) < (\gamma^2 P + q)$, which is true since $\gamma < 1$, $h > 0$, P and q are > 0.

2. Proposition 2 claim: $d(P-P_{t+1})/dP_t > 0$

Proof.

$P_{t+I} = h(\gamma^2 P_t + q) / (\gamma^2 P_t + q + h)$. $P_t - P_{t+1} = P_t - g(P_t)$.

Since we have shown earlier that $| g'(x)| < 1$, it follows that $1-g'(P_t) > 0$.

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