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CURRENT MONETARY POLICY RESEARCH AT THE FEDERAL RESERVE BOARD

The Impact of Uncertainty on the Feasibility of Humphrey-Hawkins Objectives

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I. Introduction[1]

"I know not of aught in the world that so profits a man as taking good counsel with himself; for even if things fall out against one's hopes, still one has counselled well, though fortune has made the counsel of no effect: whereas if a man counsels ill and luck follows, he has gotten a windfall, but his counsel is none the less silly."
Herodotus ([7], p. 500.)

A STOCHASTIC FRAMEWORK for coordination of macroeconomic policies is introduced in this paper. It is suggested that: (i) measures of policy accountability should allow for the climate of uncertainty that surrounds policy decisions, and (ii) most models of aggregate economic activity impose arbitrary specifications of uncertainty that do not appear to be empirically justifiable. Ambiguities in interpreting the Humphrey-Hawkins reports of policy authorities are sketched in section II; a proposal for maximizing the *ex ante* prospects of policy objectives is illustrated in section III; finally, nonstationary allocations of uncertainty are discussed in sections IV and V.

II. The Humphrey-Hawkins Policy Dialogue

Two purposes of the Humphrey-Hawkins law, passed in late 1978, were to (i) "set forth explicit short-term (two-year horizon) and medium-term (five-year horizon) economic goals" and (ii) "improve the coordination of economic policymaking within the Federal Government" to attain these objectives [3]. Under provisions of the law, economic goals are provided in the Annual Report of the Council of Economic Advisers, and the Board of Governors of the Federal Reserve must respond with semi-annual reports on its "objectives and plans . . . with respect to the ranges of growth or diminution of the monetary and credit aggregates for the calendar year . . . and the relationship of the aforesaid objectives and plans to the short-term goals . . ." [3].

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[1] This paper provides an overview of recent work by members of the Special Studies section on the role of uncertainty in policy forecasts and is based on work described in the papers [8], [9], [10], [13], and subsequent work. We are grateful for the computations of S. Schloss and the typing of V. Watkins. Opinions expressed in this paper are those of the authors and do not reflect the views of the Board of Governors or the staff of the Federal Reserve System.

Major quantitative results of this legislated policy discussion are summarized in Table I. It is not evident that an informed layman can interpret these results in an unambiguous manner. Some of this ambiguity stems from various interpretations of the reported statistics:

(i) *The hindsight interpretation.* This approach adopts what de Finetti has termed "wisdom after the event", [5] p. 207, where the effective yardstick of performance is the distance between initial goals and subsequent outcomes. The attempt to assess *ex post* culpability tends to discourage discussions of the projected consequences of alternative policies.

(ii) *The forecast interpretation.* This approach explicitly recognizes the stochastic context of policy projections but considers projected ranges to be rigid delimiters of successful coordination. By this criterion, the statistics in Table I indicate that policies are coordinated in the first year of each projection (since the first-year CEA goals are contained within the FRB ranges) but uncoordinated in the second year projections (because the second-year price inflation (P) goals lie outside the FRB ranges).

Explicit probability statements do not accompany either the CEA or the FRB projection ranges reproduced in Table I.[2] If the FRB ranges are viewed as 70% confidence intervals, the CEA ranges might then be interpreted as 20–40% confidence intervals. Consequently, the two sets of projections may be statistically compatible if there is substantial overlapping of equivalent confidence regions.

(iii) *The contractual interpretation.* This approach is exclusively preoccupied with the projected ranges of intermediate targets, such as M-1A, where the prescribed boundary is interpreted as a contractual commitment by the monetary authority. Monetary policy is considered successful if monetary aggregates are constrained to lie within the projected boundaries. A difficulty with this interpretation is that the probability basis of the monetary aggregate ranges is not explicit.

At least a portion of the monetary aggregate range must be ascribed to conventional projection uncertainty concerning monetary aggregates given planned settings of the monetary policy instrument, bank reserves or the Federal funds rate. A closely related source of uncertainty is the recent difficulty in formulating and projecting an estimate of "money" related to transactions requirements, given the chaotic proliferation of arrangements to pay interest on demand balances.[3]

It is also possible that intervals of monetary aggregates may signal the extent of future policy responses to unanticipated and unfavorable movements in the direct targets of policy, such as price inflation and unemployment rates. By this interpretation, monetary aggregate ranges are conditioned on the uncertainty ranges projected for direct targets, and a breach of a monetary aggregate range may be an appropriate response to unexpectedly large deteriorations in direct target performance.

[2] The most recent FRB report describes the intervals for projections of nonmonetary variables as "ranges for key variables that generally encompass the judgments of the individual FOMC members about the probable performance of the economy..." [6], July 1980, p. 532.

[3] Tinsley et. al. [12] suggests that the existence of repurchase agreements have increased the uncertainty of money demand projections by about 20%.

Table I

Short-Term Goals and Forecasts for 1979–81 by Council of Economic Advisers (CEA) and Federal Reserve Board (FRB)

	Source and Date of Forecasts[a]							
	Jan/Feb, 1979		July, 1979		Jan/Feb, 1980		July, 1980	
Variable[b]	CEA	FRB	CEA[c]	FRB	CEA	FRB	CEA[c]	FRB
1979								
$\dot{GNP}\$$	9.4 to 10.2	n.a.	9.2	8.0 to 10.0	9.9			
$\dot{GNP}$	2.0 to 2.5	n.a.	−0.5	−2.0 to −0.5	0.8			
U	6.0 to 6.5	n.a.	6.6	6.2 to 7.0	5.9			
$\dot{P}$	7.2 to 7.5	n.a.	9.8	9.5 to 11.0	9.0			
$\dot{M}$-1	n.a.	1.5 to 4.5	n.a.	1.5 to 4.5	5.5			
1980								
$\dot{GNP}\$$	9.8	n.a.	10.3	8.5 to 11.5	7.5 to 8.3	7.5 to 11.0	6.8	5.0 to 7.5
$\dot{GNP}$	3.2	n.a.	2.0	−0.5 to 2.0	−1.2 to −0.8	−2.5 to 0.5	−3.0	−5.0 to −2.5
U	6.2	n.a.	6.9	6.8 to 8.2	7.2 to 7.8	6.8 to 8.0	8.5	8.5 to 9.2
$\dot{P}$	6.4	n.a.	8.1	8.5 to 10.5	8.8 to 9.2	9.0 to 11.0	10.0	9.0 to 10.0
$\dot{M}$-1/$\dot{M}$-1A	n.a.	n.a.	n.a.	1.5 to 4.5	n.a.	3.5 to 6.0[d]	n.a.	3.5 to 6.0[d]
1981								
$\dot{GNP}\$$	10.0	n.a.	n.a.	n.a.	11.6	n.a.	12.5	8.5 to 11.5
$\dot{GNP}$	4.6	n.a.	n.a.	n.a.	2.8	n.a.	1.5	0.5 to 3.0
U	5.4	n.a.	n.a.	n.a.	7.3	n.a.	8.5	8.0 to 9.2
$\dot{P}$	5.2	n.a.	n.a.	n.a.	8.6	n.a.	9.8	7.8 to 9.5
$\dot{M}$-1A	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	3.0 to 5.5

[a] Obtained from selected issues of the CEA *Annual Report* [4] and Federal Reserve *Bulletin* [6].

[b] $\dot{GNP}\$$—fourth quarter to fourth quarter percentage change for nomimal GNP.
$\dot{GNP}$—fourth quarter to fourth quarter percentage change for real GNP.
U—fourth quarter civilian unemployment rate.
$\dot{P}$—fourth quarter to fourth quarter percentage change of implicit GNP deflator.
$\dot{M}$-1/$\dot{M}$-1A—fourth quarter to fourth quarter percentage change of monetary aggregates.
n.a.—not available in sources cited.

[c] Based on administration's mid-year budget review.

[d] Range for $\dot{M}$-1A.

III. Economic Weather Forecasting

Much of the ambiguity that inhibits a straightforward appraisal of Humphrey-Hawkins reports could be eliminated by more direct exposition of the underlying probability assumptions:

First, Humphrey-Hawkins reports are simply economic weather forecasts with provisions for cloudseeding. Policy projections in the reports must be received in the same "climate" of *ex ante* uncertainty that is accorded meteorological forecasts.

Second, clear statements of prior uncertainty will permit a sharper focus on areas of substantive disagreement. Differences in measurements, conditioning assumptions, and even mean projections may be discounted if the discrepancies are statistically insignificant.

Third, an explicit stochastic approach to policy projections provides unequivocal and succinct measures of evaluation. The object of cloudseeding is to increase the probability of rain in a particular location. Similarly, the aims of policy proposals are to increase the probabilities of favorable direct target outcomes. An operational definition of policy coordination may be based on the criterion that proposed policies should maximize the probability that outcomes fall in a prescribed neighborhood of policy goals.

One way of formulating this approach is to view the process of policy selection as a maximum likelihood estimation procedure where the optimal coefficient estimates (policy strategies) maximize the likelihood of obtaining the observed data (the Humphrey-Hawkins objectives). A simple approach is to tabulate the probability of outcomes falling within a small neighborhood of Humphrey-Hawkins objectives for alternative policies.[4]

Representative 70% confidence intervals are listed in the first column of Table II for the case of fixed policy instrument settings.[5] This policy is termed *instrument targeting* to denote that settings of the policy instrument, the Federal funds rate (RFF), are not altered in response to measurements of direct target performance received over the two-year horizon. A summary measure of the dispersion of probable outcomes is provided by the generalized variance, $|\Sigma_y|$, of direct target outcomes.

Under normality, the likelihood of attaining Humphrey-Hawkins objectives can be affected not only by shifting the means of the policy projection but also by altering the variances of direct target outcomes. Selection of a reactive policy that will respond to future measurements of direct target performance will alter the dispersion of probable outcomes about the Humphrey-Hawkins objectives.

[4] This is approximately the procedure used to present staff stochastic forecasts prior to recent Humphrey-Hawkins reporting dates since it enables FOMC members to conduct their own "grid search" of the probable outcomes of alternative policies. The stochastic forecasts combine replications of historical forecast uncertainty with judgemental distributions of conditioning assumptions for which there are no historical precedents.

[5] All experiments reported in Table II are based on a public version of the FRB quarterly model. The model was conditioned on information that was publically available at the beginning of 1979. The policy instrument trajectory for instrument targeting was the Federal funds rate path associated with a projected 4½% growth in M-1A over the two-year horizon, 1979–80. Computations of the policies are somewhat different than those discussed in [13] and will be described in a sequel.

Table II

Univariate 70% Confidence Intervals for One-year (t) and Two-year ($t + 1$) Projections of Alternative Policies

	Variable	Policy: Instrument Targeting	Policy: Intermediate Targeting	Policy: Direct Targeting
direct targets (y)	$\dot{\text{GNP}}\$_t$	±2.30	±1.94 (−16%)[a]	±1.91 (−17%)[a]
	$\dot{\text{GNP}}\$_{t+1}$	±4.27	±3.45 (−19%)	±2.82 (−34%)
	U_t	±0.58	±0.50 (−14%)	±0.43 (−26%)
	U_{t+1}	±1.22	±0.94 (−23%)	±0.77 (−37%)
	$\dot{P}_t$	±1.10	±1.05 (−5%)	±1.00 (−9%)
	$\dot{P}_{t+1}$	±2.02	±1.85 (−8%)	±1.83 (−9%)
intermediate targets (x)	$\dot{M}\text{-}1A_t$	±1.20	±0.41 (−66%)	±0.66 (−45%)
	$\dot{M}\text{-}1A_{t+1}$	±2.45	±0.87 (−64%)	±2.12 (−13%)
	$\dot{M}\text{-}2_t$	±1.00	±0.43 (−57%)	±0.78 (−22%)
	$\dot{M}\text{-}2_{t+1}$	±1.98	±0.52 (−74%)	±1.92 (−3%)
policy instrument	*RFF*	±0.0	±3.0[b]	±3.0[b]
generalized variance (direct targets)	$\lvert\Sigma_y\rvert$	.24	.19 (−21%)	.12 (−50%)
autocorrelation of instrument resets	ρ_{RFF}	—	.74	.31

[a] Numbers in parentheses are percentage comparisons with instrument targeting results.
[b] Binding constraint on quarterly resets of policy instrument.

The efficiencies of two reactive policies are contrasted in the second and third columns of Table II.

The *intermediate targeting* policy attempts to keep the two intermediate targets, M-1A and M-2, on initial target tracks by quarterly resets of the Federal funds rate in response to quarterly measurements of the monetary aggregates. As shown in the second column of Table II, the variances of all target outcomes are lowered by this policy, especially those of the intermediate targets. By contrast, the *direct targeting* policy explicitly maximizes the likelihood of the 1979–80 Humphrey-Hawkins objectives for the direct targets, $\dot{\text{GNP}}\$$, U, and $\dot{\text{P}}$. As indicated in Table II, the direct targeting policy is able to achieve significant reductions in the dispersions of nominal GNP and unemployment while the dispersion of inflation is roughly comparable to that obtained by intermediate targeting. As a measure of overall efficiency, the generalized variance of the direct targets is reduced by about 20% by intermediate targeting and by 50% by direct targeting. These results demonstrate that projection intervals, such as those provided in the Humphrey-Hawkins reports, are not well defined unless the policy responses to future disturbances are also specified.

IV. Of Second-order Consequences

All formulations of policy forecasts contain arbitrary assumptions concerning the allocation of uncertainty. Several variants involved in the maximum likelihood example may be noted:

One aspect of the maximum likelihood procedure is that the policy metric—the characterization of policy preferences concerning direct target tradeoffs—is represented by the inverse of the direct target covariance. This metric implies that large uncertainty surrounding forecasts of goal achievement should be associated with small (relative) efforts to alter the expected shortfall. This uncertainty discounting effect also influences intertemporal allocations of policy. The variances of second year outcomes are uniformly larger than those of first year outcomes reflecting the larger uncertainty associated with forecasts of more distant periods. In the particular examples of Table II, the average discounting of second year outcomes ranges from about 70% for instrument targeting to about 30% for direct targeting.

Another manifestation of the notion that uncertainty inhibits discretionary policy is the practice of discounting measurements of activity that is believed to be transitory. The conventional wisdom that short-term disturbances will "wash out" is internally inconsistent when unconditional temporal independence is used to justify conditional negative correlation between past known disturbances and future unmeasured disturbances. A more plausible rationalization of cautious policy is based on the prospect that frequent switches in the direction of policy resettings may be interpreted as signals of confused and floundering policy. Note, in Table II, that the first order autocorrelation of resets in the policy instrument, ρ_{RFF}, under intermediate targeting is 0.74, more than twice the quarterly autocorrelation of the direct targeting interventions.

The maximum likelihood example also illustrates that the distributions of stochastic disturbances depend on agent reactions. In the example above, the monetary authority attempts to reduce the variances of direct target outcomes. Illustrations of interactions of objective and subjective probabilities can be developed using examples of non-cooperative games, see Aumann [2]. Since economists do not possess well-developed theories of controllable probability,[6] the modelling of uncertainty must be tempered with skepticism.

In a recent paper, Swamy, Barth, and Tinsley [10] interpret use of rational expectations in macroeconomic models as the application of a linguistic axiom where the hypothesis is imposed, typically, rather than tested. This procedure confounds agent error and modelling error (a point also discussed by Arrow [1]) and tends to overstate the statistical reliability of the restricted model. As an alternative, the authors suggest a more modest modelling approach where the existence of unobservables is recognized by the adoption of a stochastic coefficient procedure that permits uncertainty to be allocated over all estimated parameters of a model.

V. The Case Against Additive Uncertainty

Prominant econometric models used by private and public policy advisers are constructed on the assumption that all uncertainty is confined to the additive intercepts of the model equations. Preliminary work on an alternative allocation of uncertainty in the FRB quarterly model is summarized in Table III. Core

[6] Theil [11] outlines an early effort to develop an economic theory of uncertainty allocation.

Table III

Decomposition of One-Quarter Conditional Variances[a]

Dependent variable	a intercept	b time-varying regressors	c covariance (x2) of a and b	Modal source of uncertainty (disregarding intercept)
	Sources of Uncertainty (%)			
personal consumption	16	80	4	household net worth
consumers' durables	0	100	0	lagged dependent variable
producers' durables	0	100	0	equilibrium stock
single-family housing	35	116	−51	age composition of population
durable business inventories	0	99	1	defense goods contracts
wage rate	202	153	−255	expected price inflation
demand deposits	4	65	31	GNP
small time and savings	1	87	12	value of common stock
C&I loans by banks	0	100	0	Treasury bill rate less commercial loan rate
corporate bond rate	23	194	−117	expected price inflation

[a] Average decomposition 1965 Q1—1979 Q4 based on stochastic coefficient estimation of selected structural equations in FRB quarterly model. The basic equation specification is

$$y_t = \underset{\sim}{x}_t'\beta_t, \quad \beta_t = \bar{\beta} + \tilde{\beta}_t$$

$$\tilde{\beta}_t = \theta\tilde{\beta}_{t-1} + \underset{\sim}{a}_t, \quad \underset{\sim}{a}_t \sim WS(\underset{\sim}{0}, \Delta)$$

Decomposition of the conditional variance of y is obtained by averaging (over 60 quarters) the partitioned variance proportions

$$\underset{\sim}{x}_{it}'\Delta\underset{\sim}{x}_{jt}/\underset{\sim}{x}_t'\Delta\underset{\sim}{x}_t, \quad i, j = 1, 2$$

where x_{1t} denotes the intercept ($x_{1t} \equiv 1$) and $\underset{\sim}{x}_{2t}$ the vector of time-varying regressors, $\underset{\sim}{x}_t' = [x_{1t}\underset{\sim}{x}_{2t}']$.

equations of the model were reestimated under the assumption that slope coefficients, like the intercepts, may be buffeted from time to time by stochastic disturbances. The total uncertainty of the dependent variables is not increased by this procedure; rather, the estimator allows the data to distribute the residual variance over all estimated coefficients.[7]

As shown in column a of Table III, the intercept (or the traditional additive disturbance) receives a small share of the uncertainty in most equations. The paper by Swamy, Barth, and Tinsley [10] also offers the conjecture that aggregation over disparate characteristics (including subjective expectations) of individual agents may be a significant source of coefficient uncertainty in macroeco-

[7] The estimators used are described in Swamy and Tinsley [9]. It is emphasized that the results in Table III are preliminary results of ongoing work. To examine properties of the existing policy model, existent model coefficients are assumed to be consistent estimates of the unconditional means of the coefficient processes.

nomic models. As indicated in Table III, many channels of uncertainty appear to be associated with aggregate measures of the unique characteristics of individual agents such as constructions of wealth, transaction requirements, and price expectations, rather than uniform market signals such as measured interest rates.

In the context of Humphrey-Hawkins planning, stochastic coefficient models offer a convenient way of incorporating alternative, nested models of economic behavior into policy formulations where some probability may be allocated by the data to competing coëfficient specifications, including zero assumptions. The computational costs of exploring the design of policy interventions under stochastic coefficient specifications are extravagant. A paper by Norman and Tinsley [8] surveys recent work on sparse matrix coding and suggests a method of calculating the covariance of direct targets that may be used in computing a stochastic coefficient analogue to the maximum likelihood procedure for policy selection.

VI. Summary Remark

This paper provides a brief survey of ongoing work by members of the Federal Reserve Board staff on the role of uncertainty in policy forecasts. It suggests that policy discussion could be improved by more explicit consideration of the allocation of uncertainty.

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