MONEY, OUTPUT, AND INFLATION: TESTING THE P-STAR RESTRICTIONS

Kenneth N. Kuttner

Working Paper Series
Macro Economic Issues
Research Department
Federal Reserve Bank of Chicago
June, 1990 (WP-90-8)

Money, Output, and Inflation: Testing the P-Star Restrictions

Kenneth N. Kuttner

Introduction

In the search for a reliable relationship between some monetary aggregate and economic variables of interest, the relatively stable relationship between M2 and nominal GNP has lately emerged as a promising candidate. As demonstrated elsewhere,[1] while other aggregates' velocities of circulation have displayed increasingly erratic behavior throughout the 1980s, the (logarithm of) the velocity of M2[2] has been relatively stable; to be precise, it has remained stationary around its post-1955 sample mean. If the velocity of M2 remains stationary around a fixed mean, in the long run, nominal GNP will be proportional to the stock of M2.

The additional assumption that real GNP ultimately depends only on real factors transforms the relationship between M2 and nominal income into a link between M2 and the price level: With real GNP following an exogenous trajectory (thought of as "potential GNP"), and the velocity of M2 stationary around its mean, M2 will effectively determine, or "anchor" the price level in the long run. In other words, using mean velocity and potential GNP in the Equation of Exchange, $MV = PQ$, given a hypothetical stock of M2, one can solve for the target price level towards which the actual price level is destined to revert.

This target price level corresponds to the P^* variable constructed by Hallman, Porter and Small (1989). Attempting to exploit its long-run link to the price level, the authors construct a quarterly inflation model which includes the divergence between P and P^* as an explanatory variable. At least since Davidson, Hendry, Srba and Yeo (1978), the value of such "error-correction" terms has been recognized as a means of incorporating equilibrium relationships in regression models, and imposing desirable long-run properties.

More than the mere inclusion of this error-correction term, what makes the Hallman, Porter and Small (hereafter HPS) specification so noteworthy[3] (and controversial) is its remarkable simplicity; the *only* exogenous variable driving inflation is the gap between the price level and its P^* target. While some see having a "simple empirical guidepost" as a major attraction of this specification,[4] the approach has not been without its critics. Questioning its utility as an indicator of future inflation, Christiano (1989) points out that the real-time forecasting performance of the P^* equation is no better than other simple forecasting models, such as those based on Treasury bill yields.

Despite this finding, because the Federal Reserve presumably can determine the stock of M2 while T-Bill yields are determined on the open market, the P^* model retains a powerful attraction as a policy guide. Its natural implication is that a policy which seeks to maintain a stable price level or growth rate should, through P^*, rely exclusively on M2 targeting. However, the use of P^* as an intermediate target makes stronger demands on the model than its use as a mere forecasting tool; while the inflationary factors that are suppressed in the simple P^* specification may wash out in the long run, they may figure prominently over the shorter horizons at which policy is made.

Specifically, the central simplification of P^* is that real factors — the unemployment rate or the level of capacity utilization, for instance — have no effect on inflation. While the HPS results show that P^* passes one test against a slightly expanded model, which includes a single lagged measure of real economic activity, given the limited nature of this scrutiny, it is important to ask whether the P^* specification stands up to empirical tests conducted in the context of a more extensive univariate quarterly inflation model. The analysis in this paper embeds P^* within a model that utilizes separate measures of real output, and money growth, and exploits the information content of price indices other than the GNP Implicit Price Deflator.

The paper's main finding is that enlarging the set of regressors used to predict inflation has a major impact on the equation's fit, estimated parameters, and hypothesis tests. In the expanded model, the P^* restrictions consistently fail F-tests at stringent significance levels. Although these results are based on the GNP Implicit Price Deflator and the Federal Reserve Board's potential GNP series, the appendix demonstrates their robustness with respect to the choice of price index and potential output measures.

This finding suggests a somewhat richer description of the inflation process than the one embodied in the simple P^* specification. While not contradicting the proposition that M2, assuming its velocity remains stationary, will anchor the level of the GNP Implicit Price Deflator in the long run, it suggests that in a quarterly model, the simple P^* specification is a poor description of the underlying determinants of inflation.

A benchmark univariate inflation model

A useful framework for examining the properties of P^* is a reduced-form regression of inflation changes on both monetary and non-monetary factors. The real economy is represented by an "output gap" term, defined as the deviation of (the logarithm of) real GNP from its "potential," $(q_t - q_t^*)$. As a version of the Phillips Curve or "Lucas Supply" function, a positive output gap is associated with rising inflation.

One candidate for a regressor to represent monetary pressure on inflation is the "velocity gap," defined in terms of the difference between (the logarithm of) the observed velocity of circulation, v, from its historical mean, $\bar{v}$. Using lower-case m

and y to denote the logarithms of the money stock and nominal GNP respectively, the velocity gap can be written as:

$$\bar{v} - v_t = m_t - y_t + \bar{v}.$$

A positive velocity gap indicates that given $\bar{v}$, the money stock is higher than warranted by the current level of nominal income. For velocity to return to its mean, as it must if it is stationary, requires a rise in either real income or the price level; thus the velocity gap defines an error-correction mechanism for the price level. As the only monetary aggregate whose velocity has remained stationary through the 1980s,[5] M2 is uniquely suited to this approach.

However, there is no reason to think that money growth is inflationary *only* to the extent that it affects the velocity gap; rapid money growth may be associated with some amount of transitory inflation, even when the velocity gap is negative. One way to capture this direct effect of money growth is to include the difference between the growth rate of money and the growth rate of real GNP: $(\Delta m_{t-1} - \Delta q_{t-1})$.

A further extension involves exploiting the information content of other price indices to improve the short-run forecast of the inflation rate of interest. Over time, inflation rates computed from various price indices — the Consumer Price Index (CPI), the Producer Price Index (PPI), and the GNP Implicit Price Deflator (IPD), for example — should be roughly equal, up to a small constant term reflecting a gradual drift in the level of the index. If this is true, then the change in one price index may help to predict the change in another. The PPI, for instance, is a well-known leading indicator of inflation; therefore, a positive divergence between PPI and IPD inflation suggests that with time, either the rate of PPI inflation will fall, or the rate of IPD inflation will rise. This motivates the inclusion of an error-correction term between the inflation rate under consideration, in this case the IPD, and a second inflation measure, such as the PPI, labelled $\tilde{\pi}$. As $\tilde{\pi}$ may also have a direct impact on future inflation, $\Delta\tilde{\pi}_{t-1}$ is included as an additional regressor.

Incorporating these variables yields the most general version of the four equations used in this paper to model inflation:

$$\begin{aligned}(1)\qquad \Delta\pi_t = {} & \alpha_1(q_{t-1} - q^*_{t-1}) + \alpha_2(q_{t-2} - q^*_{t-2}) + \\ & \beta_1(\bar{v}_{t-1} - v_{t-1}) + \beta_2(\bar{v}_{t-2} - v_{t-2}) + \\ & \gamma(\Delta m_{t-1} - \Delta q_{t-1}) + \phi(\tilde{\pi}_{t-1} - \pi_{t-1}) + \theta\,\Delta\tilde{\pi}_{t-1} + \text{ lags of } \Delta\pi.\end{aligned}$$

The regressors fall into two categories. The output and velocity gaps and the change in money balances are in a sense the "fundamentals" of interest, as they carry an economic interpretation, and represent quantities over which policy can exert some degree of control. On the other hand, the $(\tilde{\pi} - \pi)$, $\Delta\tilde{\pi}$ and the lagged $\Delta\pi$ terms lack substantive economic content, but are useful to the extent that they can capture short-run dynamics and inflation pass-through phenomena.

To the extent that the P^* specification has an economic interpretation beyond that implied by the stationarity of the M2 velocity, it is that inflation responds identically to monetary in real shocks, *i.e.*, $\beta_1 = \alpha_1$. This, combined with the exclusion of the second lags ($\beta_2 = \alpha_2 = 0$), allows the q (real GNP) terms in the output and velocity gap terms to cancel, collapsing those variables into a single "price gap" term. This yields a variant of the P^* model, augmented with three additional regressors:

$$\Delta\pi_t = \beta\,(p^*_{t-1} - p_{t-1}) + \gamma(\Delta m_{t-1} - \Delta q_{t-1}) + \phi\,(\tilde{\pi}_{t-1} - \pi_{t-1}) + \theta\,\Delta\tilde{\pi}_{t-1} + \text{ lags of } \Delta\pi, \tag{2}$$

where p^*_t, the logarithm of P^*, is defined as $m_t + \bar{v} - q^*_t$.

To examine the sensitivity of the tests of P^* to the inclusion of these extra regressors, we also estimate a version of the model that excludes them:

$$\Delta\pi_t = \alpha_1(q_{t-1} - q^*_{t-1}) + \alpha_2(q_{t-2} - q^*_{t-2}) + \beta_1(\bar{v}_{t-1} - v_{t-1}) + \beta_2(\bar{v}_{t-2} - v_{t-2}) + \text{ lags of } \Delta\pi. \tag{3}$$

Finally, simultaneously imposing both of the above sets of restrictions on Equation 1 — excluding the extra regressors, and imposing the constraints on the output and velocity gap coefficients — results in the original P^* equation of HPS:

$$\Delta\pi_t = \beta\,(p^*_{t-1} - p_{t-1}) + \text{ lags of } \Delta\pi. \tag{4}$$

Results

This section presents the results from estimating the inflation models discussed above. As in HPS, these results use the GNP Implicit Price Deflator (IPD) to compute the inflation rate, while using the Producer Price Index (PPI) as the basis for $\tilde{\pi}$. The Federal Reserve Board's estimate of potential GNP is used for q^*. Two sets of alternative results appear in the appendix: one which uses the Hodrick-Prescott filter to compute potential GNP, and another which uses CPI inflation as the dependent variable. Neither modification alters the results of the analysis.

The Dickey-Fuller t-statistics in Table 1 confirm the stationarity of the velocity of M2, rejecting the null hypothesis of non-stationarity at the 5% level for the statistic estimated without a deterministic time trend. The table also confirms the stationarity of the difference between π^{PPI}_t and π^{IPD}_t.

Ordinary least squares estimates of Equations 1 through 4 appear in Table 2. Each equation includes three lags of $\Delta\pi$ as regressors,[6] and is estimated over the 1955–1989 sample period.

Table 1: Stationarity Tests
Dickey-Fuller t-statistics with four lags, 1955–1989.

	Without time trend	With time trend
M2 velocity (v_t)	−3.13*	−3.08
($\pi_t^{PPI} - \pi_t^{IPD}$)	−3.59**	−3.59*

* Significant at the 5% level; ** significant at the 1% level.

In the estimate of Equation 1, each coefficient is individually significant at traditional levels. In particular, the coefficients on both lags of the output and velocity gaps are large and significantly different from zero, as are the lagged change in money balances, and the inflation pass-through terms.

Joint tests of the restrictions embodied in Equations 2–4 appear in the lower portion of Table 2. In evaluating the P^* approach, the key test is of the "Equation 2" restrictions, *i.e.*, the three restrictions that allow the output and velocity gaps to be combined into the "P^* gap". The F-statistic associated with this test is 4.94, rejecting the restrictions at the 0.3% level. As indicated by the Equation 3 F-statistic in the first column of the table, the exclusion of the additional money and inflation variables is rejected at less than the 0.1% level. Not surprisingly the combination of these two sets of restrictions — which yields the P^* model of Equation 4 — also fails at less than the 0.1% level.

Although each of the three restricted specifications is rejected when nested within Equation 1, to highlight the estimates' sensitivity to omitted variables, Table 2 also includes the estimates of Equations 2 through 4. With the output and velocity gap terms condensed into the single $(p^*_{t-1} - p_{t-1})$ term, Equation 2 represents something of a variant on the P^* approach, in the sense that it excludes any effects from the output gap. With the imposition of these three restrictions, however, the $(\Delta m_{t-1} - \Delta q_{t-1})$ and $\Delta\pi_{t-1}^{PPI}$ terms are insignificant; only the coefficient on the error-correction term between π_{t-1}^{PPI} and π_{t-1}^{IPD} differs statistically from zero, although all three terms remain jointly significant at the 0.2% level. Excluding the second lags of the velocity and output gaps also increases the magnitude of estimated coefficients on lagged $\Delta\pi_t^{IPD}$, as these terms are forced to capture more of the short-run dynamics.

Similarly, by excluding the lagged money balances and inflation pass-through terms in going from Equation 1 to Equation 3, the coefficients on the fundamentals — the output and velocity gaps — shrink substantially; the velocity gap parameters fall by as much as a factor of four. Because of the changes in these parameter

Table 2: Estimation Results
Dependent variable: $\Delta\pi_t^{IPD}$, sample: 1955–1989.

Coefficient on: (*t*-statistic)		Equation 1	Equation 2	Equation 3	Equation 4
1	$(q_{t-1} - q^*_{t-1})$	0.179	...	0.109	...
		(3.11)		(1.85)	
2	$(q_{t-2} - q^*_{t-2})$	−0.140	...	−0.066	...
		(2.58)		(1.19)	
3	$(\bar{v}_{t-1} - v_{t-1})$	0.290	...	0.085	...
		(4.08)		(1.75)	
4	$(\bar{v}_{t-2} - v_{t-2})$	−0.281	...	−0.063	...
		(3.63)		(1.16)	
5	$(p^*_{t-1} - p_{t-1})$	...	0.034	...	0.035
			(4.12)		(4.23)
6	$(\pi^{PPI}_{t-1} - \pi^{IPD}_{t-1})$	0.306	0.197	...	...
		(5.21)	(3.74)		
7	$\Delta\pi^{PPI}_{t-1}$	−0.121	−0.052	...	...
		(2.39)	(1.05)		
8	$(\Delta m_{t-1} - \Delta q_{t-1})$	−0.156	−0.020	...	...
		(2.59)	(0.70)		
9	$\Delta\pi^{IPD}_{t-1}$	−0.298	−0.573	−0.587	−0.637
		(2.82)	(7.16)	(6.23)	(7.89)
10	$\Delta\pi^{IPD}_{t-2}$	−0.258	−0.437	−0.367	−0.406
		(2.74)	(5.13)	(3.74)	(4.61)
11	$\Delta\pi^{IPD}_{t-3}$	−0.205	−0.289	−0.236	−0.255
		(2.70)	(3.83)	(2.88)	(3.31)
	$\bar{R}^2$	0.433	0.382	0.316	0.322
F-statistic for the test of: (*p*-value)					
	Equation 2	4.938	...	...	...
		(0.003)			
	Equation 3	10.06	...	...	...
		(< 0.001)			
	Equation 4	5.386	5.356	0.589	...
		(< 0.001)	(0.002)	(0.623)	

estimates, the joint P^* restrictions can no longer be rejected when nested within Equation 3, even though they failed in the context of Equation 1.

Finally, Table 2 shows that the combined restrictions embodied in the plain P^* specification of Equation 4 involve a significant deterioration in goodness-of-fit, reflected by the fall in the $\bar{R}^2$ from 0.433 to 0.322. Furthermore, the uninformative lagged $\Delta\pi$ terms are now forced to capture more of the short-run dynamics of inflation.

Interpretation

The foregoing results demonstrate that the quarterly evolution of inflation is considerably more complicated than suggested by the simple P^* specification, a finding anticipated in the conclusion of HPS, who concede that the forecasts from P^* "clearly miss much of importance in the inflation process over the short run."[7] By expanding the set of independent variables used to model quarterly inflation changes, these regressions help to identify exactly what P^* misses at a quarterly frequency.

The most important result from a policy standpoint is that contrary to the P^* approach, the output gap *does* appear have a discernable impact on subsequent inflation rates. The main simplification of P^*, that the inflationary effect of a positive output gap would be offset through its disinflationary effect on the velocity gap, is soundly rejected in these regressions. Furthermore, other variables, such as PPI inflation, also contain information useful for predicting future movements in the GNP Implicit Price Deflator.

Clearly, the importance of many of these variables, whose effects are so strong at a quarterly level, diminish in the long run. For instance, in predicting the inflation rate ten years from today, it makes little sense to assume that output deviates significantly from its long-run trend; if real GNP is stationary around an exogenous trend (potential GNP), then output will revert to its potential in the long run, and the expected value of the output gap will converge to zero. Similarly, fluctuations in PPI inflation are of little use in predicting IPD inflation ten years hence. For this reason, adapting Equation 1 to long-run forecasts is problematic, and conditioning forecasts of future inflation on an assumed trajectory of M2 is likely to provide the best forecast over a long horizon.

However, as pointed out by Christiano (1989), adapting even the simple P^* model of Equation 4 to long-run forecasting presents some difficulties when the "true" long-run velocity, $\bar{v}$, is unknown. Treating the average velocity over the sample as the population mean is likely to produce significant errors in out-of-sample forecasts — errors which do not plague in-sample "forecasts," as within the sample, velocity reverts to its average simply by construction.

A further implication of these results is that given the information available from the PPI, over certain horizons, forecasts may benefit considerably from a multivariate approach.

Conclusion

The continued stationarity of the M2 velocity does suggest a durable long-run link between M2 and the GNP Implicit Price Deflator; given an exogenous trajectory of real GNP, it implies that M2 "anchors" the price level in the long run. These results do not challenge that conclusion. However, they do call into question the value of a quarterly model that includes *only* a long-run adjustment term, as in the P^* specification.

As a policy tool, P^* may serve a useful rhetorical purpose by abstracting from the more immediate determinants of inflation to focus on the long-run consequences of money growth. By distilling the implications of velocity's stationarity and money's long-run neutrality into a single, intuitively appealing measure of inflationary pressure, it indeed provides a "simple empirical guidepost" that anyone can understand.

For better or for worse, however, the Federal Reserve is in the business of conducting policy over a horizon far shorter than the elusive "long run." These results have demonstrated how misleading the P^* guidepost may be over the relevant policy horizons; real factors, such as the unemployment rate or the gap between real GNP and its potential, have a significant, if transitory, impact on the evolution of inflation. Therefore, so long as policymakers care not only about the long run but also how the economy gets there, it behooves them to pay attention to the state of the real economy.

Appendix: using alternative price and potential GNP series

Because potential GNP is unobservable and must itself be constructed or estimated, treating it as a known datum may be inappropriate. Short of using state-space techniques to estimate jointly the inflation model and a latent variable time-series process for potential GNP, checking the results' robustness with respect to alternative measures is essential. For comparability with the original HPS study, the results in the body of the paper used an unpublished Federal Reserve Board potential GNP series, composed of a four-part piecewise linear trend.[8]

For comparison purposes, Table A.1 presents an alternative set of results using the growth component from the Hodrick-Prescott (1980) filter, with $\lambda = 6400$, applied to real GNP as the measure of potential output (q^*). These alternative results tell much the same story as those in Table 2, but deliver even stronger rejections of the P^* restrictions.

Furthermore, the GNP Implicit Price Deflator (IPD) is widely recognized as a flawed basis for measuring price changes. In fact, in its statistical releases, the Department of Commerce warns: "[Because] the prices are weighted by the composition of GNP in each period, ...the Implicit Price Deflator reflects not only changes in prices but also changes in the composition of GNP, and its use as a measure of price change should be avoided." This well-known property is also highlighted in Webb and Willemse's (1989) survey of macroeconomic price indices.

Table A.2 displays another set of results using the overall Consumer Price Index (CPI-U) to calculate the rate of inflation, rather than the IPD. As in the earlier regressions, the Federal Reserve Board's measure of potential GNP is used for q^*. The preferred CPI specification differs slightly from IPD versions in that it includes three additional variables: two lags of the change in the rate of crude oil inflation, and the "inflation gap" between the IPD and the CPI inflation rates (the CPI is known to lag both of the other two indices). The CPI results mirror those which use the IPD; again, the P^* restrictions consistently fail at even the most generous significance levels.

Table A.1: Estimation Results
Dependent variable: $\Delta\pi_t^{IPD}$, sample: 1955–1989;
Hodrick-Prescott filter used to compute q^*.

Coefficient on: (*t*-statistic)		Equation 1	2	3	4
1	$(q_{t-1} - q^*_{t-1})$	0.184	...	0.141	...
		(3.28)		(2.45)	
2	$(q_{t-2} - q^*_{t-2})$	−0.129	...	−0.065	...
		(2.51)		(1.26)	
3	$(\bar{v}_{t-1} - v_{t-1})$	0.273	...	0.107	...
		(3.88)		(2.22)	
4	$(\bar{v}_{t-2} - v_{t-2})$	−0.254	...	−0.079	...
		(3.35)		(1.51)	
5	$(p^*_{t-1} - p_{t-1})$	...	0.043	...	0.043
			(4.22)		(4.28)
6	$(\pi^{PPI}_{t-1} - \pi^{IPD}_{t-1})$	0.287	0.201	...	...
		(4.81)	(3.83)		
7	$\Delta\pi^{PPI}_{t-1}$	−0.114	−0.057	...	...
		(2.25)	(1.15)		
8	$(\Delta m_{t-1} - \Delta q_{t-1})$	−0.135	−0.016	...	...
		(2.23)	(0.57)		
9	$\Delta\pi^{IPD}_{t-1}$	−0.324	−0.565	−0.583	−0.630
		(3.06)	(7.10)	(6.34)	(7.85)
10	$\Delta\pi^{IPD}_{t-2}$	−0.269	−0.430	−0.370	−0.398
		(2.84)	(5.05)	(3.83)	(4.54)
11	$\Delta\pi^{IPD}_{t-3}$	−0.211	−0.285	−0.244	−0.251
		(2.75)	(3.80)	(3.01)	(3.26)
	$\bar{R}^2$	0.427	0.385	0.332	0.324
F-statistic for the test of: (*p*-value)					
	Equation 2	4.207	...	...	...
		(0.001)			
	Equation 3	8.290	...	...	...
		(< 0.001)			
	Equation 4	5.052	5.497	1.557	...
		(< 0.001)	(0.001)	(0.203)	

Table A.2: Estimation Results
Dependent variable: $\Delta\pi_t^{CPI}$, sample: 1955–1989.

Coefficient on: (t-statistic)		Equation 1	2	3	4
1	$(q_{t-1} - q^*_{t-1})$	0.178	...	0.158	...
		(3.45)		(2.94)	
2	$(q_{t-2} - q^*_{t-2})$	−0.135	...	−0.106	...
		(2.76)		(2.08)	
3	$(\bar{v}_{t-1} - v_{t-1})$	0.116	...	0.088	...
		(2.82)		(2.06)	
4	$(\bar{v}_{t-2} - v_{t-2})$	−0.112	...	−0.075	...
		(2.41)		(1.56)	
5	$(p^*_{t-1} - p_{t-1})$	...	0.030	...	0.037
			(3.56)		(4.49)
6	$(\pi_{t-1}^{IPD} - \pi_{t-1}^{CPI})$	0.181	0.162	...	...
		(2.43)	(2.20)		
7	$(\pi_{t-1}^{PPI} - \pi_{t-1}^{CPI})$	0.160	0.148	...	...
		(2.90)	(2.70)		
8	$\Delta\pi_{t-1}^{CPI}$	−0.258	−0.313	−0.403	−0.415
		(2.58)	(3.35)	(4.41)	(4.82)
9	$\Delta\pi_{t-2}^{CPI}$	−0.322	−0.392	−0.420	−0.445
		(3.39)	(4.47)	(4.52)	(5.23)
10	$\Delta\pi_{t-3}^{CPI}$	0.106	0.070	0.090	0.078
		(1.27)	(0.85)	(1.05)	(0.95)
11	$\Delta\pi_{t-1}^{OIL}$	0.416	0.427	0.823	0.777
		(1.00)	(1.02)	(1.95)	(1.83)
12	$\Delta\pi_{t-2}^{OIL}$	0.730	0.843	0.905	0.960
		(1.72)	(1.98)	(2.11)	(2.23)
	$\bar{R}^2$	0.371	0.343	0.304	0.286
F-statistic for the test of: (p-value)					
	Equation 2	2.967	...	...	...
		(0.034)			
	Equation 3	7.986	...	...	...
		(0.001)			
	Equation 4	4.608	6.760	2.128	...
		(0.001)	(0.002)	(0.010)	

Footnotes

1 Engle and Granger (1987), Friedman and Kuttner (1989), and King, Plosser, Stock and Watson (1989) all report a stationary M2 velocity.

2 The velocity of M2 is defined as the ratio of nominal GNP to the stock of M2.

3 Since its initial appearance in a front-page story in the June 13, 1989 *New York Times*, articles on P^* have appeared in *Business Week*, *The Economist*, and even *Chance: New Directions for Statistics and Computing*.

4 For example, see Carlson (1989).

5 This deterioration is noted in Friedman and Kuttner (1989).

6 This specification differs slightly from the HPS version by using three lags of $\Delta\pi$ instead of four, and by omitting wage-price control and oil shock dummy variables. The fourth lag of $\Delta\pi$ was dropped after it was found to be small and statistically insignificant, while the dummy variables used in HPS appeared to be spuriously fitting individual observations. Neither of these changes was found to have a significant impact on either the estimates or the tests.

7 Hallman, Porter and Small, p. 28.

8 Footnote 2 in HPS claims the potential GNP series is based on the technique outlined in Clark (1983). Clark's method utilizes a long two-sided moving-average of the unemployment rate, inferring real GNP by way of Okun's Law. Exactly how such a procedure could yield a piecewise linear trend is not clear.

References

Bureau of Economic Analysis, Commerce Department (1989), "GNP Report and Tables," various issues.

Carlson, J. B. (1989), "The Indicator P-Star: Just What Does It Indicate?" Federal Reserve Bank of Cleveland *Economic Commentary*, September 15.

"Chance Musings, From the Press: 'Federal Reserve Sees a Way to Gauge Long-Run Inflation'," (1989), *Chance: New Directions for Statistics and Computing* **2**(3), 3–4.

Christiano, L. J. (1989), "P^*: Not the Inflation Forecasters' Holy Grail," Federal Reserve Bank of Minneapolis *Quarterly Review* **13**, Fall, 3–18.

Clark, P. K. (1983), "Okun's Law and Potential GNP," Board of Governors of the Federal Reserve System.

Davidson, J. E. H., D. F. Hendry, F. Srba, and S. Yeo (1978), "Econometric Modelling of the Aggregate Time-Series Relationship Between Consumers' Expenditure and Income in the United Kingdom," *Economic Journal* **88**, December, 661-692.

Engle, R. F. and C. W. J. Granger (1987), "Co-Integration and Error Correction: Representation, Estimation, and Testing," *Econometrica* **55**, March, 251-276.

Friedman, B. M. and K. N. Kuttner (1989), "Money, Income and Prices After the 1980s," NBER Working Paper # 2852, Cambridge: National Bureau of Economic Research.

Hallman, J. J., R. D. Porter, and D. H. Small (1989), "M2 per Unit of GNP as an Anchor for the Price Level," Board of Governors of the Federal Reserve System: Staff Study #157.

Hodrick, R. and Prescott, E. (1980), "Post-War U.S. Business Cycles: An Empirical Investigation," Carnegie-Mellon working paper.

Kilborn, P. T. (1989), "Federal Reserve Sees a Way to Gauge Long-Run Inflation" *The New York Times* **138**, June 13, 1.

King, Robert G., Charles I. Plosser, James H. Stock, and Mark W. Watson (1989), "Stochastic Trends and Economic Fluctuations," Mimeo.

McNamee, M. (1989), "Putting Keynes' Head on Milton Friedman's Body," *Business Week* , July 31, 66.

"Star Gazing" (1989), *The Economist* **312**, July 15–21, 65.

Webb, R. H. and R. Willemse (1989), "Macroeconomic Price Indexes," Federal Reserve Bank of Richmond *Economic Review* **75**, July–August, 22–32.

Federal Reserve Bank of Chicago

RESEARCH STAFF MEMORANDA, WORKING PAPERS AND STAFF STUDIES

The following lists papers developed in recent years by the Bank's research staff. Copies of those materials that are currently available can be obtained by contacting the Public Information Center (312) 322-5111.

Working Paper Series—A series of research studies on regional economic issues relating to the Seventh Federal Reserve District, and on financial and economic topics.

Regional Economic Issues

*WP-82-1	Donna Craig Vandenbrink	"The Effects of Usury Ceilings: the Economic Evidence," 1982
**WP-82-2	David R. Allardice	"Small Issue Industrial Revenue Bond Financing in the Seventh Federal Reserve District," 1982
WP-83-1	William A. Testa	"Natural Gas Policy and the Midwest Region," 1983
WP-86-1	Diane F. Siegel William A. Testa	"Taxation of Public Utilities Sales: State Practices and the Illinois Experience"
WP-87-1	Alenka S. Giese William A. Testa	"Measuring Regional High Tech Activity with Occupational Data"
WP-87-2	Robert H. Schnorbus Philip R. Israilevich	"Alternative Approaches to Analysis of Total Factor Productivity at the Plant Level"
WP-87-3	Alenka S. Giese William A. Testa	"Industrial R&D An Analysis of the Chicago Area"
WP-89-1	William A. Testa	"Metro Area Growth from 1976 to 1985: Theory and Evidence"
WP-89-2	William A. Testa Natalie A. Davila	"Unemployment Insurance: A State Economic Development Perspective"
WP-89-3	Alenka S. Giese	"A Window of Opportunity Opens for Regional Economic Analysis: BEA Release Gross State Product Data"
WP-89-4	Philip R. Israilevich William A. Testa	"Determining Manufacturing Output for States and Regions"
WP-89-5	Alenka S.Geise	"The Opening of Midwest Manufacturing to Foreign Companies: The Influx of Foreign Direct Investment"
WP-89-6	Alenka S. Giese Robert H. Schnorbus	"A New Approach to Regional Capital Stock Estimation: Measurement and Performance"

*Limited quantity available.
**Out of print.

Working Paper Series *(cont'd)*

WP-89-7	William A. Testa	"Why has Illinois Manufacturing Fallen Behind the Region?"
WP-89-8	Alenka S. Giese William A. Testa	"Regional Specialization and Technology in Manufacturing"
WP-89-9	Christopher Erceg Philip R. Israilevich Robert H. Schnorbus	"Theory and Evidence of Two Competitive Price Mechanisms for Steel"
WP-89-10	David R. Allardice William A. Testa	"Regional Energy Costs and Business Siting Decisions: An Illinois Perspective"
WP-89-21	William A. Testa	"Manufacturing's Changeover to Services in the Great Lakes Economy"
WP-90-1	P.R. Israilevich	"Construction of Input-Output Coefficients with Flexible Functional Forms"
WP-90-4	Douglas D. Evanoff Philip R. Israilevich	"Regional Regulatory Effects on Bank Efficiency"
WP-90-5	Geoffrey J.D. Hewings	"Regional Growth and Development Theory: Summary and Evaluation"
WP-90-6	Michael Kendix	"Institutional Rigidities as Barriers to Regional Growth: A Midwest Perspective"

Issues in Financial Regulation

WP-89-11	Douglas D. Evanoff Philip R. Israilevich Randall C. Merris	"Technical Change, Regulation, and Economies of Scale for Large Commercial Banks: An Application of a Modified Version of Shepard's Lemma"
WP-89-12	Douglas D. Evanoff	"Reserve Account Management Behavior: Impact of the Reserve Accounting Scheme and Carry Forward Provision"
WP-89-14	George G. Kaufman	"Are Some Banks too Large to Fail? Myth and Reality"
WP-89-16	Ramon P. De Gennaro James T. Moser	"Variability and Stationarity of Term Premia"
WP-89-17	Thomas Mondschean	"A Model of Borrowing and Lending with Fixed and Variable Interest Rates"
WP-89-18	Charles W. Calomiris	"Do "Vulnerable" Economies Need Deposit Insurance?: Lessons from the U.S. Agricultural Boom and Bust of the 1920s"

*Limited quantity available.
**Out of print.

Working Paper Series *(cont'd)*

WP-89-23	George G. Kaufman	"The Savings and Loan Rescue of 1989: Causes and Perspective"
WP-89-24	Elijah Brewer III	"The Impact of Deposit Insurance on S&L Shareholders' Risk/Return Trade-offs"

Macro Economic Issues

WP-89-13	David A. Aschauer	"Back of the G-7 Pack: Public Investment and Productivity Growth in the Group of Seven"
WP-89-15	Kenneth N. Kuttner	"Monetary and Non-Monetary Sources of Inflation: An Error Correction Analysis"
WP-89-19	Ellen R. Rissman	"Trade Policy and Union Wage Dynamics"
WP-89-20	Bruce C. Petersen William A. Strauss	"Investment Cyclicality in Manufacturing Industries"
WP-89-22	Prakash Loungani Richard Rogerson Yang-Hoon Sonn	"Labor Mobility, Unemployment and Sectoral Shifts: Evidence from Micro Data"
WP-90-2	Lawrence J. Christiano Martin Eichenbaum	"Unit Roots in Real GNP: Do We Know, and Do We Care?"
WP-90-3	Steven Strongin Vefa Tarhan	"Money Supply Announcements and the Market's Perception of Federal Reserve Policy"
WP-90-7	Prakash Loungani Mark Rush	"Sectoral Shifts in Interwar Britain"
WP-90-8	Kenneth N. Kuttner	"Money, Output, and Inflation: Testing The P-Star Restrictions"
WP-90-9	Lawrence J. Christiano Martin Eichenbaum	"Current Real Business Cycle Theories and Aggregate Labor Market Fluctuations"
WP-90-10	S. Rao Aiyagari Lawrence J. Christiano Martin Eichenbaum	"The Output, Employment, And Interest Rate Effects of Government Consumption"

*Limited quantity available.
**Out of print.

Staff Memoranda—A series of research papers in draft form prepared by members of the Research Department and distributed to the academic community for review and comment. (Series discontinued in December, 1988. Later works appear in working paper series).

**SM-81-2	George G. Kaufman	"Impact of Deregulation on the Mortgage Market," 1981
**SM-81-3	Alan K. Reichert	"An Examination of the Conceptual Issues Involved in Developing Credit Scoring Models in the Consumer Lending Field," 1981
SM-81-4	Robert D. Laurent	"A Critique of the Federal Reserve's New Operating Procedure," 1981
**SM-81-5	George G. Kaufman	"Banking as a Line of Commerce: The Changing Competitive Environment," 1981
SM-82-1	Harvey Rosenblum	"Deposit Strategies of Minimizing the Interest Rate Risk Exposure of S&Ls," 1982
*SM-82-2	George Kaufman Larry Mote Harvey Rosenblum	"Implications of Deregulation for Product Lines and Geographical Markets of Financial Instititions," 1982
*SM-82-3	George G. Kaufman	"The Fed's Post-October 1979 Technical Operating Procedures: Reduced Ability to Control Money," 1982
SM-83-1	John J. Di Clemente	"The Meeting of Passion and Intellect: A History of the term 'Bank' in the Bank Holding Company Act," 1983
SM-83-2	Robert D. Laurent	"Comparing Alternative Replacements for Lagged Reserves: Why Settle for a Poor Third Best?" 1983
**SM-83-3	G. O. Bierwag George G. Kaufman	"A Proposal for Federal Deposit Insurance with Risk Sensitive Premiums," 1983
*SM-83-4	Henry N. Goldstein Stephen E. Haynes	"A Critical Appraisal of McKinnon's World Money Supply Hypothesis," 1983
SM-83-5	George Kaufman Larry Mote Harvey Rosenblum	"The Future of Commercial Banks in the Financial Services Industry," 1983
SM-83-6	Vefa Tarhan	"Bank Reserve Adjustment Process and the Use of Reserve Carryover Provision and the Implications of the Proposed Accounting Regime," 1983
SM-83-7	John J. Di Clemente	"The Inclusion of Thrifts in Bank Merger Analysis," 1983
SM-84-1	Harvey Rosenblum Christine Pavel	"Financial Services in Transition: The Effects of Nonbank Competitors," 1984

*Limited quantity available.
**Out of print.

Staff Memoranda *(cont'd)*

SM-84-2	George G. Kaufman	"The Securities Activities of Commercial Banks," 1984
SM-84-3	George G. Kaufman Larry Mote Harvey Rosenblum	"Consequences of Deregulation for Commercial Banking"
SM-84-4	George G. Kaufman	"The Role of Traditional Mortgage Lenders in Future Mortgage Lending: Problems and Prospects"
SM-84-5	Robert D. Laurent	"The Problems of Monetary Control Under Quasi-Contemporaneous Reserves"
SM-85-1	Harvey Rosenblum M. Kathleen O'Brien John J. Di Clemente	"On Banks, Nonbanks, and Overlapping Markets: A Reassessment of Commercial Banking as a Line of Commerce"
SM-85-2	Thomas G. Fischer William H. Gram George G. Kaufman Larry R. Mote	"The Securities Activities of Commercial Banks: A Legal and Economic Analysis"
SM-85-3	George G. Kaufman	"Implications of Large Bank Problems and Insolvencies for the Banking System and Economic Policy"
SM-85-4	Elijah Brewer, III	"The Impact of Deregulation on The True Cost of Savings Deposits: Evidence From Illinois and Wisconsin Savings & Loan Association"
SM-85-5	Christine Pavel Harvey Rosenblum	"Financial Darwinism: Nonbanks—and Banks—Are Surviving"
SM-85-6	G. D. Koppenhaver	"Variable-Rate Loan Commitments, Deposit Withdrawal Risk, and Anticipatory Hedging"
SM-85-7	G. D. Koppenhaver	"A Note on Managing Deposit Flows With Cash and Futures Market Decisions"
SM-85-8	G. D. Koppenhaver	"Regulating Financial Intermediary Use of Futures and Option Contracts: Policies and Issues"
SM-85-9	Douglas D. Evanoff	"The Impact of Branch Banking on Service Accessibility"
SM-86-1	George J. Benston George G. Kaufman	"Risks and Failures in Banking: Overview, History, and Evaluation"
SM-86-2	David Alan Aschauer	"The Equilibrium Approach to Fiscal Policy"

*Limited quantity available.
**Out of print.

Staff Memoranda *(cont'd)*

SM-86-3	George G. Kaufman	"Banking Risk in Historical Perspective"
SM-86-4	Elijah Brewer III Cheng Few Lee	"The Impact of Market, Industry, and Interest Rate Risks on Bank Stock Returns"
SM-87-1	Ellen R. Rissman	"Wage Growth and Sectoral Shifts: New Evidence on the Stability of the Phillips Curve"
SM-87-2	Randall C. Merris	"Testing Stock-Adjustment Specifications and Other Restrictions on Money Demand Equations"
SM-87-3	George G. Kaufman	"The Truth About Bank Runs"
SM-87-4	Gary D. Koppenhaver Roger Stover	"On The Relationship Between Standby Letters of Credit and Bank Capital"
SM-87-5	Gary D. Koppenhaver Cheng F. Lee	"Alternative Instruments for Hedging Inflation Risk in the Banking Industry"
SM-87-6	Gary D. Koppenhaver	"The Effects of Regulation on Bank Participation in the Market"
SM-87-7	Vefa Tarhan	"Bank Stock Valuation: Does Maturity Gap Matter?"
SM-87-8	David Alan Aschauer	"Finite Horizons, Intertemporal Substitution and Fiscal Policy"
SM-87-9	Douglas D. Evanoff Diana L. Fortier	"Reevaluation of the Structure-Conduct-Performance Paradigm in Banking"
SM-87-10	David Alan Aschauer	"Net Private Investment and Public Expenditure in the United States 1953-1984"
SM-88-1	George G. Kaufman	"Risk and Solvency Regulation of Depository Institutions: Past Policies and Current Options"
SM-88-2	David Aschauer	"Public Spending and the Return to Capital"
SM-88-3	David Aschauer	"Is Government Spending Stimulative?"
SM-88-4	George G. Kaufman Larry R. Mote	"Securities Activities of Commercial Banks: The Current Economic and Legal Environment"
SM-88-5	Elijah Brewer, III	"A Note on the Relationship Between Bank Holding Company Risks and Nonbank Activity"
SM-88-6	G. O. Bierwag George G. Kaufman Cynthia M. Latta	"Duration Models: A Taxonomy"
	G. O. Bierwag George G. Kaufman	"Durations of Nondefault-Free Securities"

*Limited quantity available.
**Out of print.

Staff Memoranda *(cont'd)*

SM-88-7	David Aschauer	"Is Public Expenditure Productive?"
SM-88-8	Elijah Brewer, III Thomas H. Mondschean	"Commercial Bank Capacity to Pay Interest on Demand Deposits: Evidence from Large Weekly Reporting Banks"
SM-88-9	Abhijit V. Banerjee Kenneth N. Kuttner	"Imperfect Information and the Permanent Income Hypothesis"
SM-88-10	David Aschauer	"Does Public Capital Crowd out Private Capital?"
SM-88-11	Ellen Rissman	"Imports, Trade Policy, and Union Wage Dynamics"

Staff Studies—A series of research studies dealing with various economic policy issues on a national level.

SS-83-1	Harvey Rosenblum Diane Siegel	"Competition in Financial Services: the Impact of Nonbank Entry," 1983
**SS-83-2	Gillian Garcia	"Financial Deregulation: Historical Perspective and Impact of the Garn-St Germain Depository Institutions Act of 1982," 1983

*Limited quantity available.
**Out of print.