THE MEASUREMENT AND SOCIAL COSTS OF INFLATION:

THE RECENT INFLATION AND OUR NEW MONETARY STANDARD

By

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Much of the discussion of the recent inflationary experience fails to recognize a fundamental contradiction between professional economic opinion and general public attitudes concerning the harmful effects of inflation. Economists distinguish between anticipated and unanticipated inflation and, within the context of commonly accepted economic theory, assert that the sole cost of fully anticipated inflation is that it leads individuals to economize on real cash balances and thereby substitute real resources for money and reallocate resources towards the production of less cash intensive commodities. The public, on the other hand, seems to regard inflation as per se evil.[1] In particular, some evidence is presented here which indicates that the current inflation is extremely steady and therefore may be considered largely anticipated; yet public opposition to the recent inflation appears to be deep and widespread. This is difficult to explain solely on the grounds that inflation is an inefficient excise tax.[2] While merely asserting that the public is myopic, i.e., that they generally think their income would have risen the same nominal amount independent of the inflation rate, seems to be too easy as an entire explanation for the phenomenon.

Current policy discussions usually ignore the theory and accept the general public attitude by implicitly or explicitly entering price change in a social welfare function, i.e., by assuming inflation is a bad which should be avoided and traded off against other social costs such as involuntary unemployment. But this general practice should leave us somewhat uneasy.

Have we economists failed in our didactic task and merely reinforced an irrational belief? Or does the current opposition to inflation rest on rational grounds and is it our analysis that is deficient?

Our answer to this question can perhaps most usefully be placed in the context of the "new inflationist" answers supplied, for example, by Gordon [9] and Tobin and Ross [23]. Since the current inflation is steady and therefore largely anticipated, they argue, it entails little or no costs. Hence, economists must educate the public that government policy should be geared to permitting individuals to more costlessly adjust to and live with inflation, e.g., by eliminating maximum interest rate restrictions and adopting escalator clauses, rather than to creating unemployment to reduce the rate of inflation. This paper attempts to demonstrate that this analysis is incomplete and that there may be a rational explanation for the general public opposition to the current inflation. By surveying the movement of prices over the last century the recent inflationary experience is put into historical perspective and evidence is presented which suggests that we have only very recently moved to a fiduciary monetary standard where the long-term trend in prices is no longer presumed to be zero and where large price changes in one direction are not expected to be reversible. It is shown that under this new standard the variance of estimates of the price level expected in the future (e.g., five years from now) may be relatively high and therefore, although the annual inflation rate is steady, inflation cannot now be described as almost perfectly predictable.

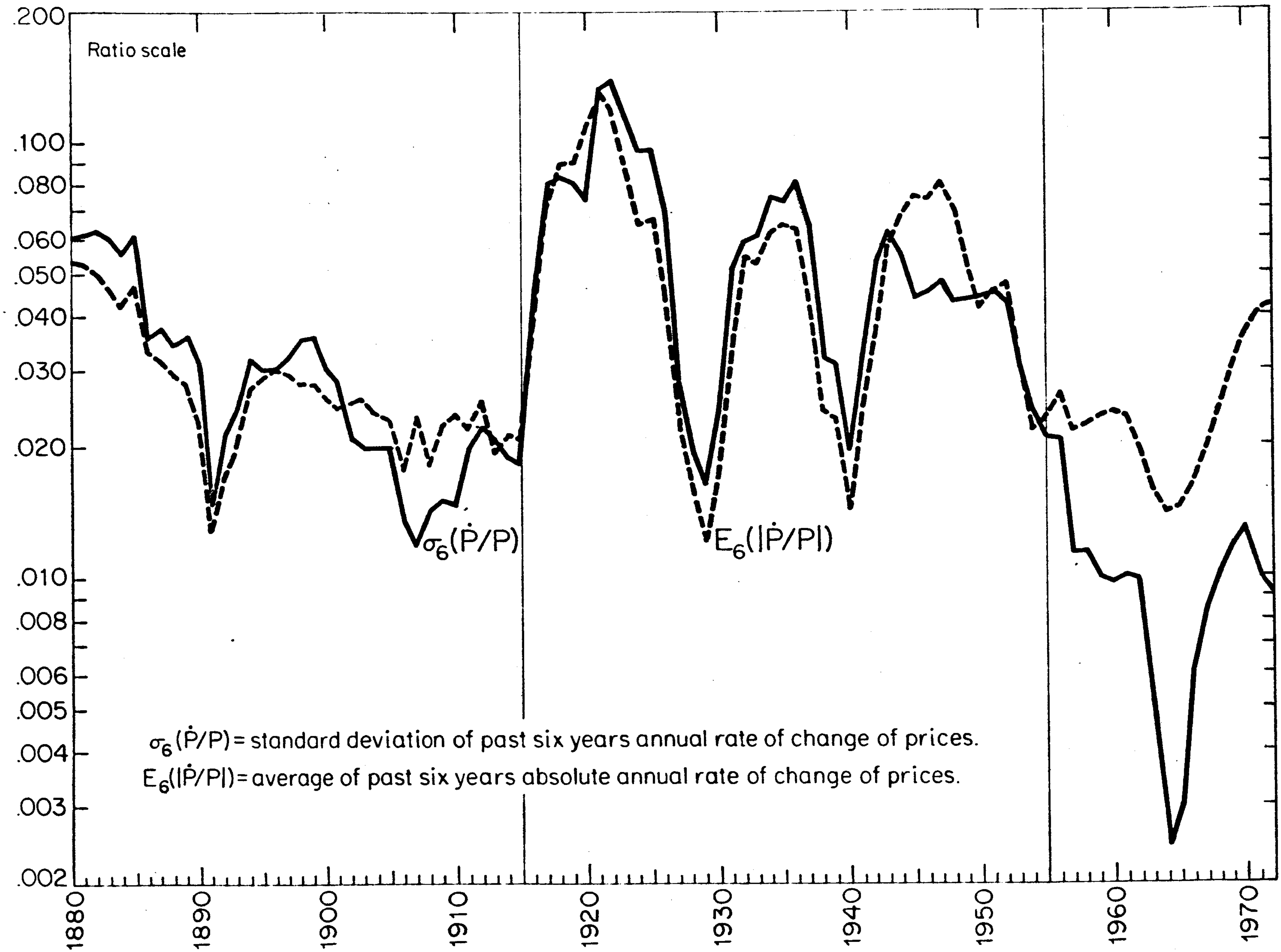
I. Predictability of the Price Level

Traditional economic theory emphasizes the predictability and not the stability of price change as the primary determinant of the real monetary service flow from money. It is unanticipated price change which decreases the usefulness of money as a store of value and unit for long-term contracts by redistributing income and wealth between individuals and introducing a random element in all monetary agreements for future payment. The added uncertainty of an increase in the expected value of unanticipated price changes, i.e., of an increase in the variance of the prior probability price change distribution,[3] leads individuals to devote increased quantities of scarce resources in attempting to predict future price movements and, as Fisher stated so well in The Purchasing Power of Money, discourages the formation of long-term contracts.

To get some idea of the historical movement of these costs of uncertainty from unpredictable price change, Chart 1 (solid line) shows the variability of the annual rate of price change over the period 1880-1972. Variability is measured by the log of the six-term moving standard deviation of the annual rate of change of prices.[4] If price anticipations are not formed regarding the acceleration of prices, this series may be regarded as an operational measure of the amount of unanticipated annual price change over the past six years and the amount of unanticipated price change (or price uncertainty) expected for the immediate future.[5]

These costs and the riskiness of long-term commitments can, in principle, be cheaply avoided by the use of price escalator clauses or the adoption of a tabular standard. The fact that we do not now observe purchasing-power bonds nor escalator clauses in many long-term contracts indicates that price change uncertainty is low relative to how accurately our price indices measure the price changes. Economists who now advocate general adoption of price escalators as a panacea,[6] fail to recognize that our price indices

Chart 1. Variability and Extent of Annual Rate of Price Change, 1880-1972



have failed the market test. Since there generally are no regulations prohibiting the use of escalators these economists must be assuming that profit motivated businessmen are ignorant in this regard. This I find difficult to believe. If, in fact, existing price indices are rather poor measures of the purchasing power of money,[7] adoption of price escalators will reduce the variance of the anticipated real pay off only if the variance of future anticipated price change is high. This explains why such clauses are generally written into contracts only in countries, such as Israel, Brazil and Argentina, that have experienced great price variability and not necessarily high inflation rates. In the U.S. relatively few contracts possess escalator clauses, e.g., approximately five percent of the labor force is currently working under contracts with escalator provisions, but use of such clauses over time is more highly correlated with measures of price unpredictability than with measures of the expected mean rate of price change . Over the 1957-71 period the correlation of the percent of the labor force covered by escalators with the variability of price change measure plotted in Chart 1 is .53 (and with a measure of long-term price unpredictability to be presented later it is .84) while the correlation with the moving average of the past six years rate of price change is only .19.[8]

II. Stability of the Price Level

Traditional theory emphasizes price predictability but does not ignore price stability. Even if perfectly predictable, there may be information and transaction costs associated with changing prices. Fisher [6], in a largely unknown popular tract published nine years after The Purchasing Power of Money, modified his position noted above and emphasized the calculation costs which exist when prices change. By drawing an analogy between the dollar and other measures such as the inch he advocated a policy of "standardizing" the dollar by varying its gold content to produce a stable and not solely a predictable price level. The greater the rate of inflation, the more rapid is the depreciation of unadjusted price information and therefore the greater the economic incentive to discount monetary magnitudes. Since discounting is costly, inflation thereby decreases the usefulness of money as a measure of value. It is also important to recognize that there are adjustment costs of altering prices. Some prices are less than perfectly (i.e., costlessly) flexible in the face of changing anticipations because they were <u>previously</u> fixed by long-term contracts and the renegotiating costs are significant. "Even in the absence of explicit contracts, prices may be kept from adjustment by implied understandings and by the mere inertia of custom" (Fisher [5 , p. 185]). Our tax code, accounting conventions, legal system and other long-term institutional arrangements are also far from perfectly flexible. In addition, the costs of changing price signs, labels, bookkeeping entries, coin vending machines and currency denominations may also be significant.[9] Therefore, inflation, even if perfectly predictable, increases the cost of monetary exchange. Such an inflation produces both more frequent price changes and greater discrepancies from "equilibrium" prices (i.e., prices that would prevail in the absence of adjustment costs) and reallocates resources towards industries in which prices and factor payments can be adjusted more cheaply.

To get some idea of the historical movement of these transaction costs associated with anticipated inflation, Chart 1 (dashed line) shows the <u>extent</u> of annual price change over the period 1880-1972. The variable plotted is the log of the six-term moving average of the absolute annual rate of change of prices. This series can be regarded as an operational measure of the extent of annual price change over the last six years. (The moving average of the absolute annual rate of change of prices is used since the transaction costs associated with anticipated inflation that we have considered above are also present with anticipated deflation, i.e., price change per se is what is costly.)

III. Predictability versus Stability

The most obvious fact about Chart 1 is that the moving standard deviation of the rate of price change and the moving average absolute rate of price change coincide remarkably well. Although there is no necessary relationship between them, large annual price changes in a six year period have historically been closely associated with highly variable price changes in the same period. The closeness in the levels of our two time series suggests that large annual rates of price change have generally been largely unanticipated. It is therefore understandable why stability is often identified with predictability when individuals contemplate the evils of inflation.

But after 1955 a wide separation appears in the two series and therefore it is crucial that the distinction between stability and predictability be explicitly made when analyzing recent experience. This unprecedented separation is produced by the combination of two historically unique characteristics of our present monetary situation: a relatively steep trend in the average rate of change of prices and a very low variability of price change around that trend. The only other time interval of similar length that compares with the most recent period in terms of a continuous upward trend in prices is the pre-World War I gold inflation of 1897-1914 when prices rose at an average annual rate of nearly two per cent. But this 18 year period follows a long period of deflation and includes three years when prices actually declined. The last twenty years is the only period in our recorded history without a single year in which prices fell. This is reflected in the moving standard deviation of prices, which is significantly lower during the last fifteen years than in any other period, reaching an historically unprecedented low level of .0024 (i.e., .24 percentage points) in 1964.[10] For the first time in our recorded history we are experiencing a significant inflation that is steady and therefore, may lead us to assume, largely anticipated.[11]

Upon examination of Chart 1 we therefore seem to be faced with uneasy acceptance of the conclusion that if the present opposition to inflation is rational, it must be based on the somewhat vague calculation and adjustment costs associated with price change and not on the costs of price uncertainty. While the moving average absolute rate of price change variable is now relatively high by historical standards (reaching .0413 in 1972) and is rising, the moving standard deviation variable is now exceptionally low. Although the moving standard deviation has risen since 1964, it is unlikely that this recent increase in the unpredictability of prices is the basis of the recent opposition to inflation. The level of the moving standard deviation was still very low by historical standards at the 1970 peak (.0130) and by 1972 was less than one percent (.0091). (If the rate of increase of prices for 1973 is near four percent, the moving average absolute rate of change of prices will rise further while the moving standard deviation will continue to decline to the low level reached during 1962-65 of about one-half of a percentage point.) Therefore, unless the public's tolerance of price level unpredictability has fallen drastically, our figures seem to indicate that a satisfactory explanation for the continued opposition to the U.S. inflation cannot be based on the fact that the inflation is now largely unpredictable. However, under the more complete analysis that follows, this conclusion will be shown to be incorrect.

IV. A New Monetary Standard

It will be useful for our analysis to compare the annual rate of price change and the movement of the two derivative variables plotted in Chart 1 over different time periods. The total period covered in the chart can be conveniently divided into three subperiods: a) the "gold standard" period from 1880 to 1915, b) the "transitional" period from 1916 to 1955 and c) the "new standard" period from 1956 to 1972. The corresponding average level of the moving standard deviation variable over each of these subperiods is: a) .0310, b) .0569, c) .0095. While the transitional period has the largest average standard deviation, this period contains the Great Depression, the two World Wars and the Korean War and comparisons with the other two periods are not entirely relevant. The comparison between the latest period and the gold standard period, however, is striking. The average standard deviation was more than three times as great during the gold standard period than during the recent period. This merely confirms the argument of the previous section regarding the historically unique character of the extremely low level of price unpredictability which now seems to exist.

But comparison of the recent period with earlier time periods in terms of a moving standard deviation as a measure of the predictability of prices is misleading. The post-1952 period contains only positive price changes while the earlier time period contains positive and negative price changes. Large price changes were previously unsteady because price changes of similar magnitude but of opposite sign occurred temporally close to one another. During the gold standard period from 1880 to 1915, for example, although the mean of the moving six-year average <u>absolute</u> annual rate of change of prices was near three percent (.0284), the mean of the moving six-year average annual rate of change of prices was very close to zero (.0017). This explains the closeness of our two series during this period. At any point in time the average absolute rate of changes of prices, $E(|X|)$, is mathematically related to the variance of the rate of change of prices, $V(X)$, by:

$$\text{(1)} \qquad [E(|X|)]^2 = V(X) + [E(X)]^2 - V(|X|)$$

where $E(X)$ is the average rate of change of prices and $V(|X|)$ is the variance of the absolute rate of change of prices. During much of the gold standard period, $E(X)$ <u>and</u> $V(|X|)$ were both close to zero.[12]

Further evidence for the presence of this gold standard presumption that periods of inflation were expected to be followed by periods of deflation is provided by the following regression which includes the actual rate of change of prices in a secular demand for money function.[13] Although the rate of change of prices enters negatively and significantly over the 1916-1968 period (25 observations)

$$\text{(2)} \quad \log (M/PN) = -.9973 + \underset{(17.36)}{1.1515} \log (Y/PN) - \underset{(6.22)^L}{.1312r} - \underset{(2.90)}{.0134}(\dot{P}/P) \qquad \bar{R}^2 = .938, \; DW = 1.07, \; SE = .0887$$

it enters positively (but insignificantly) over the 1880-1916 period (21 observations).

$$(3)\ \log(M/PN) = -6.0450 + \underset{(10.47)}{2.0356}\log(Y/PN) - \underset{(5.43)^L}{.3199r} + \underset{(1.01)}{.0096}(\dot{P}/P) \quad \bar{R}^2 = .952,\ DW = 0.59,\ SE = .0916$$

This suggests that actual price change may have been negatively correlated with anticipated price change during the pre-World War I period and may explain why "expected" price change variables, measured as a weighted average of past actual price changes with all the weights positive, do not show up significantly in long-run U.S. demand for money studies.

This gold standard phenomenon can perhaps be seen clearest by examining the sample autocorrelations of the annual rates of price change presented in Table 1. Each of our first two subperiods has been divided into two twenty year periods,[14] thus leaving us with five periods of similar length over which autocorrelations have been calculated. The first two gold standard periods are quite distinctly different from the final new standard period. The autocorrelations during the gold standard periods are generally negative or close to zero while the autocorrelations during the most recent period are positive, in fact quite strongly positive for the one and two year lag terms. The gold standard can be considered to have been a period of <u>mean reversion</u> in the rate of price change while the current period is one of <u>persistence</u> in the rate of price change. Hence, the current rate of price change is now a good indication of what the rate of price change will be in the immediate future while under the gold standard the relationship between the current rate and future rates was negative and weaker.

Table 1

Sample Autocorrelations of Annual Rates of Price Change

lag	1876-95	1896-1915	1916-35	1936-55	1956-72
1	.027	-.357	.421	.487*	.857*
2	-.009	.058	.211	-.039	.598*
3	-.258	.032	.071	-.146	.342
4	-.461*	-.527*	-.229	-.090	.012

* indicates autocorrelation significantly different from zero at the .95 confidence level. (The asymptotic standard error of each sample autocorrelation is $1/\sqrt{n}$, where n is the number of observations in each time period under the null hypothesis that the true autocorrelations are zero, cf. Box and Jenkins [2 , ch. 2].) Each autocorrelation is calculated only using data over the time period indicated.

Under a commodity standard, therefore, an average of past price changes has no direct positive relationship with long-term price anticipations, and so our standard deviation of the annual rate of price change variable cannot be regarded as a complete measure of the unpredictability of prices in such an economy. Although annual rates of price change may have been highly variable, the price level expected in five or ten years may have been more predictable during much of our early history than now. The historically unique characteristic of the inflation of the last decade and a half represented by the separation of our two series in Chart 1 is therefore not that we are experiencing a predictable price movement, but that we have moved fully to a new monetary standard where the long-term trend in prices is not expected to be zero and where large price changes in one direction are not expected to be reversible.

Realization that we were on this new monetary standard, in which rapid inflation would not likely later be followed by deflation must have occurred gradually over the last twenty-five years. First the post-World War II deflation did not materialize and then prices also failed to fall after the Korean War[15] and during the recessions of the 1950's and early 1960's and finally the de facto adoption of the international dollar standard reduced the force of the balance of payments as a constraint on U.S. monetary policy. But even as late as 1964 firm expectations must have been held that a long-term monetary policy necessary to maintain foreign convertibility of the dollar at $35/oz. would be followed. The index of the official commodity value of gold (the ratio of the official dollar value of gold to the wholesale price index) was only slightly lower in 1964 than after the sharp deflation of 1921-22, i.e., the official dollar price of gold was not too low. The inflation of the 1940's, and the 1950's and the early 1960's merely readjusted the level of prices for the deflation and devaluation in the 1930's. Since 1964, however, in spite of the recent U.S. devaluations, the purchasing power of official gold has fallen (by late 1973) an additional twenty percent. Within this context the twenty percent increase in the official dollar price of gold that has occurred since 1971 has clearly been of insufficient magnitude. But a major deflation is certainly not now generally anticipated.[16]

Further evidence that individuals began to realize during the late 1950's and 1960's that a new pure fiduciary standard was replacing any remaining semblance of a gold commodity standard is the substantially shorter lag of adjustment of interest rates to price level changes found by Yohe and Karnosky [24] than found in many earlier studies. If the Yohe and Karnosky regressions are extended backward in time from the 1952-69 period which they cover, the total effect of price level changes on long-term interest rates is much smaller and slower, with the initial price change coefficients often negative and the sum of the coefficients often close to zero -- results one would expect under a commodity standard with long-term expectations of a stable price level. For example, using a 48 month six degree polynominal lag structure, over the 1917-33 period the sum of the monthly annual rate of CPI change coefficients on the long-term interest rate is .057, the sum of the coefficients for the first six months is -.005, and the mean lag is 28.61; for the 1933-52 period, the total sum of coefficients is -.112, the six month sum of coefficients is -.022, and mean lag is 22.41; while for the 1952-72 period the total sum of coefficients is 1.068, the six month sum is .577 and the mean lag is 14.86.[17] Alternatively, to measure the short-run impact of a change in the rate of change of prices on the level of interest rates, Table 2 below presents decade by decade results of the sum of the first six months coefficients for similar regressions using a 36 month sixth degree Almon lag of the annual rate of monthly price change in the CPI against both long and short interest rates. These results clearly indicate that a significant positive short-run impact of price change on the level of interest rates is present only in the last decade. The short-run Fisherian price anticipations effects emphasized by Yohe and Karnosky only make sense under the pure fiduciary standard of the late 1960's with its substantially shorter lag of adjustment of price anticipations to rising prices.[18]

An alternative way of describing these results is by claiming not that in the 1960's price expectations adjusted faster to past actual price changes but that price expectations merely had more of an impact on interest rates during the 1960's. Gibson [8], using the Livingston price expectations data discussed above (n 4), finds a much greater effect of this particular expected rate of price change variable on the level of interest rates after 1959 than before.[19] Gibson "explains" the fact that price predictions were more inaccurate before 1959 (and therefore given less weight by rational market participants) by asserting that "information costs made predicting inflation less rewarding for the market before 1959." This tautology is then fleshed out with two possible hypotheses: a) since the actual inflation rate was lower before 1959, the benefits from accurately predicting it would also be lower, and b) it became cheaper to predict prices after 1959.

Table 2

Six Month Impact of Rate of Change in CPI on Level of Interest Rates

time period	r_L	r_S
1920-30	.0048	.0029
1930-40	-.0641	-.1021
1940-50	-.0048	.0057
1950-60	-.0318	-.0068
1960-70	.2083	.7246

The long-term interest rate, r_L, is the basic yield on high grade (Aaa) corporate bonds to 30 year maturity. The short-term interest rate, r_S, is the yield on 4-6 month NYC commercial paper. The elements in the table are $\sum_{i=0}^{6} \beta_i$ from the regression: $r_t = \alpha_0 + \sum_{i=0}^{36} \beta_i (\dot{P}/P)_{t-i} + \varepsilon_t$, where the β_i are estimated using a sixth degree Almon lag with the far term constrained to zero.

Unfortunately, hypothesis a) ignores the fact that price uncertainty and the gains from increased accuracy are related to the variance and not the mean of expected price change, and Gibson suggests no reasons why hypothesis b) may be correct, i.e., why the production function regarding future price level information shifted up in the 1960's. The analysis of this paper, however, suggests that the 1950's were part of the transitional phase of final adjustment to the new monetary standard. Since market participants were not yet fully aware of the fact that the gold standard, in the sense of relative stability in the long-term trend of prices and short-term reversibility of large price changes, was nearing its demise, we should of course expect less accurate price predictions.

V. Long-Term Price Predictability

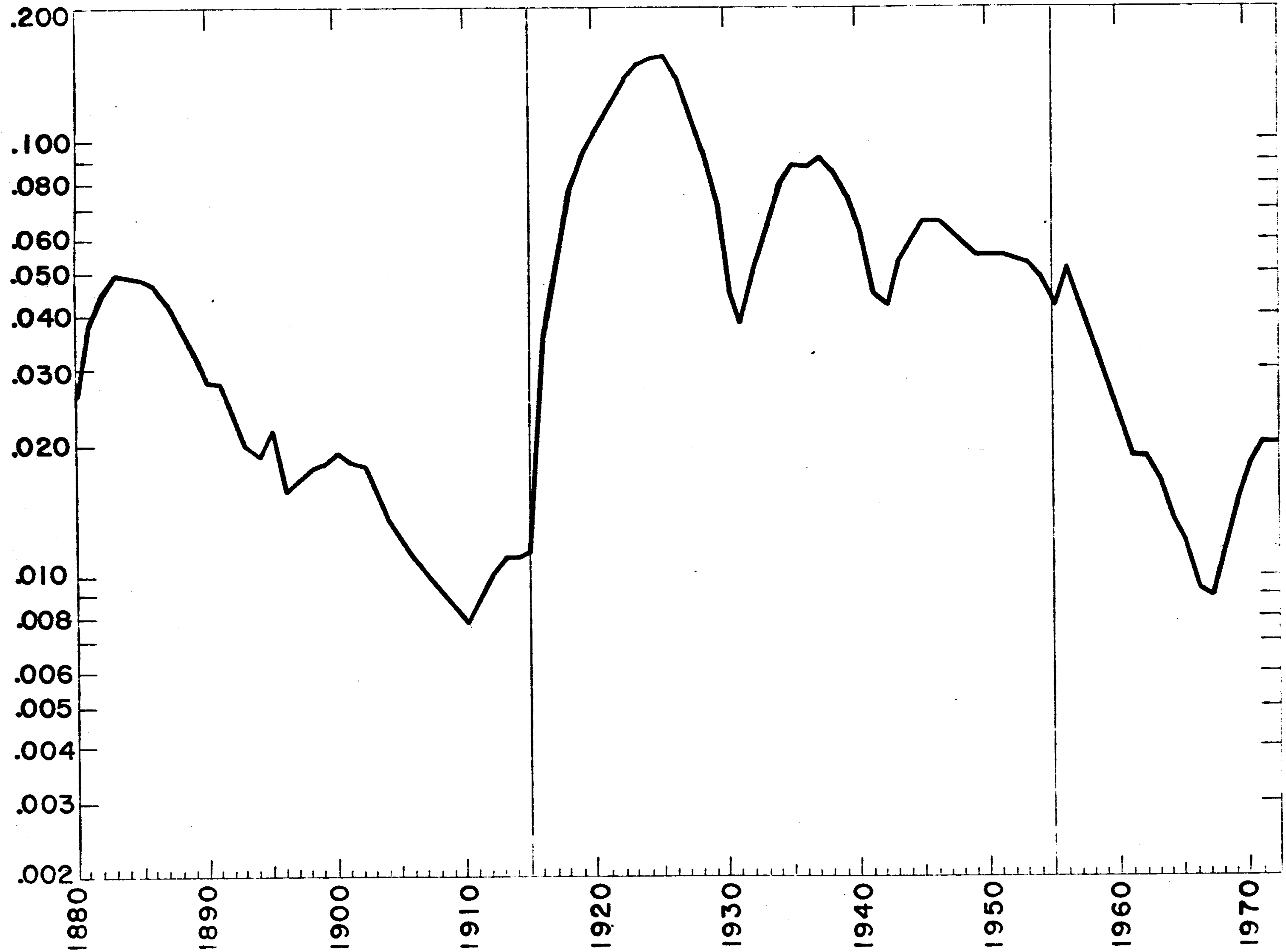
If we assume stability in the underlying process generating the annual rates of price change in each of the five time periods isolated in Table 1 and consider these sample autocorrelations as the best point estimates of the true autocorrelations of the underlying statistical processes, we may conveniently define a measure of longer-term price unpredictability than what is plotted in Chart 1. Let us consider our six-term moving standard deviation of the rate of price change variable, denoted σ_S, as a measure of short-term price unpredictability or uncertainty in next year's rate of price change. If we wish to derive a measure of price uncertainty over a longer time period, think of the annual rate of price change expected for each future year as a random variable and merely use the formula for the variance of the sum of n random variables:

$$(4)\quad \mathrm{Var}\left(\sum_{i=1}^{n} x_i\right) = \sum_{i=1}^{n} \mathrm{Var}\,(x_i) + \sum_{i}\sum_{j} 2\,\mathrm{Cov}(x_i, x_j)\ .$$

Uncertainty of the rate of price change over the next five years, for example, may be measured by the sum of our σ_S^2 variable over the current and previous four years plus a term to measure the expected covariance of the annual rate of price change over these five years, $\sum_i \sum_j \sigma_S(i)\sigma_S(j)r_{i,j}$, where the value of $r_{i,j}$ is taken from Table 1 for the year for which we are defining long-term price unpredictability. This variable is divided by five and the square root taken to get a measure of uncertainty regarding the average annual rate of change of prices over the next five years, denoted σ_L and plotted in Chart 2. This variable can be compared to the σ_S of Chart 1. When price predictability is measured in this manner the new standard period no longer appears to be historically unique. The average level of this longer-term price unpredictability variable over each of our three subperiods is a) .0229, b) .0777, c) .0223. The transitional period, once again, has the highest average level. By far this period has the greatest degree of price uncertainty with both short-term and long-term price unpredictability, σ_S and σ_L, extremely high. But what has changed in comparison to the relative levels of our σ_S series is that the degree of price uncertainty experienced during the new standard period no longer is one-third what was experienced during the gold standard period. The average values of σ_L are approximately the same and, in fact, if we confine our attention to the 1890-1915 part of the gold standard period (where σ_L averages .0157), long-term price unpredictability is higher now. σ_L has risen more than a percentage point since the rapid inflation began in 1966 and now stands at slightly more than two percent, a level we remained below for the entire 1896-1915 period. And even the low level briefly

Long-Term Price Unpredictability, 1880-1972

Chart 2



reached by σ_L in 1965-67 (.0100) is above the 1909-11 trough (.0084), but, more importantly, the entire 1905-15 period averaged only slightly more than one percent (.0102).

Clearly we cannot say, as we did with regard to σ_S, that under the new standard <u>long-term</u> price unpredictability is at an historically unprecedented low level.[20] There has been a secular upward shift in the amount of long-term relative to short-term price unpredictability. The average ratio of σ_L to σ_S over our three subperiods is: a) .74, b) 1.37, c) 2.35. At the turn of the century (σ_L/σ_S) was around .5 while now it is above 2.0. This phenomenon can be attributed to the general increase over time in the autocorrelations of the annual rate of change of prices. The σ_S variable indicates that it is less likely now than under the gold standard to experience next year a rate of price change that is more than, for example, two percentage points away from the mean estimate. But the high autocorrelations imply that if in fact we do experience such an unanticipated price change, it is more likely now to continue for a few years while under the gold standard it was likely to reverse or "correct" itself, i.e., "average out" over time.

VI. Implications

If the current period is one in which long-term price uncertainty has risen relative to short-term price uncertainty, we would expect the increase in the short-run impact of prices on interest rates to be greater for short-term than for long-term interest rates. This can be seen,[21] if we assume that the underyling population from which the annual rate of price change is being drawn is distributed $N(\mu,\sigma^2)$, and that individuals wish to obtain an estimate of the true mean, μ, which enters the level of the market rate of interest. Assume they form a prior probability distribution, distributed $N(m_1,\tau_1^2)$,[22] that they then observe some sample information (e.g., six monthly observations on the annual rate of price change), and that they then form a posterior distribution, which will be distributed $N(m_2,\tau_2^2)$. The posterior mean (or Bayes estimate of μ) will be a weighted average of the mean of the given prior distribution, m_1, and the mean of the sample information, $\bar{x}$:

(5) $$m_2 = \gamma\, \bar{x} + (1-\gamma)\, m_1 \ ,$$

where γ, the weight placed on the sample information, is:

(6) $$\gamma = \frac{n\, \tau_1^2}{n\, \tau_1^2 + \sigma^2} \ ;$$

or the relative weight attached to the sample information, compared to the prior mean, is:

(7) $$\frac{\gamma}{(1-\gamma)} = \frac{n\, \tau_1^2}{\sigma^2}$$

During the 1960's the variance of the underlying generating process or population, σ^2, decreased (measured by the high positive sample autocorrelations). This implies that γ should rise. Intuitively, the weight placed on the sample information should increase because the data has lower variability and the information it supplied by our sample is therefore more reliable.

But during the 1960's, the variance of the prior probability of price change, τ_1^2, may have also changed. A decrease, for example in τ_1^2 or a narrow prior distribution implies that γ should fall. Intuitively, the weight placed on the sample information should decrease because individuals have a stronger conviction or confidence that m_1 is near the true μ. With regard to our operational measures of this concept, τ^2 has fallen for short-term price change and has risen for long-term price change (measured by σ_S and σ_L respectively). The direction of change in the relative weight placed on sample information with regard to estimates of long-term price movements is therefore an unambiguous increase, while with regard to estimates of short-run price movements the change in relative weight is ambiguous. Since $\sum_{i=0}^{6} \beta_i$, the six month impact of a change in the rate of change of prices on the level of interest rates reported in Table 2, has increased in the latest decade compared to earlier time periods for both r_L and r_S, we must conclude that the fall in σ^2 was proportionately greater than the fall in τ^2 with regard to short-term price estimates. But, most importantly, the fact that the increase in $\sum_{i=0}^{6} \beta_i$ is much greater for r_L than for r_S implies that long-term price uncertainty has risen relative to short-term price uncertainty. Since the underlying generating process or σ^2 is the same for long-term and short-term price changes, an increase in $\sum_{i=0}^{6} \beta_i$ for long-term relative to short-term price predictions implies an increase in τ^2 for long-term relative to short-term price predictions. This is what we have independently measured as a rise in the ratio of σ_L to σ_S.

If there has been an increase in the amount of long-term price uncertainty relative to short-term price uncertainty, we should also expect a decrease in the demand for and therefore the quantity of long-term debt relative to short-term debt.[23] This implication is examined in Table 3 below which traces the average matruity of new corporate debt issues for

Table 3

Weighted Average Maturity of New Corporate Debt, 1900-72

date	average maturity	date	average maturity
1900	40.0	1937	19.0
1901	32.1	1938	19.1
1902	33.5	1939	24.1
1903	40.7	1940	23.0
1904	39.4	1941	23.4
1905	28.5	1942	21.8
1906	26.4	1943	21.4
1907	23.8	1944	21.8
1908	27.8	1945	30.4
1909	31.0	1946	23.9
1910	24.7	1947	22.9
1911	24.9	1948	21.2
1912	21.4	1949	19.2
1913	24.5	1950	21.9
1914	24.9	1951	20.7
1915	24.3	1952	21.7
1916	26.7	1953	20.0
1917	19.9	1954	22.8
1918	10.6	1955	21.8
1919	11.3	1956	22.5
1920	10.4	1957	22.7
1921	15.5	1958	21.7
1922	25.7	1959	21.7
1923	23.1	1960	22.1
1924	25.0	1961	20.5
1925	21.4	1962	21.9
1926	22.8	1963	20.6
1927	25.1	1964	19.9
1928	25.6	1965	19.4
1929	21.0	1966	20.8
1930	26.6	1967	20.1
1931	29.1	1968	18.7
1932	22.2	1969	20.6
1933	20.6	1970	
1934	14.1	1971	
1935	21.7	1972	
1936	23.5		

Sources: 1900-43 from [10, table 94], weighting the yearly dollar volume in each maturity classification by the median maturity of the class; 1943-72 NBER table 94 was extended for 1943-72 by categorizing the par values of all single maturity obligations offered yearly in the same maturity classifications and then obtaining a similar weighted average. The yearly debt offers were compiled from [4] (1943-49), [11] (1950-60), and [12] (1961-72). The reported 1943 figure is an average of the NBER estimate (22.0) and the estimate obtained from our compilations (20.7).

the period 1900-72. As we would expect, the average maturity of debt issued during 1900-15 (29.2 years) is significantly greater than that issued during 1956-69 (20.8 years).[24] At the turn of the century, 100 year railroad bonds were often issued while now it is uncommon to find a maturity of a new issue that is greater than 30 years. This movement is in spite of the fact that, because of the constraint imposed by a statute which prohibits the Federal Government from paying yields greater than 4.25 percent on debt maturities over seven years, since 1966 the Treasury has issued very little long-term debt (cf. Jordon [13]). We would therefore expect corporate issuers to partially substitute for the reduction in long-term and the increase in short-term Treasury issues by increasing the relative quantity of their long-term issues.

The figures in Table 3, however, are somewhat misleading. An improper amount of weight is given to long-term issues because the length of time from the present at which the bond generates the average present value dollar is certainly not, for example, ten times as great for a 100 year issue compared to a 10 year issue. That is, long-term bonds are not as long in an economic sense as they may first appear. This concept of the average life or duration of a bond (first defined by Macaulay [18], pp. 44-8) will also decrease, for a given maturity and coupon, as market rates increase. A given maturity is therefore economically shorter in the recent high interest rate period than previously. Our average maturity figures in Table 3 are converted in Table 4 into average duration figures and the relationship holds up. The average duration of debt issued during 1900-15 is 15.9 years, while the average duration issued during 1956-69 is 13.3 years and has been generally declining over the period.

Table 4

Weighted Average Duration of New Corporate Debt, 1900-72

date	average duration	date	average duration
1900	21.3	1937	14.1
1901	19.4	1938	14.0
1902	19.2	1939	16.1
1903	21.9	1940	15.7
1904	17.0	1941	16.0
1905	15.1	1942	15.4
1906	15.1	1943	15.3
1907	13.1	1944	15.3
1908	14.7	1945	19.3
1909	16.4	1946	18.5
1910	14.3	1947	15.8
1911	13.7	1948	15.4
1912	12.8	1949	14.7
1913	12.7	1950	15.7
1914	12.3	1951	15.2
1915	14.7	1952	15.7
1916	14.1	1953	14.2
1917	10.8	1954	16.1
1918	6.2	1955	15.3
1919	7.4	1956	15.9
1920	7.1	1957	14.6
1921	10.1	1958	14.2
1922	12.4	1959	14.2
1923	12.4	1960	12.9
1924	12.7	1961	13.7
1925	11.6	1962	14.2
1926	13.7	1963	13.7
1927	14.8	1964	13.4
1928	14.7	1965	13.4
1929	12.2	1966	12.6
1930	14.4	1967	12.3
1931	15.4	1968	10.7
1932	11.2	1969	10.5
1933	11.7	1970	
1934	9.2	1971	
1935	14.1	1972	
1936	16.2		

Sources: same as Table 3. The underlying figures are converted into durations for each maturity classification by assuming that all securities were priced at par when issued and that the market yield equaled r_L for all maturities greater than five years, r_S for maturities less than or equal to one year and $(r_L+r_S)/2$ for all maturities greater than one and up to five years. If interest is assumed to be paid semi-annually, the duration of bond equals $\left[\frac{.5(1+r/2)}{(r/2)}\right]\left(1 - \frac{1}{(1+r/2)^{2n}}\right)$, where r is the annual yield and n the years to maturity of the bond.

VII. Summary and Conclusion

The variability of annual price change series plotted on Chart 1 suggests that if unpredictability of annual price change were the only crucial economic variable accounting for the opposition to inflation, then no attempt should be made to reduce the current rate of price rise. Such an attempt would entail transitional unemployment costs while a major deceleration of price rise would, in fact, increase the unpredictability of prices, as measured by this variable. Abstracting from the possible increased transaction costs associated with a higher rate of change of prices,[26] maximization of the monetary service return from money would then seem to imply a policy of maintaining the inflation rate at about four percent.

But a closer historical examination of annual rates of price change indicates that the recent inflationary episode is much more unique than is commonly believed and that our moving standard deviation of the annual rate of price change variable does not measure the unpredictability of prices properly. A measure of uncertainty in the annual rate of change of prices expected over the next five years was derived and this variable showed a markedly different historical pattern than our measure of short-term price uncertainty. This measure of long-term price uncertainty is higher now than at the turn of the century. Under the gold standard annual price changes were relatively unpredictable, but the price level expected in five years was relatively more predictable, and if we had enough information to obtain a measure of price uncertainty with regard to the very far future (e.g., 10-20 years), these effects would probably be increased.

In addition to a survey of price movements over the last century, evidence was presented on the relationship between the demand for money and "expected" price change, on the adjustment of interest rates to price level changes, and on the change in the composition of new corporate debt issues which suggests that a major institutional monetary change has occurred over the last decade and that long-term price uncertainty has increased relative to short-term uncertainty. The long-term movement of the monetary framework away from a gold exchange commodity standard accelerated over the postwar period and has finally culminated in an irredeemable pure fiduciary standard. Although the bond markets appear to have adjusted to this new monetary standard where the long-term trend in prices is no longer presumed to be zero and where large price changes in one direction are not expected to be reversible, it is unclear whether there has been full adjustment of all contractual arrangements to this new institutional arrangement. Recognition of and adjustment to such a major alteration in the underlying monetary framework should take place very gradually.

If this delay in recognition and adjustment were the sole basis of the opposition to the recent inflation, we would expect over time for more and more individuals to realize that we were operating under a new monetary standard and for the opposition to decline. But permanent opposition to the current inflation may rationally be based on the high and rising level of long-term price uncertainty. Compared to the gold standard, the current standard entails the economic benefits of greater short-run price predictability but also the costs of greater long-term price unpredictability. The net gain or loss crucially depends upon the importance of long-term contracts, both explicit and implicit, and upon how good our published price indices are as measures of changes in purchasing power.

The current crucial question with respect to price predictability is the credibility of the government regarding the long-term trend of price change. A commodity standard (with a low probability of change in the official price of the commodity) severely limits the possible extent of changes in the price level expected over the long-term and can be thought of as a public investment in long-term monetary trust. The price behavior since 1955 has destroyed a large part of this capital. Although the annual inflation rate over the recent past may have been steady and near, for example, four percent, there is now little public confidence that the government will maintain this rate over the next decade. While gold convertibility implied an expected long-term price trend within relatively narrow bounds, there is nothing sacrosanct about a four or five or six percent inflation rate. In order to reduce the variance around estimates of long-term price change, what is required is a new myth to replace the now defunct gold standard mentality. Unfortunately resources and information are scarce and this confidence cannot be created costlessly. Socially accepted and enforced taboos are therefore not necessarily "irrational."

Footnotes

*I am especially indebted to Armen Alchian and also to Phillip Cagan, Levis Kochin, Roger Kormendi, Anna Schwartz and Paul Wachtel for rewarding discussions, to participants at a VPI Center for Study of Public Choice seminar and at a UCLA Monetary Theory workshop for useful comments, to Irene Abramson, Steven Ferris and Laura LaHaye for able research assistance, and to H. Irving Forman and Scott Harris for drawing the charts, while remaining solely responsible for the opinions expressed and for any remaining errors.

[1]Stigler [22] finds that although the unemployment rate has no influence on national voting patterns, the rate of inflation is negatively related to the incumbant's share of votes.

[2]Since there is evidence that market-determined interest payments are being made by commercial banks on some demand deposits (cf. Klein [15], the empirical importance of this argument is reduced. It is also difficult to explain the international opposition to the U.S. inflation solely on these grounds since most U.S. dollar liabilities held by foreigners bear a market-determined interest return.

In addition to assuming that interest is not paid on money, the usual argument that anticipated inflation is an inefficient tax also assumes that a) real cash balances are costless to produce and that b) a more efficient alternative source of government revenue exists. But the monetary confidence capital that must "back" money does not have a zero cost of creation and maintenance, cf. Klein [14]. And given the transaction costs of levying and collecting taxes and the relatively low price elasticity of demand for real cash balances, an excise tax on money may be an efficient element in an optimal tax package (see Phelps [20, ch. 6]).

[3] This is how "unpredictability" of price change will be used in the paper. Most discussions of inflation implicitly assume a degenerate prior probability price change distribution. Individuals are assumed to estimate an "expected" rate of price change (which can be thought of as the mean of the prior probability distribution), but the confidence interval on this estimate (the variance of the prior probability distribution) is ignored and implicitly assumed to equal zero. It is useful, however, to distinguish between two separate questions: a) does the current actual rate of price change, in fact, equal the mean of the expected or predicted price change distribution, i.e., assuming that contracts were adjusted to this mean, does the inflation produce any wealth redistribution effects? and b) how much uncertainty now exists regarding future price changes, i.e., what is the variance of the expected price change distribution? The actual rate of price change may equal the mean expected rate of price change (and we can therefore call this price change "fully anticipated") yet there may exist a great deal of price change uncertainty. Zero information costs would imply not just that, ex post, the actual rate of price change equals the mean predicted rate of price change but also that the prior variance of predicted rate of price change equals zero, i.e., perfect accuracy and perfect certainty. The actual rate of price change may not equal the mean predicted rate of price change and therefore be "unanticipated" yet may be "expected" (if, say, the actual is within one standard deviation of the mean). The variance of the prior probability distribution can be thought of as a measure of how much unanticipated price change is "expected."

[4] This is similar to the concept used by Friedman and Schwartz [7] as a measure of the variability of money and income. I first computed

logarithmic first differences of a price index series centered in mid year and then computed moving standard deviations from these year-to-year percentage rates of price change for six terms and dated the result as of the final year. The vertical scale on the chart is logarithmic to minimize the heteroscedasticity problem (cf. Friedman and Schwartz, p. 202). The price series is the implicit GNP deflator using Gallman's estimates for 1874-1909 and Kuznets' estimates, adjusted in wartime, for 1910-1946 and the Commerce Department's estimates for 1947-1972.

[5]Joseph A. Livingston conducts a semi-annual survey of price predictions of economists which has been reported in the Philadelphia Bulletin since 1946. The standard deviation of these (mean) predictions across individuals (which is not necessarily equal to my concept of the standard deviation of a representative individual's expected price change distribution) coincides remarkably closely to my variability measure. Both series fall over the postwar period and reach a low point in the early 1960's (0.62 percentage points in 1963 for the Livingston series and 0.24 percentage points in 1964 for my variability series) and then both rise to a peak in the early 1970's (1.56 in 1971 for the Livingston series and 1.30 in 1970 for my variability series). The correlation between the two series over the 1947-72 period is .77. I am indebted to Paul Wachtel for making the Livingston data available to me.

[6]This is a policy prescription which has been advocated for more than a century. See, for example, Alfred Marshall, Answers to Questions on the Subject of Currency and Prices Circulated by the Royal Commission on the Depression of Trade and Industry in [19 , p. 10; also p. 31]. The issuance by the Treasury of purchasing power securities would serve the socially useful function of providing a market measure of the expected

rate of change in the tied price indices and this data series could then be compared to the more common ad hoc measures of price expectations, such as an Almon lag on current and past price changes.

[7]One of the major deficiencies in using either of the two common measures of inflation (the CPI or the GNP deflator) as an escalator in all contracts is the insufficient weight these narrowly based indices give to existing capital goods prices (cf. Alchian and Klein [1]). The recent price controls have exacerbated the usual difficulties with these indices. I suspect that the discrepancy between quoted and transaction prices has probably widened (with, in many cases, barter transactions actually being made to hide transaction prices), while quality has probably depreciated. In addition, there has been a substantial increase in the "indirect" or non-measured cost elements of purchases, e.g., the increase in queues and other time and inconvenience costs associated with stores "running out" of particular products, the elimination of trading stamps, and the higher inventory costs to consumers due to the increase in uncertainty. (The large increase in freezer sales during the beef "shortage" and the recent gasoline "topping-off" phenomenon are dramatic cases.) Much of this can be blamed on policies designed to quickly move commonly quoted statistical indicators rather than to move the economy.

[8]The number of workers covered by escalator clauses for the 1957-73 period is reported in Larson and Bolton [16]. This figure is then deflated by a moving average of the labor force where the current year's labor force was weighted one-half and the previous and future year's labor force weighted one-quarter each. The moving average was taken to reduce the possibility of spurious cyclical movements in the measured labor force,

but the correlations using the current year's labor force as the deflator are nearly identical. These correlations are remarkably high when you consider that an increase in future price unpredictability should not only increase the use of escalators in long-term contracts but also decrease the fraction of workers operating under long-term contracts. This latter effect of a decrease in the average length of contracts produces a downward bias in our fraction of labor force covered by price escalators variable as a measure of the degree of price uncertainty.

[9]It is important to note in this context that the commonly made distinction between open and repressed inflation which is usually defined in terms of the extent of government intervention in the market place that prevents prices from reaching their equilibrium values should more generally be made in terms of the degree of price adjustment costs present in a particular market. Given the existence of costs of changing prices, all prices will not be fully adjusted at all times to anticipations and hence can sometimes be said to be "repressed." Prices fixed by law may be extremely rigid, but the evasion or alteration of governmental regulatory constraints is just one type of the more general price adjustment costs present in all markets. The costs of adjustment in the political market place are not infinite and may be in some cases less than in some private markets. For example, a primary motivation for the 1969 income tax modifications may have been the political disequilibrium produced by inflation given our progressive income tax structure. On the other hand, an obvious example of very slow (costly) adjustment of governmentally controlled prices can be found in some of the legal fines and penalties which now give a convicted defendant a grossly unbalanced choice between

days in jail and a monetary fine (e.g., 30 days or $250). Lack of upward adjustment of these monetary fines over time is one of the factors that has led to the recent Supreme Court decision that the few poor defendants "forced" to go to jail are treated unequally under the law.

[10]Note, however, that part of the secular decline in the variability of price change may be due to the statistical improvement over time in our price measures.

[11]The only other period of fairly steady moderate inflation occurred briefly during 1902-1907, producing a large gap in the two series in 1907. But the post-1955 inflation has, by comparison, been higher, less variable and of much greater duration.

[12]Similarly for the 1915-55 period, although the long-term trend in the rate of change of prices is no longer zero (the average inflation rate was .0242), the prominent peaks and troughs in the two series on Chart 1 coincide because large (small) price changes in one direction are frequently closely followed by large (small) price changes in the opposite direction, a pattern one would also expect under a commodity standard. For example, the peak in the early 1920's includes the large World War I and post-War inflation and the large 1921-1922 deflation, the peak in the mid-1930's is due to the unusually large price decreases in 1931-1932, followed by a fairly rapid inflation, and the sharp troughs in 1929 and 1940 are due to very brief periods in the late 1920's and 1930's of fairly steady mild inflation and deflation. Only the peak in the mid-1940's can be ascribed solely to price changes in one direction, with the unsteadiness of the large reported price increases during and after World War II possibly due to price controls.

The average rate of change of prices during the 1956-72 period, .0279, was very close to that of this previous transitional period. The "new standard" is therefore not very "new" with regard to the mean rate of price change but solely with regard to the standard deviation of the annual rate of price change. The major increase in the secular rate of inflation occurs between our first two periods. Going back even further, prices in the Western world generally were relatively stable secularly during the 18th and 19th centuries (when the gold standard substantially reduced governmental control of the money supply). The current world wide secular inflation that is now commonly taken for granted is a relatively modern phenomenon dating from World War I.

[13]The basic unit of observation is the average value over annually dated cycle phases, where the initial and terminal turning point observations are weighted by one-half and the intervening observations by unity. The regression is then run using these phase averages weighted by $2n^2/(2n-1)$, where n is the duration of the phase. (Assuming each annual observation entering the phase average is statistically independent and has the same disturbance variance, this weight is inversely proportional to the variance of the phase average.) The rate of change of prices, $(\dot{P}/P)$, is calculated from three successive phase averages. The slope of least squares line is calculated for each triplet, weighting the phase average observations by $2n^2/(2n-1)$, and this is defined as the rate of change of prices for the midpoint of the central phase of the three phases covered. M is broadly defined money balances (currency plus all commercial bank deposits), Y is net national product, P is the GNP deflator, N is population and r_L is the long-term yield on high-grade corporate bonds. The years noted

refer to mid-phase dates, i.e., 1916-1968, for example, refers to the period from 1914-18 expansion to the 1967-69 expansion. For the entire time period the average length of an expansion phase observation is 2.6 years and for a contraction phase observation is 1.4 years. I am indebted to Anna Schwartz for the data underlying these series.

[14]The gold standard subperiod happens to be divided at the point where post-Civil War deflation can be thought of as turning into a period of gold inflation. That is, although the average rate of change of prices over the entire subperiod is close to zero, in terms of the average inflation rate it really consists of two rather distinct periods.

[15]The Livingston survey noted above (n 4) reported a forecasted rate of change of the CPI for the following year which, except for the Korean War period during 1951, was consistently negative over the 1946-54 period. The reported "expected" annual rate of price decline immediately following World War II in 1946-47 was greater than eight percent.

[16]It is instructive to note in this context that until very recently the ratio of the total stock of high-powered money to the official dollar value of the total U.S. gold stock has been historically rather stable (cf. Cagan [3 , p. 56 Chart 4 and appendix table F7 and also pp. 49-67]). The ratio of H to gold was 2.5 as late as 1960, which was very close to the average level of 2.3 during the 1880-90 period after the return to convertibility. In fact, the ratio averaged 2.2 over the entire 1880-1915 gold standard period. The ratio reached an alltime low of 1.0 in 1941 after the massive gold inflows of the 1930's and a pre-1961 alltime high value of 2.9 in 1893 when the Treasury experienced significant gold drains. In spite of the large increases in the dollar value of gold, the post-1960

rise in the (H/gold) ratio has been dramatic and is currently close to 10.0. This indicates how unique the last decade has been in terms of the break of the tie between our money stock and gold and the de facto movement off the gold standard.

[17]The time period noted for these and all other distributed lag regressions refers to the dependent variable. In this case there is therefore another previous four years of rate of price change data entering each estimate.

These regressions implicitly assume that the level of the real rate of interest is statistically independent of current and past rates of price change, making it possible to treat it as a constant plus a residual term. Sargent [21] has demonstrated that this procedure is most appropriate when the interest elasticity of demand for money is zero, a condition that makes some theoretical sense when competitive interest payments are made on money (cf. Klein [15]). But, in any event, we are merely comparing the effects of current and past price change on interest rates over different time periods and need only assume that whatever short-run changes in the real rate do occur have not changed over time.

[18]This explains why the St. Louis macroeconomic model has a dummy variable for the post-1960 period in their interest rate equations. Yohe and Karnosky note that the larger and prompter effects of price level changes on interest rates during the 1960's may be due to "institutional changes." But, in a listing of the plausible explanations for a shift in the underlying framework, they never suggest that the complete movement from a commodity to a fiduciary monetary standard may be a major force explaining the shift in behavior.

[19]His regressions begin in 1952. If he took them back to 1946, when the Livingston data begins, the difference of the results between the early and latter periods would be much greater.

[20]In addition, σ_S peaked in 1970 while σ_L has continued to rise.

[21]See, for example, Lindgren [17, pp. 181-84].

[22]Note that τ_1^2 is not an estimate of σ^2, but the variance of the estimate of μ, i.e., the variance around M_1. τ^2 is therefore similar to our σ_S and σ_L variables.

[23]If suppliers of debt instruments are risk neutral, there will be a shift leftward only of the demand schedule and not of the supply schedule of long-term debt. In such a case the price of long-term bonds would fall relative to short-term debt. (r_L-r_S) has, in fact, been higher recently than under the gold standard. During 1880-1915 (r_L-r_S) averaged -1.00 percent (r_S levels may have been relatively high to compensate for the great deal of relative short-term price unpredictability), while during 1956-72, (r_L-r_S) averaged +.42.

[24]The average maturity during the transitional period 1916-55 is 21.6 years.

[25]The average duration during the transitional period 1916-55 is 13.8 years.

[26]An estimate of the magnitude of these transaction costs must await development and testing of the implications of the rapidly progressing work on the microfoundations of monetary exchange.

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Table A1

Annual Rate of Change of GNP Implicit Price Deflator, 1870-1972

Date	$(\dot{P}/P)$	Date	$(\dot{P}/P)$	Date	$(\dot{P}/P)$	Date	$(\dot{P}/P)$
1870	-5.66	1897	0.45	1924	-1.30	1951	6.49
1871	1.59	1898	2.87	1925	1.99	1952	2.20
1872	-5.14	1899	2.58	1926	0.49	1953	0.90
1873	-1.21	1900	5.17	1927	-2.68	1954	1.42
1874	-1.07	1901	-0.61	1928	0.70	1955	1.46
1875	-2.34	1902	3.39	1929	-0.10	1956	3.37
1876	-4.69	1903	0.98	1930	-4.60	1957	3.69
1877	-3.71	1904	1.54	1931	-12.83	1958	2.51
1878	-7.68	1905	2.08	1932	-12.27	1959	1.62
1879	-3.59	1906	2.04	1933	-1.36	1960	1.60
1880	9.88	1907	4.13	1934	6.34	1961	1.27
1881	-1.93	1908	-0.18	1935	-1.29	1962	1.05
1882	3.15	1909	3.47	1936	4.07	1963	1.29
1883	-1.21	1910	2.52	1937	0.87	1964	1.61
1884	-5.37	1911	-0.83	1938	-0.50	1965	1.87
1885	-6.85	1912	4.26	1939	-0.75	1966	2.72
1886	-1.39	1913	0.48	1940	1.12	1967	3.19
1887	0.99	1914	1.43	1941	7.61	1968	3.92
1888	1.76	1915	3.10	1942	12.27	1969	4.68
1889	0.58	1916	12.20	1943	12.37	1970	5.41
1890	-1.95	1917	21.12	1944	7.17	1971	4.53
1891	-0.99	1918	13.97	1945	4.32	1972	3.06
1892	-4.06	1919	1.51	1946	0.87		
1893	2.45	1920	13.15	1947	11.21		
1894	-6.47	1921	-16.01	1948	6.50		
1895	-1.52	1922	-5.04	1949	-0.66		
1896	-2.89	1923	2.31	1950	1.39		