INFLATION, EXPECTATIONS, AND WEALTH REDISTRIBUTION

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ABSTRACT

INFLATION, EXPECTATIONS, AND
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By

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This work is an attempt to determine the nature and extent of wealth redistribution from inflation in the market for debt instruments. A rigorous analysis of the bond market is presented, showing the influence of inflation on expectations in this market. Inflation is presented in the context of a general correctness of expectations framework. A precise analysis of what constitutes wealth redistribution is then presented.

The incorporation of a model of expectations into the theory of wealth redistribution is then undertaken.

Empirical testing of the model of wealth redistribution constitutes the next portion of the work. Various types of testing methods are applied to the collected data on wealth and debt. Finally, the conclusions of the author regarding wealth redistribution are presented.

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

The makers of economic policy are rarely afforded the luxury of selecting Pareto optimal paths of action. Various alternatives among which they have the liberty to choose almost always involve not only gains for some set of members of society, but also losses for some set of members of society. In making their choice, then, policymakers should make some attempt to weigh the relative gains and losses accruing to various segments of society. Their choice should be the wiser the more information economists can provide about the scope and extent of these gains and losses from the effects of various possible policy actions.

One of the most significant of these tradeoffs is the one between unemployment and inflation, which has recently come to occupy an important place, not only in the literature of economics, but also in the established body of issues concerning the informed general citizenry.

This paper is concerned with inflation. Inflation is important as a public issue partly because the public views it as a vehicle of wealth redistribution. A crucial task is thus handed to the economist, that of determining the validity of this view by examining the actual conditions under which wealth redistribution from inflation occurs, and the possible extent of any wealth redistribution which has occurred, is occurring, or might occur in the future.

This work is restricted to inflation-caused wealth redistribution in the market for debt instruments. Any effects resulting in other markets from any wealth redistribution in this particular market are not considered. The reason for limiting the study in this way is the convenience of focusing the attention of the study solely on one problem. Developing a rigorous definition of wealth redistribution in this market occupies a major part of this work. Therefore, in certain preliminary sections and in reviewing some of the literature in this field, the term wealth redistribution will be used in a more general sense. It will refer to changes in the distribution of wealth which occur from the existence of debt obligations and changes in price levels.

CHAPTER II

REVIEW OF PREVIOUS STUDIES

This review will include not only studies of inflation-caused wealth redistribution in the market for debt instruments, but also inflation-induced wealth redistribution in other markets. The latter is included to outline the method of previous studies involving wealth redistribution from inflation, regardless of the market involved. Actually, studies dealing with this subject are so few as to render a complete treatment of all of them both convenient and instructive.

Previous study of the effects of inflation on the distribution of wealth has proceeded along several distinct lines. The earliest and crudest work consists of historical studies examining the possible existence of a lag of wages behind prices in inflationary periods, this lag supposedly signifying a redistribution away from labor and to capital or entrepreneurship. These efforts have utilized time series data on real wages and price index levels for a variety of countries and a variety of inflationary periods. While some have found a lag,[1] Alchian and Kessel[2] and Felix[3] have cast doubt upon the validity of the results of these studies.

With the appearance of comprehensive national income data came numerous investigations into the effect of inflation on relative shares. The wage lag hypothesis seems to be consistent with the data during some inflations in the U.S., particularly during the period 1945-54, but in another inflation (1956-57), the data do not seem to support it.[4] A problem with most of these studies is that the real effects of productivity changes occurring with changes in levels of output over the business cycle are difficult to separate from any effects due to the presence of wage lags. This difficulty has been partially overcome by the inclusion of productivity as a factor in some studies. Phelps-Brown and Browne[5] surveyed a whole

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[1] Earl J. Hamilton, "Profit Inflation and the Industrial Revolution," QJE, 56 (1942); and Wesley C. Mitchell, Gold, Prices, and Wages under the Greenback Standard, University of California Press, 1908, reprinted Augustus Kelley, Chicago, 1966.

[2] Armen Alchian and Reuben Kessel, "The Meaning and Validity of the Inflation-Induced Lag of Real Wages Behind Prices," AER, 50 (March 1960).

[3] David Felix, "Profit Inflation and Industrial Growth," QJE, 70 (August 1956).

[4] See G. L. Bach and Albert Ando, "The Redistributional Effects of Inflation," Review of Economics and Statistics, 37 (February 1957), pp. 1-13.

[5] E. H. Phelps-Brown and M. H. Browne, "Distribution and Productivity under Inflation, 1947-57," Economic Journal, 70 (December 1960).

range of countries during a period of world-wide inflation, while Schultze[6] studied a range of different industries in the U.S. Both studies fail to reveal that any significant redistribution away from labor has occurred. Alchian and Kessel[7] used an entirely different technique which also failed to reveal any gain to business firms from a wage lag.

However, work on income distribution using national income figures has been rather conclusive on the proposition of redistribution away from certain "passive" classes of income recipients (rentiers and lenders, mainly) to "active" classes (entrepreneurship and labor, mainly) during inflationary periods in the U.S. This type of redistribution is that of the oft-cited "erosion" of purchasing power of claims on income which are fixed in nominal terms belonging to pensioners, bondholders, leaseholders, and others.

A particular form of this theory, labeled the "debtor-creditor" hypothesis,[8] concerns the market for debt instruments, bonds, mortgages, and other forms of debt, which are fixed in nominal money terms. This hypothesis states that during periods of rising prices,

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[6]Charles Schultze, "Recent Inflation in the United States," Study Paper #1, Employment, Growth, and Price Levels, Joint Economic Committee, 1960.

[7]Alchian and Kessel, op. cit.

[8]That this is a special case of incorrect expectations will be discussed in Chapter III.

purchasing power is redistributed from creditors to debtors because the repayment of debt involves a payment of less purchasing power than would have been made if prices had been stable for the period for which the debt had been contracted.

This hypothesis clearly involves an assumption about expectations; the assumption being that creditors do not anticipate correctly the rate of inflation, under-estimating it, and/or do not incorporate this knowledge into their market behavior. It is clear that wealth redistribution can occur if creditors anticipate inflation in part of the period covered by a debt contract, but because a contractual agreement has already been reached are unable to alter their behavior. However, even in this case wealth redistribution occurs because anticipations about future price levels were not correct at the time of the contractual agreement. The agreement is the manifestation of market behavior at the time of its making, and this behavior presumably was influenced by expectations of the future values of economic variables, including price levels.

The integration of price level variations, expectations, and the market for debt instruments can be shown as follows: Assume riskless debt (riskless in the sense that default is ruled out) is in the form of obligations to pay a fixed nominal amount (F) at time (t + 1). These are sold at time (t) at market price (V) to lenders.

Then,

$$r = \frac{F(t + 1)}{V(t)} - 1$$

(r is not necessarily used here on an annual basis, but is the rate of interest over any single period, so that there are no compounding problems.)

The payment of V occurs at the time t, whereas the payment of F occurs at period t + 1. If the general price index (I) in period t, I(t), does not equal I(t + 1), then the "real" interest rate (r') does not equal the nominal interest rate (r). (The distinction between these two rates was developed by Fisher.)[9]

Summarizing the above,

$$r' = \frac{\frac{F(t + 1)}{I(t + 1)}}{\frac{V(t)}{I(t)}} - 1 = \frac{F(t + 1)}{V(t)} \cdot \frac{I(t)}{I(t + 1)} - 1$$

With both V(t) and F(t + 1) contractually fixed at time t, then $r' = r$ if and only if $\frac{I(t + 1)}{I(t)} = 1$.

Suppose inflation (or deflation) is anticipated at time t, and both demand and supplies of debt are functions of r', not r. Then if anticipated $\frac{I(t + 1)}{I(t)} > 1$, equilibrium r must be greater than if anticipated $\frac{I(t + 1)}{I(t)}$ had equaled one, in order that r' remain unchanged.

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[9] Irving Fisher, The Theory of Interest (New York: Macmillan, 1930), p. 42.

Thus the basis of any wealth redistribution occurring from the debtor-creditor hypothesis in this example must be that r does not rise sufficiently or at all, and that as a result r' is lower in inflationary periods than in non-inflationary periods. The redistribution effect operates through a price, r', the real cost of borrowing, which lags during inflation. Because this cost is reduced during inflation, wealth is redistributed from creditors to debtors.

It is clear that if we postulate that demand and supply functions for debt instruments are based on the real cost of borrowing (r'), wealth redistribution occurs only if individuals do not correctly anticipate price level changes over time and r' over time is thus altered.

If the foregoing conditions hold, the extent of wealth redistribution from the debtor-creditor hypothesis will depend upon the degree of accuracy of anticipations and the extent of debt instruments outstanding.[10]

Fisher, in The Theory of Interest, clearly was of the opinion that wealth redistribution did ordinarily occur from the debtor-creditor mechanism:

> When prices are rising, the rate of interest tends to be high but not so high as it should be to compensate for the rise; and when prices are falling, the rate of interest tends to be low, but not so low as it should be to compensate for the fall.[11]

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[10] This will be shown rigorously in Chapter III.

[11] *Ibid.*, p. 43.

He went on to observe that the real rate of interest in the United States from March to April, 1917 (a period of rising prices), fell below minus seventy per cent.[12]

De Alessi[13] has constructed a model which is designed to measure the degree of accuracy of anticipations of inflation. He defines the net monetary position of an individual (M) as the current market value of his stock of monetary liabilities (ML) (accounts payable, bonds, loans, and other obligations to pay fixed nominal amounts) less his stock of monetary assets (MA) (accounts receivable, cash, and other claims to fixed dollar amounts of income). Each variable is a function of time so that:

(2.1) $$M(t) \equiv ML(t) - MA(t)$$

$M(t) > 0$ denotes net debtor status.

Non-monetary position (R) is defined as the current market value of the stock of non-monetary assets (NMA) held by an individual (land, buildings, inventory) less the current market value of the stock of non-monetary liabilities (NML) (depreciation, maintenance), so that:

(2.2) $$R(t) \equiv NMA(t) - NML(t)$$

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[12] *Ibid.*, p. 44.

[13] Louis de Alessi, "The Redistribution of Wealth by Inflation: An Empirical Test with United Kingdom Data," *Southern Economic Journal*, 30 (October 1963).

Note here that R(t) and M(t) are not symmetrically defined in terms of assets and liabilities.

Nominal wealth (W) is then defined as:

$$W(t) \equiv R(t) - M(t) \tag{2.3}$$

De Alessi excludes all other wealth-affecting phenomena except "normal income under conditions of static equilibrium," so that net non-monetary assets (R) grow at some rate (r), normal income rate, and this is termed the real rate of interest stated in terms of constant purchasing power. Net monetary liabilities (M) grow at a "money" rate of interest (m) which is contractually specified. Under de Alessi's assumptions, m = r. This gives:

$$W(t + 1) - W(t) = r[R(t)] - m[M(t)], \tag{2.4}$$

or since r = m, r[R(t) - M(t)], which is specified as continuous.[14]

De Alessi's definition of wealth differs from that which is generally used in economic theory. The usual definition of wealth [W'(t)] at any time is:

$$W'(t) = Y(t) + \frac{Y(t+1)}{(1+r)} + \frac{Y(t+2)}{(1+r)^2} + \cdots + \frac{Y(t+n)}{(1+r)^n}$$

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[14] *Ibid.*, p. 114.

where (Y) equals an economic unit's income in period (t) and where the economic unit's time horizon is assumed to be a constant number of periods from the period for which its wealth position is defined. If we define its wealth position at t, and its time horizon is then t + n, then if we define its wealth position at t + 1, its time horizon is t + n + 1.

Now W'(t + 1) > W'(t) if and only if

$$[Y(t+1) + \frac{Y(t+2)}{(1+r)} + \frac{Y(t+3)}{(1+r)^2} + \ldots + \frac{Y(t+n+1)}{(1+r)^n}]$$

$$> [Y(t) + \frac{Y(t+1)}{(1+r)} + \frac{Y(t+2)}{(1+r)^2} + \ldots + \frac{Y(t+n)}{(1+r)^n}]$$

We can reconcile the two definitions to the extent of making one a monotonic transformation of the other by making the following assumptions:

In the de Alessi definition if M is assumed zero in t,

a) $W(t + 1) - W(t) = Y(t + 1)$

and if $Y(t + 1) > 0$ and any $Y(t + n)$, $n > 1$, is a positive function of $W(t + 1)$, then if

b) $W(t + 1) > W(t)$

then, c) $W'(t + 1) > W'(t)$.

If all prices increase at some rate (K) per period, and only normal income is assumed to affect wealth, then the income stream produced by net non-monetary assets R must also increase at the same rate of inflation K. Specified in current prices, R would grow at a rate r + K. Net monetary liabilities (M) would grow at a rate $r + K_a$ in current prices, where K_a is the anticipated rate of inflation at the time of debt contraction and is the supplement to r required if behavior in debt markets is a function of real variables. This gives:

$$(2.5) \qquad W(t + 1) - W(t) = (r + K)R(t) - (r + K_a)M(t)$$

Substituting for R(t) from (2.3) gives:

$$W(t+1) - W(t) = (r+K)W(t) + (r+K)M(t) - (r+K_a)M(t)$$

or

$$(2.6) \qquad W(t + 1) - W(t) = (r + K)W(t) + (K - K_a)M(t)$$

Since K[W(t)] is the change in nominal wealth necessary to maintain constant purchasing power during an inflation of rate K, real wealth will be redistributed between debtors and creditors if $K_a \neq K$, assuming $M(t) \neq 0$. Having assumed only one r for all W, we can say that no redistribution occurs from a rate of inflation equal to K only if all wealth grows at a rate r + K. From (2.6) it can be seen that this will hold only if K is correctly anticipated ($K_a = K$) and/or net debtor position (M) is equal to zero during any period of inflation.

When inflation is not anticipated and $K_a < K$, then during inflation, an economic unit "gains nominal wealth on its monetary liabilities at a rate $K - K_a$, and loses wealth on its monetary assets at the same rate."[15]

In de Alessi's terms:

(a) gain of net debtor $(M > 0) = (K - K_a)[M(t)]$,

(b) loss of net creditor $(M < 0) = -(K - K_a)[M(t)]$.

De Alessi then introduces a variable denoting the degree of anticipation of inflation which is labeled (B), where:

$$B \equiv \frac{K - K_a}{K}$$

and is restricted by de Alessi to be $0 < B \leq 1$.

Substituting B in equation (2.6) gives:

$$(2.7) \qquad W(t + 1) - W(t) = (r + K)W(t) + B[KM(t)]$$

De Alessi then makes the crucial assumption that all other phenomena which may change W over time are independent of net monetary debtor status (M) so that his model becomes stochastic with these phenomena allowed for by the error term u(t).[16]

$$(2.8) \qquad W(t + 1) - W(t) = (r + K)W(t) + B[KM(t)] + u(t)$$

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[15] Ibid., p. 115.

[16] Ibid.

Variables are now converted to units relative to their values at t = 0 (they are converted to indices with base year t = 0), with a time interval from zero to t considered, and rates of return not compounded, giving:

$$(2.9) \quad \frac{W(t)}{W(0)} = r(t) + \frac{I(t)}{I(0)} + B\left[\frac{I(t) - I(0)}{I(0)} \left(\frac{M'}{W'}\right)\right] + u(t)$$

where I is used as an index of prices, so that $\frac{I(t)}{I(0)}$ is K over period 0 to t. $(\frac{M'}{W'})$ is an estimate of M/W over period 0 to t.

The formal model is now completed. De Alessi has formulated it so that the debtor-creditor hypothesis is reduced to a hypothesis about the value of B, the degree of anticipation of inflation. If the debtor-creditor hypothesis does in fact hold, then the value of B should be significantly different from zero.

His empirical test consisted of using "business firms whose common stocks are quoted on an exchange"[17] in the United Kingdom during a period of inflation. The necessary data for approximating M and W are available for these economic units. M' is derived by observing the firm's balance sheet, and W' is computed by taking the number of shares outstanding multiplied by their market price. As an estimate of $\frac{W(t)}{W(0)}$, relative change in wealth over time, relative changes in the market price of firm

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[17] Ibid.

shares, $\frac{P(t)}{P(0)}$, is used with appropriate adjustments made for changes in the number of shares outstanding and cash dividends paid over time from 0 to t.

De Alessi's final regression equation is derived by manipulating terms in (2.9) and by his assumption that r is the normal rate of return, replacing it by a constant (a), and replacing B by b.

$$(2.10) \qquad \frac{P(t)}{P(0)} - \frac{I(t)}{I(0)} = a + b\left[\frac{I(t) - I(0)}{I(0)}\left(\frac{M'}{W'}\right)\right] + u(t)$$

The model now has:

(a) an independent variable $\left[\frac{I(t) - I(0)}{I(0)}\left(\frac{M'}{W'}\right)\right]$ whose economic meaning is the net debtor status of a unit divided by its total wealth, all weighted by the rate of inflation, over time from 0 to t.

(b) one constant, a, whose economic meaning is that all firms experience some normal income from R, their non-monetary wealth, and that this income is constant between firms, so that no change in wealth between firms arises from R.

(c) a dependent variable, $\frac{P(t)}{P(0)} - \frac{I(t)}{I(0)}$, whose economic meaning is the relative change in adjusted share prices of firms less the rate of inflation. This is an indicator of whether firms have gained or lost in real terms, and since $\frac{I(t)}{I(0)}$ is assumed the common denominator of real wealth for all firms (the usual price index assumption that for all individuals, all weights are equal), then relative $\frac{P(t)}{P(0)}$ among firms is dependent on the values taken by the independent variable for each firm.

A brief summary of de Alessi's method of testing and results follows. The sample was drawn from firms in the United Kingdom, the period covered was from December 31, 1948 to December 31, 1957, during which time the annual rate of inflation (retail price index) varied between 1.2% and 12.5% and the price index climbed 52% over the entire time period covered.[18]

De Alessi's tests for the levels of significance at which the null hypothesis that b = 0 could be rejected, yielded indecisive results. In only three out of a possible set of 36 possibilities was this level less than the .05 level.

Although his other tests did not yield much more decisive results either, de Alessi concludes that, "The results observed therefore are not inconsistent with the results predicted by the debtor-creditor hypothesis; they suggest that individuals failed to anticipate inflation correctly over the period from 1948-1957."[19]

De Alessi's model has been implicitly used in several other studies which have proceeded along quite similar

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[18] Ibid., p. 117.

[19] Ibid., p. 123.

lines, using firm balance sheet information and changes in stock prices. These studies have used U.S. data, however.

Ando and Bach[20] used a random sample of 52 firms and investigated the performance of these economic units over the period 1939-1952, an inflationary one. The testing period was divided into three subperiods due to the prevalence of switching from debtor to creditor status among the firms over the entire period. Apparently net debtor status was not determined for each year, but classification proceeded from only three samples in the period. Rank correlation testing was used, with the variables being as follows:

Case	Rank Correlation Coefficient			
	1939-1952	1939-1956	1946-1949	1949-1952
<u>Case A</u>				
Ind.-creditor-debtor rank Dep.-increase in net return	.04	-.01	-.02	-.01
<u>Case B</u>				
Ind.-creditor-debtor rank Dep.-increase in stock prices	.26	.23	.09	.18

Source: Ando and Bach, p. 12.

[20] Ando and Bach, op. cit.

In no case did the rank correlation coefficient take on values greater than .26, leading Ando and Bach to conclude that "These results do not confirm the prediction that debtor companies will gain more during inflation than will creditors, for any of the three periods shown, the results are mixed, and over all show no very significant differences."[21]

Kessel[22] used three samples to test the debtor-creditor hypothesis.

A sample of 16 firms in the banking industry was submitted to a rank correlation test, the rankings based on relative net creditor status (all 16 firms were found to be net creditors) and relative per cent increase in stock prices from 1942 to 1948, an inflationary period. "Roughly 23% (R^2 = .48) of the observed variation was explained by the debtor-creditor hypothesis."[23]

Industrial firms were tested, one test covering a period of inflation and one test covering a period of deflation. During the interval 1942-1948, a random sample of 30 industrials drawn from the population of firms listed on the New York Stock Exchange was submitted to the Mann and Whitney test for differences in random

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[21] *Ibid.*, p. 10.

[22] Reuben A. Kessel, "Inflation-Caused Wealth Redistribution: A Test of a Hypothesis," *AER*, 66 (March 1956), pp. 128-141.

[23] *Ibid.*, p. 132.

variables, the variables being the changes in share prices of the 15 creditor firms and the changes in share prices of the 15 debtor firms in the sample over the period. The test indicated a difference at a significance level less than .0025.[24]

Rank correlation testing was also used on the same sample, which yielded results significant at the .002 level ($R^2 = .47$), indicating correlation, the rankings based again on relative net debtor status, and per cent change in stock prices. Another sample using a different debt classification and industrials was also tried with an R^2 equal to .63.[25]

As a further test, 31 industrial firms were randomly selected from the N.Y.S.E. listings during a deflation, 1929-1933, with testing supporting the debtor-creditor hypothesis (this time creditors would be expected to gain) at significance levels of .054 and .03.[26]

Alchian and Kessel[27] used similar methods, but improved upon the other studies by enlarging the sample size, using a more comprehensive testing period, using firms divided into four distinct industry groups, and testing each individually.

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[24] _Ibid_., p. 135.

[25] _Ibid_.

[26] _Ibid_., p. 137.

[27] Armen Alchian and Reuben Kessel, "The Redistribution of Wealth through Inflation," _Science_, 130 (September 4, 1959), pp. 535-537.

The test used was the t test for differences between means, the means being the relative change in stock prices times number of shares, adjusted for dividends paid out of debtor firms and creditor firms, respectively.[28]

Their tests, for various samples, yielded good results in support of the debtor-creditor hypothesis in the context of the Alchian-Kessel definitions of debtor and creditor.

Since the testing was based on differences in means of data on two classes of firms, the method of classification is crucial. In this respect, the Alchian-Kessel study falls short. Firms were classified as net debtors or creditors for the whole period studied if they were net debtors or creditors during at least two-thirds of this period. This method permitted a firm which was a net creditor of five dollars in each of two-thirds of the years, and a net debtor of $5,000,000 in each of the remaining one-third years, to be classified as a net creditor over this period.

A general view of previous studies seems to indicate vast room for further studies of wealth redistribution from inflation, and particularly so with respect to this type of redistribution in the debt instrument market. Although each previous study seems to have made a valuable

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[28] Ibid., p. 537.

contribution, there are areas apparent in each of them in which further work should be done.

Since the most recent study devoted to the debt instrument market, de Alessi's, was done prior to 1963, using more recent data would be a significant contribution in itself. However, much more than simply this will be done here. This study is an attempt to fill in at least some of the gaps left in our information about inflation-caused wealth redistribution. Theoretical gaps will be treated in Chapter III and empirical gaps will be treated in Chapter IV.

CHAPTER III

THE THEORY OF WEALTH REDISTRIBUTION

We have seen that the debtor-creditor hypothesis is simply a particular case of a general correctness of expectations problem. All wealth, not just monetary wealth, may increase, decrease, or remain constant as expectations about the future are correct or not. Once time is introduced into economic analysis in the form of courses of action open to economic units which are non-instantaneous, i.e., some positive units of time elapse between the decision-making process and when the results of the decision are known, uncertainty is also introduced since the multitude of endogenous and exogenous variables affecting the economic system is constantly changing. The problem for the decision-making economic unit is thus adopting the proper strategy, given its utility or satisfaction function. This necessarily involves some estimation procedure about future values of variables relevant to the particular economic unit. While the strategy adopted by any unit may be the outcome of a quite complex process, it is reasonable to say that in general, the better the unit's ability to estimate future values of variables correctly, the more successful that unit will be, and the greater its wealth will be.

Alchian and Kessel, Fisher, de Alessi, and others have concentrated on one aspect of the expectations problem. They have focused on expectations about one variable, the price level, and on one market, that for debt instruments. The debtor-creditor hypothesis is the result, a hypothesis concerning how behavior in the debt market is influenced by expectations and how wealth changes in accordance with the correctness of those expectations. Inflation is a special factor only in that it describes the behavior of the variable, the general price index.

While the studies surveyed here have almost exclusively dealt with only an asymmetrical aspect of the correctness of expectations problem, a generalized study of this problem must necessarily admit of all aspects of the correctness of expectations in the debt market. The debtor-creditor hypothesis deals with an underestimate of future levels of prices, but there is at least an equal theoretical, if not actual, problem in the possibility of overestimation of future price levels and its effect on wealth through its effect on interest rates in the debt market.

(I)

In this section demand and supply functions for bonds will be developed from a theory of individual behavior.

The assumptions used are as follows:

(a) There are only two periods considered, t and t+1.

(b) Each individual has a fixed income in period t, Y_t, and a fixed income in period t+1, Y_{t+1}.

(c) Individuals always buy the same mix of goods in each period. All prices in each period are fixed and the only decision which individuals make is how much to consume in period t, X_t, and how much to consume in period t+1, X_{t+1}.

(d) Individuals' utility (U) is an additive function of X_t and X_{t+1}. (The utility derived from the consumption of goods in one period depends solely on the amount of goods consumed in this period and not on the amount of goods consumed in any other period. This assumption greatly simplifies the analysis, yet does not seem to be an outrageous affront to reality) where $\partial U/\partial X_i > 0$ and $\partial^2 U/\partial X_i^2 < 0$.

(e) At the end of period t+1, there are no savings. All wealth is spent on goods in periods t and t+1.

(f) Individuals maximize utility subject to a wealth constraint.

(g) All relevant variables, W, r, I_t, are known with certainty except I_{t+1}.

More definitions of relevant items are now given.

(a) I_t and I_{t+1} represent the price indices in periods t and t+1. Define I_t as $\equiv 1$. Let $I_{t+1}/I_t = 1 + K$. (K is the per cent change in the price index.)

(b) C is total expenditures on goods in periods t and t+1.

$$(3.1) \qquad C' = I_t X_t + I_{t+1} X_{t+1}.$$

(c) C' is the present value of total expenditures in t and t+1.

$$(3.2) \qquad C' = I_t X_t + I_{t+1} X_{t+1} (1 + r)^{-1}$$

(r is the money rate of interest.)

(d) Wealth (W) is the present value of income streams in t and t+1.

$$(3.3) \qquad W = Y_t + Y_{t+1} (1 + r)^{-1}$$

From (d):

$$U = f(X_t) + f(X_{t+1})$$

From (e), W = C', so

$$W - I_t X_t - I_{t+1} X_{t+1} (1 + r)^{-1} = 0$$

or

$$W - X_t - \left(\frac{1 + K}{1 + r}\right)X_{t+1} = 0$$

However, the maximization problem would contain expected wealth (W^e) as the budget constraint because it is the expected price in period t+1 that matters. Let K^e represent the <u>expected</u> decimal change in prices from period t to t+1.

From (f), individuals maximize:

(3.4) $$U' = f(X_t) + f(X_{t+1}) - \lambda\left[W^e - X_t - \left(\frac{1 + K^e}{1 + r}\right)X_{t+1}\right]$$

$$\frac{\partial U'}{\partial X_t} = f'(t) - \lambda = 0$$

$$\frac{\partial U'}{\partial X_{t+1}} = f'(t+1) + \left(\frac{1 + K^e}{1 + r}\right) \lambda = 0$$

$$\frac{\partial U'}{\partial \lambda} = W^e - X_t - \left(\frac{1 + K^e}{1 + r}\right)X_{t+1}$$

Assuming second order conditions hold, the equilibrium position requires that

$$f'(t) = - \lambda$$

$$f'(t+1) = - \lambda\left(\frac{1 + K^e}{1 + r}\right)$$

Manipulating terms yields

$$(3.5) \qquad \frac{f'(t+1)}{f'(t)} = \left(\frac{1 + K^e}{1 + r}\right)$$

If $K^e = 0$ (there is no expected inflation or deflation) then

$$(3.6) \qquad \frac{f'(t+1)}{f'(t)} = \frac{1}{1 + r}$$

The equilibrium position (the optimum ratio of quantities of X_t and X_{t+1} consumed) depends on the price ratio between X_t and X_{t+1} and the nominal rate of interest. The decision rule involves r (the nominal rate) explicitly--not the real rate r'.

However, once we allow K^e to differ from zero, then this term $(1 + K^e)$ cannot be dropped from the equilibrium equation. The equilibrium equation is, after manipulation,

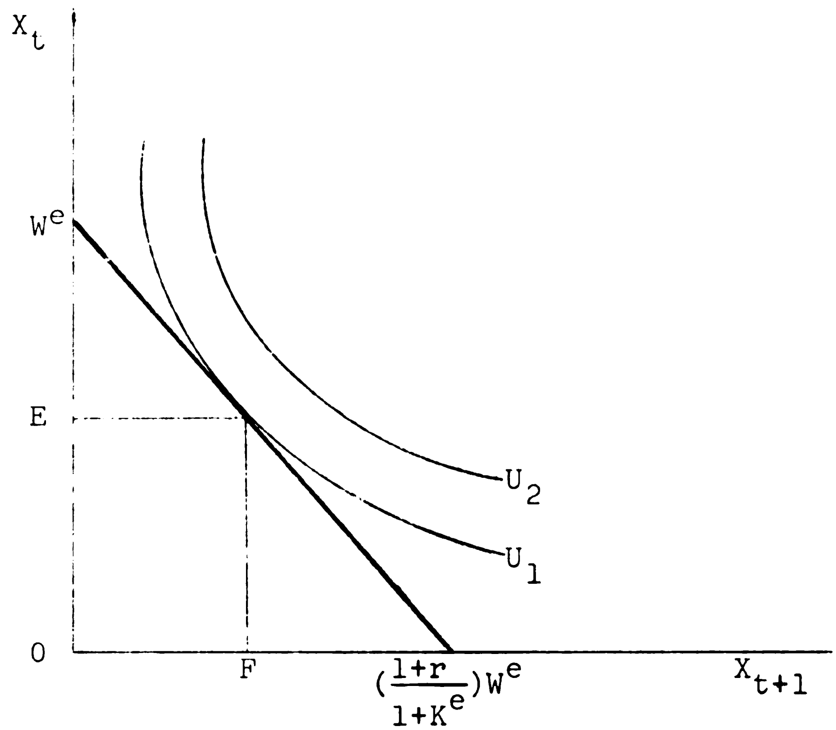
$$(3.7) \qquad \frac{f'(t+1)}{f'(t)} = \left(\frac{1 + K^e}{1 + r}\right)$$

The optimum allocation of consumption of X_t and X_{t+1} depends on K^e and r. Now, $\left(\frac{1 + K^e}{1 + r}\right)$ is the real price ratio between goods X_t and X_{t+1}, and r', the real rate of interest is $\left(\frac{1 + r}{1 + K^e}\right) - 1$.

When price levels are assumed to vary, it is the real rate of interest which determines the equilibrium consumption in t and t+1. The nominal rate of interest is the determining price only when price levels are assumed constant.

Since incomes are fixed in each period, individuals must enter the bond market to finance expenditures whenever their income in any period is not equal to their expenditures. They are demanders or suppliers of bonds according to whether their period t incomes are greater than or less than their expenditures in period t. Bond demand and supply functions are thus functions of the allocation of expenditures between t and t+1. Since this optimum allocation has been established as depending on the real rate of interest, bond demand and supply functions depend on the real rate of interest, except in the special case where $I_t = I_{t+1}$.

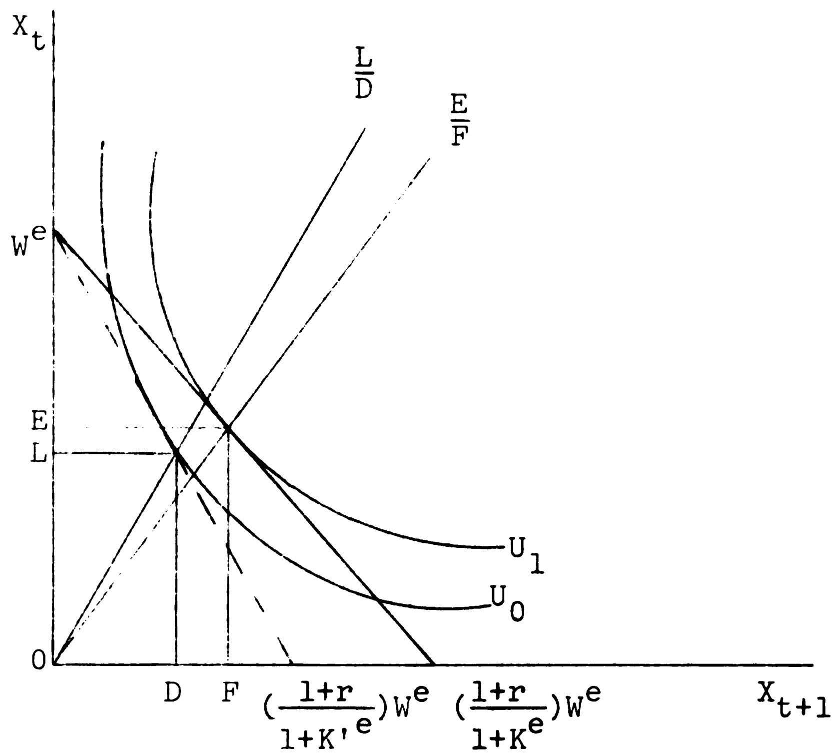
Graphically, this can be shown with indifference curves representing time preference and the budget constraint slope representing $(\frac{1 + r}{1 + K^e})$.



The equilibrium quantity of X_t is E and of X_{t+1} is F.

If the price ratio changes, because of a change in inflationary expectations (say $K'^e > K^e$), then

$(\frac{1 + r}{1 + K^e})W^e > (\frac{1 + r}{1 + K'^e})W^e$, so the new budget constraint can be represented by the dotted line.



The change in relative prices has resulted in a shift to an equilibrium position where L of X_t and D of X_{t+1} are consumed. Since L/D is greater than E/F, relatively more of X_t is now being consumed because the real rate of interest is now viewed as lower than before.

(II)

The market for debt instruments can be summarized as follows:

We have one behavioral function for potential buyers of debt instruments (lenders or creditors). This can be represented as:

$$(3.8) \qquad qD = f\left(\frac{1 + r}{1 + K^e}, \lambda\right)$$

where qD is demand for debt instruments (the units on qD are dollar amounts), $\frac{1 + r}{1 + K^e}$ is real rate of interest, and λ is a vector of other variables affecting qD which for simplicity can be assumed to be exogenous to the debt instrument market. (All variables are assumed to be flow variables, defined as values per period.)

We also have one behavioral function for potential sellers of debt instruments (borrowers or debtors). This can be represented as

$$(3.9) \qquad qS = g\left(\frac{1 + r}{1 + K^e}, \gamma\right)$$

where qS is supply of debt instruments, $\frac{1 + r}{1 + K^e}$ is real rate of interest, and γ is a vector of other variables affecting qS which are assumed exogenous.

Assuming that debt instruments are not a Giffen good, i.e., that demand functions for debt instruments are a positive function of the real rate of interest, ceteris paribus, we establish the following qualitative relation:

(3.10) $$\frac{\partial(qD)}{\partial\left(\frac{1 + r}{1 + K^{e}}\right)} > 0$$

On the supply side, if the good, debt instruments, is "non-Giffen" in the sense that supply functions for debt instruments are a positive function of the real rate of interest, ceteris paribus, we also establish the following qualitative relation:

(3.11) $$\frac{\partial(qS)}{\partial\left(\frac{1 + r}{1 + K^{e}}\right)} < 0$$

And, finally, we postulate equilibrium in the debt instrument market be setting demand and supply equal.

(3.12) $$qD = qS = q$$

Now, as has been demonstrated heretofore, $\frac{1 + r}{1 + K^{e}}$, the real rate of interest, is the nominal rate weighted by the relevant price index change over the period covered by the debt contract.

Under most contractual agreements for the purchase and sale of debt instruments, the nominal rate of interest, r, is specified in the contract and thus known with certainty. However, the degree of price change, if any, in future time periods is not known with certainty. We can assume, however, that buyers and sellers of debt instruments possess some expectations of values for future prices. Although different individuals will attach different weights to various future prices, this problem does not concern us here and can be resolved if we use some single price index, I(t), as that value, the expected value of which is an argument in the demand and supply functions for debt instruments. These are r, the nominal interest rate, and K^e, the percentage expected change in the value of I.

The relevant behavioral functions in the market for debt instruments are, after this transformation:

(3.13) $qD = f(r, K_D^e, \lambda)$

where K_D^e is <u>demanders</u>' expectations, and

(3.14) $qS = g(r, K_S^e, \gamma)$

where K_S^e is <u>suppliers</u>' expectations.

Now, given the qualitative relations that have been established in (3.10) and (3.11), namely that demand and supply functions for debt instruments are "non-Giffen" with respect to $\frac{1 + r}{1 + K^e}$, the real rate of interest, we can use the information we have on the relationship between $\frac{1 + r}{1 + K^e}$, K^e, and r to compute partial derivatives of (3.13) and (3.14) with respect to r and K^e.

We have assumed that $\frac{\partial(qD)}{\partial(\frac{1 + r}{1 + K^e})} > 0$. We have also shown in Chapter II that the definitional formula for r' is

$$r' = \frac{F(t+1)}{V(t)} \cdot \frac{I(t)}{I(t+1)} - 1$$

In order to generalize, yet avoid interest compounding problems, assume that both interest rates and inflation or deflation rates are defined over some period t to t+n, and not on a yearly basis. Also, it is the expectational value of $\frac{I(t+n)}{I(t)}$ which is relevant.

The symbols in the formula for r' represent the following:

F(t+n) = face value of promise to pay amount at t+n

V(t) = market price of debt instrument at t.

$[\frac{I(t)}{I(t+n)}]^e = \frac{1}{1 + K^e}$ = expected relative change in price index.

We now have qualitative relations for the relevant variables in (3.13) and (3.14), and the complete behavioral system is:

(3.13) $qD = f(r, K_D^e, \lambda)$

(3.14) $qS = g(r, K_S^e, \gamma)$

where

$$\frac{\partial(qD)}{\partial r} > 0, \quad \frac{\partial(qD)}{\partial(K_D^e)} < 0$$

and

$$\frac{\partial(qS)}{\partial r} < 0, \quad \frac{\partial(qS)}{\partial(K_S^e)} > 0.$$

Since λ and γ, the vectors of exogenous variables, do not directly concern this particular analysis, they will be assumed constant and dropped from the system.

Initially, assume that both demanders and suppliers formulate expectations so as to arrive at similar expected values of price changes over any given period. In our terminology, assume K_S^e equals K_D^e. This assumption will be relaxed later.

This gives a complete system, adding the market equilibrium equations of:

$$qD = f(r, K_{D,S}^e)$$

(3.15) $$qS = g(r, K_{D,S}^e)$$

$$qD = qS = q$$

Substituting q for qD and qS yields

$$q = f(r, K^e_{D,S})$$

(3.16)

$$q = g(r, K^e_{D,S})$$

We have two equations and two unknowns (q, r) with $K^e_{D,S}$ assumed to be formulated exogenously. We can work out a comparative statics analysis on this system to find the direction of change of equilibrium values of endogenous variables with respect to changes in values of exogenous variables, which in this system consist only of one variable, $K^e_{D,S}$, the expected price level change.

Writing (3.16) implicitly and taking the total differential of the system gives:[1]

$$f'(r)dr - 1dq = -f'(K^e_{D,S})dK^e_{D,S}$$

(3.17)

$$g'(r)dr - 1dq = -g'(K^e_{D,S})dK^e_{D,S}$$

Now, what is the sign of the change in the equilibrium value of r when $K^e_{D,S}$ changes? Writing (3.17) in determinant form and using Cramer's rule, we have:

[1]The analysis used here is based on the framework to be found in Don Patinkin, Money, Interest, and Prices (2nd ed.; New York: Harper and Row, 1965), Appendix 1.

$$(3.18) \quad \frac{dr}{dK^e_{D,S}} = \frac{\begin{vmatrix} -f(K^e_{D,S}) & -1 \\ -g(K^e_{D,S}) & -1 \end{vmatrix}}{\begin{vmatrix} f'(r) & -1 \\ g'(r) & -1 \end{vmatrix}} = \frac{D_1}{D}$$

D works out to equal $[g'(r) - f'(r)]$ and since we have established that $g'(r) < 0$ and $f'(r) > 0$, $D < 0$. D_1 works out to equal $[f'(K^e_{D,S}) - g'(K^e_{D,S})]$ and since we have also established that $g'(K^e_{D,S}) > 0$ and $f'(K^e_{D,S}) < 0$ $D_1 < 0$. So

$$(3.19) \quad \frac{dr}{d(K^e_{D,S})} = \frac{D_1}{D} > 0$$

This completes the formal proof of the effect of an increase in the expected degree of price increase on the equilibrium nominal rate of interest. Nominal rates will rise when the price level is expected to rise.

Now the same type of analysis can be used if the assumption that $K^e_S = K^e_D$ is dropped and we let $K^e_S \neq K^e_D$. We now have two exogenous variables and we can observe the sign of the effect on equilibrium r when one of these exogenous variables changes, and the other is held constant.

Suppose we hold K_S^e constant and desire the direction of change in r when K_D^e changes. We want to know the sign of $\frac{dr}{dK_D^e}$.

$$q = f(r, K_D^e)$$
(3.20)
$$q = g(r, K_S^e)$$

From writing the new system (3.20) implicitly and writing the determinant of its total differential, recalling that since we assume $dK_S^e = 0$, we have only dK_D^e on the right hand side of the system.

We get the determinant:

$$(3.21) \qquad \frac{dr}{dK_D^e} = \frac{\begin{vmatrix} -f(K_D^e) & -1 \\ 0 & -1 \end{vmatrix}}{D} = \frac{D_2}{D}$$

D_2 works out to equal $[f'(K_D^e)]$, which is negative, so

$$\frac{dr}{dK_D^e} = \frac{D_2}{D}$$

where $D_2 < 0$ and $D < 0$, yielding $\frac{dr}{dK_D^e} > 0$.

With suppliers' expectations constant, an increase in the expected price level on the part of demanders of debt instruments will, therefore, result in an increase in the equilibrium nominal rate of interest.

Next, a change in suppliers' expectations is considered, holding K_D^e constant. The same process performed on the system as before yields:

$$(3.22) \qquad \frac{dr}{dK_S^e} = \frac{\begin{vmatrix} 0 & -1 \\ -g(K_S^e) & -1 \end{vmatrix}}{D} = \frac{D_3}{D}$$

D_3 turns out to equal $-g'(K_S^e)$ and since $g'(K_S^e) > 0$, $D_3 < 0$ and

$$\frac{dr}{dK_D^e} = \frac{D_3}{D}$$

where $D_3 < 0$, $D < 0$, giving $\frac{dr}{dK_D^e} > 0$.

Hence, an increase in suppliers' expectations of the value of K, holding demanders' expectations constant, also results in an increase in the equilibrium nominal rate of interest.

What is the effect on q when these variables change? We can use the same method. For instance,

$$(3.23) \quad \frac{dq}{dK^e_{D,S}} = \frac{\begin{vmatrix} f'(r) & -f'(K^e_{D,S}) \\ g'(r) & -g'(K^e_{D,S}) \end{vmatrix}}{D} = \frac{D_4}{D}$$

D_4 works out to equal $-g'(K^e_{D,S})[f'(r)] - g'(r)[-f'(K^e_{D,S})]$. The first term is positive and the second term is negative so no qualitative prediction is given. Specific values of the variables must be known.

This turns out to be the result for derivatives of q with respect to the possible variables also.

This analysis, simplified though it may be, is basically the explanation for a tendency toward high interest rates during inflationary periods, abstracting from any governmental policy-making actions (which might also push interest rates upward during inflationary periods).

As stated previously, this process can be entirely symmetrical, and when deflation is expected, the equilibrium interest rate will be lower than if no price level change is expected.

With this in mind, it is, of course, no surprise to see interest rates in the immediate past and the present (1968-1969) at near record highs. If one surveys the financial literature of the period, one finds a persistent belief in the probability of future inflation.

Some examples are given below. In well known business periodicals the following appeared:

> Today, inflation is once again a major problem and it may get worse.[2]

> Why should a company wait to invest later--in the insatiable seventies--if it can do it now? In two or three years, we'll have to pay at least 10% to 15% more for the equipment we're buying now.[3]

Speaking of a recent rise in the prime lending rate, Secretary of the Treasury Kennedy called the increase "Another indication of the strength and pervasiveness of inflationary pressures."[4]

(III)

In this section we shall define what is termed wealth redistribution in the bond market due to inflation. This definition can be best arrived at by means of graphical analysis of various possible situations relevant to this study.

For simplicity and clarity of exposition some assumptions will be stated at the outset:

(a) Bond markets are competitive and are described by the behavioral functions and equilibrium conditions given in the section in Chapter III.

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[2] Fortune, October, 1966, p. 120.

[3] Business Week, April 26, 1969.

[4] Wall Street Journal, June 10, 1969.

(b) While various degrees of inflation and deflation are possible, only two rates of price level change are considered, a zero rate or no price level change, and a rate of price level increase of K, where K is greater than zero and is a constant. This K is hereafter referred to in this section as inflation. The period for which these are defined is t to t+1.

(c) All bonds are of one period, and all are bought and sold at the beginning of the period at price V(t), and the face value of the bond is paid at the end of the period. This latter amount is F(t+1). We have already shown that r can be determined from these two values and r' can be determined from these two values plus price level changes from t to t+1.

(d) Suppliers and demanders always have identical expectations about price level changes. ($K_S^e = K_D^e$)

The following situations will be analyzed individually and compared with regard to whether or not they give rise to wealth redistribution in the bond market. The question we want to ask in each situation is: if expectations had been correct, would the market look any different? If it does, then we can observe changes in real wealth of debtors and creditors since real amounts paid from one to the other are reflected in the graphical analysis.

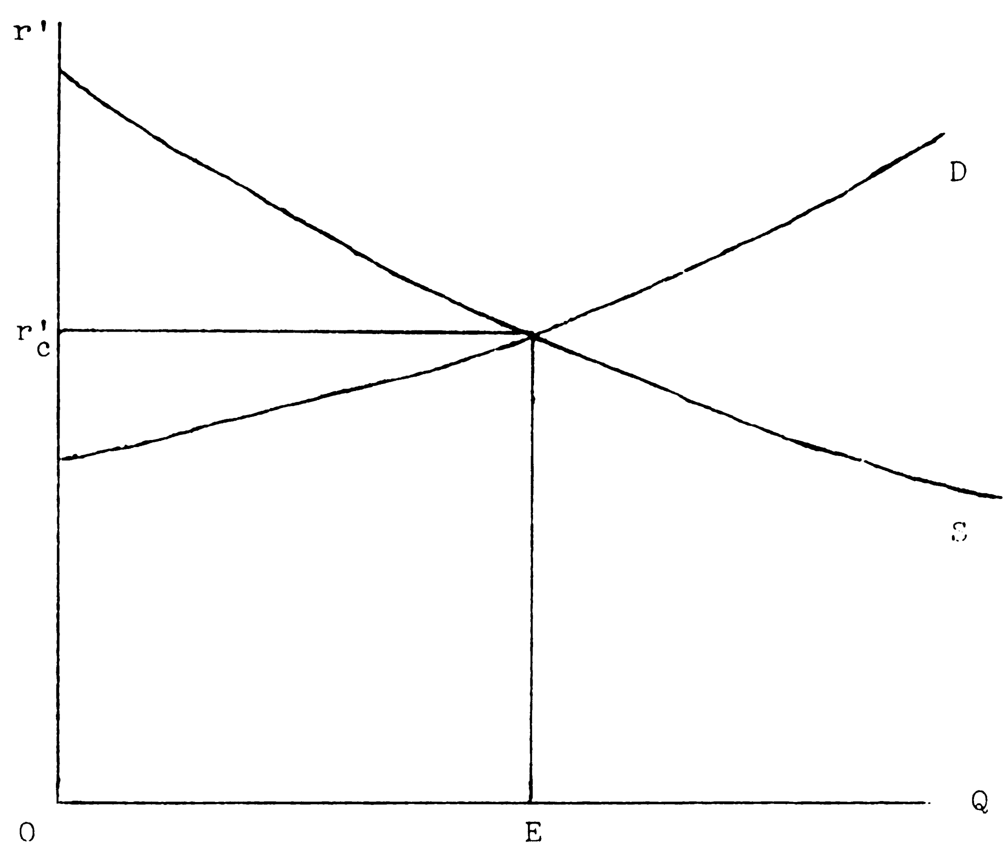
(A) Neither suppliers nor demanders expect inflation and, in fact, there is no inflation.

(B) Both suppliers and demanders expect inflation and, in fact, inflation occurs.

(C) Neither suppliers nor demanders expect inflation and, in fact, inflation occurs.

(D) Both suppliers and demanders expect inflation, and inflation does not occur.

(A) Neither suppliers nor demanders expect inflation and, in fact, there is no inflation.

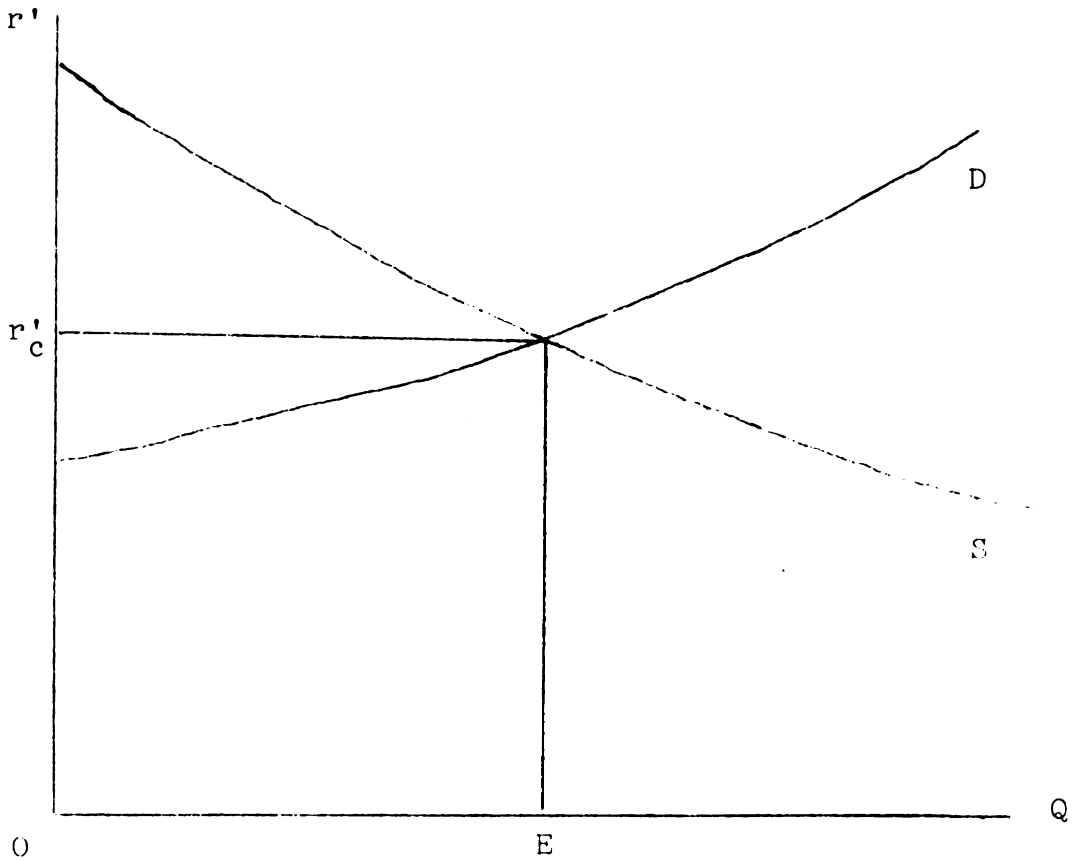


(Q is in dollar amounts)

S and D represent, respectively, the market behavioral relations between quantity of bonds demanded or supplied and the real rate of interest, r', which when multiplied by quantity (Q) gives the real amount paid by debtors to creditors for borrowing cost.

(O - E) bonds were sold at interest rate (r'_c - 0). The actual rate equaled the expected rate. Expectations of r' were correct. No wealth redistribution has occurred.

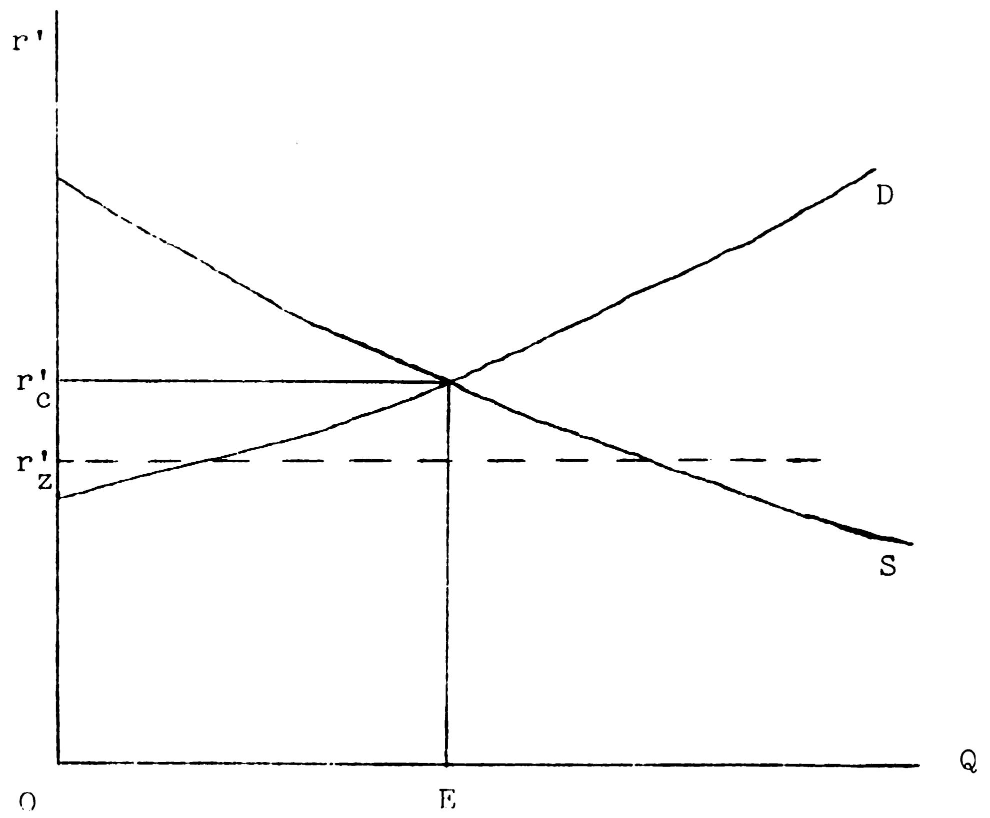
(B) Both suppliers and demanders expect inflation and, in fact, inflation occurs.



(O - E) bonds were sold at interest rate (r'_c - 0). Expectations were correct. Actual r' equaled expected r'. No wealth redistribution has occurred.

This situation is the same as (A) even though inflation has occurred in (B) but not in (A). What is different is that in (B) the nominal interest rate, r, would be higher than in (A). But, it is changes in real amounts paid for borrowing that cause wealth redistribution, not changes in nominal borrowing costs.

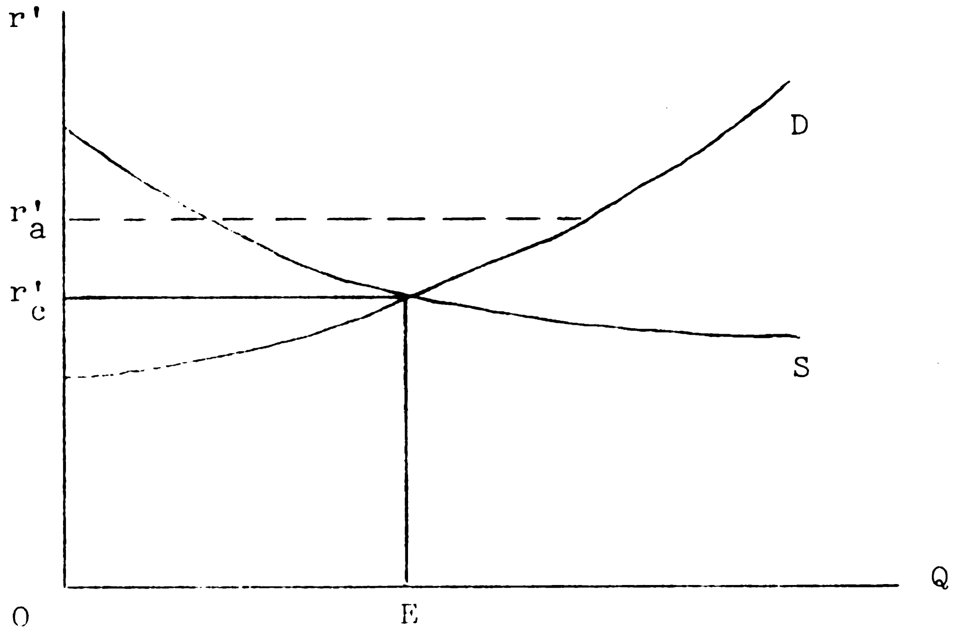
(C) Neither suppliers nor demanders expect inflation and, in fact, inflation occurs.



(O - E) bonds were sold at an expected real rate $(0 - r_c')$. However, the actual real interest rate $(r_z' - 0)$, was lower than expected. Expectations were incorrect. What is the effect of incorrect expectations on real wealth?

The actual interest rate is $(r_c' - r_z')$ lower than the expected one, which is the one which the behavioral functions at the time of the transaction were based upon. If expectations had been correct, the difference between actual r' and expected r' would have been zero, so the difference in real amounts paid for borrowing due to incorrect expectations is $OE(r_z' - r_c')$. This amount has been redistributed from demanders (creditors) to suppliers (debtors) since the r' actually prevailing is lower than the one at which suppliers would have been willing to sell OE bonds and lower than the interest rate at which demanders would have been willing to buy OE bonds.

(b) Both suppliers and demanders expect inflation and inflation does not occur.



OE bonds were sold at r'_c. However, the actual r', was higher than the expected r'. Expectations were incorrect. The effect of this on wealth redistribution is as follows: The actual r' is $r'_a - r'_c$ higher than the r' at which transactions took place. If expectations had been correct, this difference would have been zero, so the difference in real amounts paid due to incorrect expectations is $OE(r'_a - r'_c)$. This amount has been redistributed from suppliers (debtors) to demanders (creditors).

Within the confines of the strict assumptions made in this analysis, it is possible to identify the exact amount by which the nominal interest rate would have to change in the event of inflation in order that the real interest rate remain unchanged. The following table shows some sets of r and K for which r' is constant.

	K	r
r' = .048 when	.05	.10
	.10	.1528
	.20	.2576

If K doubles, r increases, but not proportionately; it does not double. The per cent increases in r necessary to keep r' constant when K increases are lower, the higher is the absolute level of r. This is because r constitutes a larger proportion of the loan and interest cost paid back in period t+1. This is the sum which must be kept constant in real terms for no wealth redistribution to occur. From the formula for r',

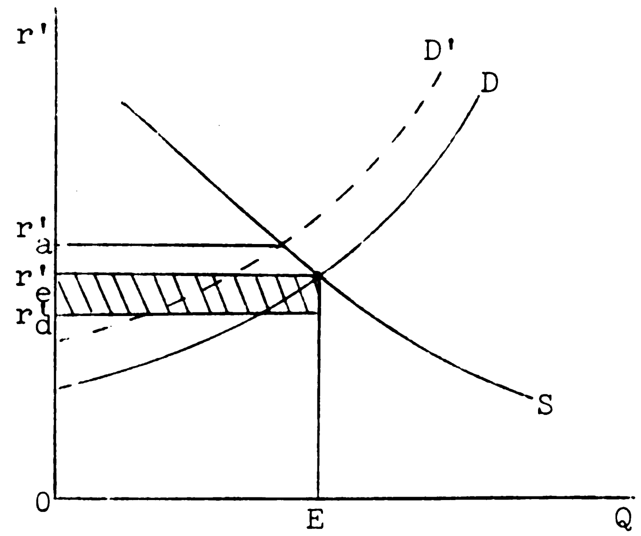
$$r' = [(1 + r) \frac{I(t)}{I(t + 1)}] - 1$$

it can be seen that 1 + r, not r, must change proportionately in the opposite direction of the change in $\frac{I(t)}{I(t + 1)}$ for r' to remain constant.

Next, let us take up the case where demanders and suppliers of bonds may have different expectations about K. ($K_D^e \neq K_S^e$)

Let the axes represent r', the real rate of interest, and Q, the dollar amount quantity of bonds traded. The same type of analysis will be used, looking at changes in the market situation which would have occurred had expectations been correct.

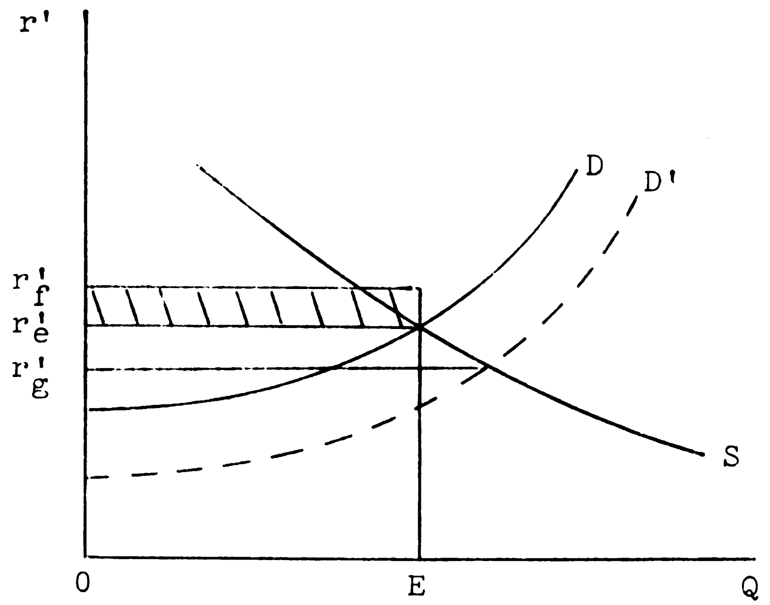
(E) $K_D^e < K = K_S^e$



(O - E) bonds were sold at r'_e. Had K^e_D equaled K, the demand curve would have been D'. Less bonds would have been sold at a higher interest rate r'_a. However, E, the equilibrium quantity actually traded is the relevant quantity in this analysis.

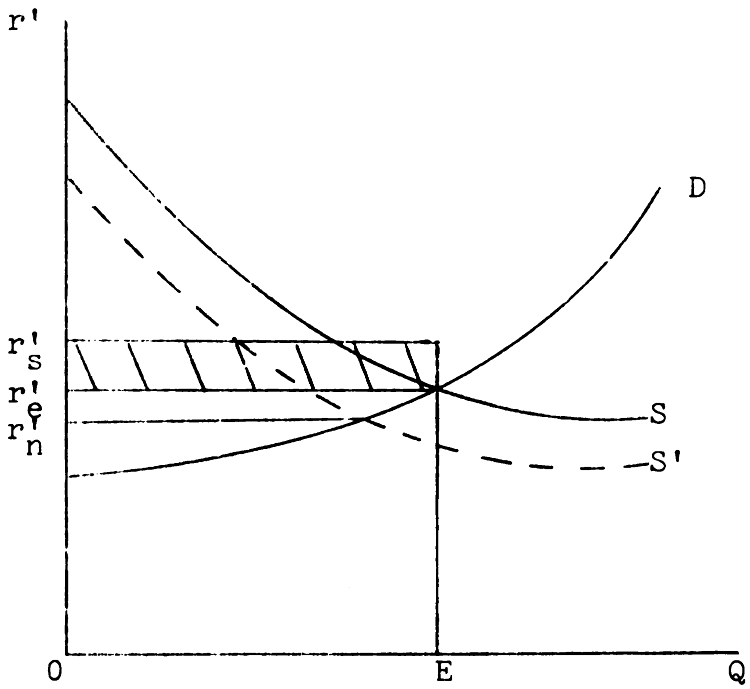
Suppliers have had to make a payment of $r'_e(O - E)$, exactly what they expected to make. However, demanders have actually received a payment of $r'_d(O - E)$, which is less than that which they expected to receive by $(r'_e - r'_d)(O - E)$. This is their loss due to incorrect expectations. The shaded area, then, is not wealth redistribution from creditors to debtors such as in cases (A) through (D). It represents simply a loss to creditors due to incorrect expectations. Debtors have neither gained nor lost.

(F) $K^e_D > K = K^e_S$



(O - E) bonds were sold at r'_e. Had K_D^e equaled K, the demand curve would have been D'. More bonds would have been traded but at a lower interest rate (r'_g). However, ex post, demanders have received a higher payment than had their expectations been correct by $(r'_f - r'_e)(O - E)$. Suppliers had to make exactly the same payment they expected to make. The shaded area represents a "gain" to demanders, but not a loss to suppliers.

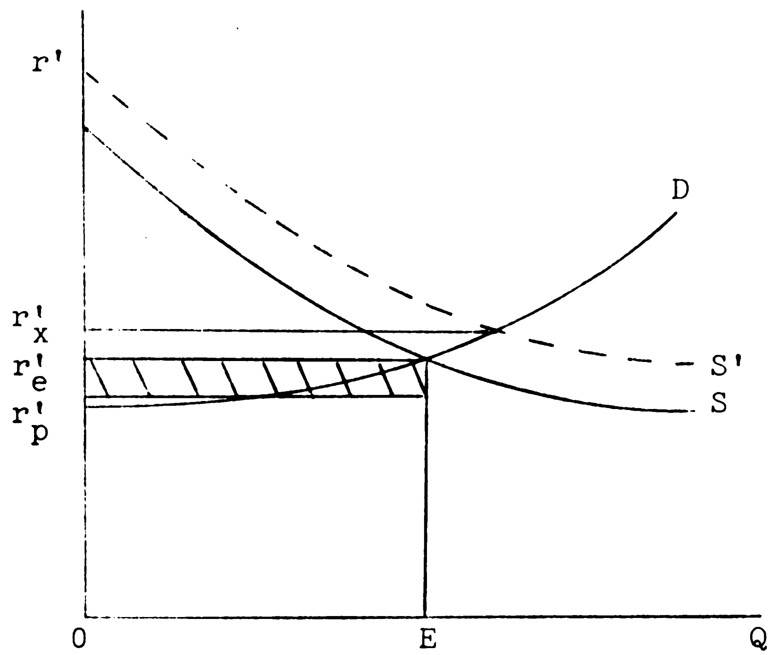
(G) $K_D^e = K < K_S^e$



(O - E) bonds were sold at r'_e. Had K_S^e equaled K, the supply curve would have been S'. Less bonds would have been sold at a lower interest rate (r'_n).

Demanders have received a payment of $r'_e(O - E)$, exactly what they expected to receive. However, suppliers have made a payment of $r'_s(O - E)$. The real rate paid by them is ($r'_s - r'_e$) higher than had their expectations been correct. The shaded area represents a loss to suppliers from incorrect expectations but not a gain to demanders.

(H) $K_D^e = K > K_S^e$



(O - E) bonds were sold at r'_e. Had K_S^e equaled K, the supply curve would have been S'. More bonds would have been sold at a higher interest rate (r'_x).

Demanders have received a payment of r'_e(O - E), exactly what they expected to receive. However, suppliers have made a payment of r'_p(O - E), less than had their expectations been correct. The shaded area represents a "gain" to suppliers but not a loss to demanders.

In cases (E) and (G), there is clearly a loss involved for the group having incorrect expectations. However, unlike cases (A) through (D), neither case (E) nor (G) involves direct wealth redistribution from debtors to creditors or from creditors to debtors.

In cases (F) and (H), there appears to be some "gain" to the group having incorrect expectations. However, this "gain" should be considered a sort of added payment occurring in spite of, not because of, incorrect expectations. Take, for example, (F). Also, consider the demand and supply curves as boundaries between attainable and unattainable points. Now, the point representing the ordered pair r'_f and E lies within the set of attainable points, i.e., the area to the left and above the demand curve, D. (O - E) bonds could have been demanded at either r'_e or r'_f. The payment r'_f(O - E) would have been acceptable to bond demanders for the purchase of (O - E) bonds.

In case (H), the point representing the ordered pair r'_p and E lies with the set of attainable points for suppliers; it is to the left and below the supply curve, S. This payment would have been acceptable to suppliers for the sale of (O - E) bonds.

In cases (E) and (G), there is a clear loss since the points representing E and the ex post real rate of interest paid do not lie with the set of attainable points for demanders and suppliers, respectively. In case (E), the point r'_d - E is to the right of the demand curve, D, in the unattainable area. In case (F), the point r'_f - E is to the right of the supply curve, S, in the unattainable area.

In situations where K^e_D and K^e_S are not equal, then, a loss occurs only in the following situations:

(1) When bond demanders (creditors) under-estimate inflation.

(2) When bond suppliers (debtors) over-estimate inflation.

A sort of gain, in the sense that some extra consumers or producers surplus is reaped, occurs in the following situations:

(1) When bond demanders (debtors) over-estimate inflation.

(2) When bond suppliers (debtors) under-estimate inflation.

(IV)

Emphasis has been placed here on the generality of the possibility of wealth redistribution from imperfect expectations in the bond market. De Alessi has restricted his model to only one aspect of this by limiting the values which B may take.[5] His model deals with a narrow interpretation of the debtor-creditor hypothesis where wealth redistribution can only occur under special conditions of incorrect expectations.

This is readily seen from re-examining his basic model (2.7), which is:

$$(2.7) \qquad W(t+1) - W(t) = (r + K)(W(t) + B[KM(t)]$$

Now it is entirely possible that incorrect expectations in the debt market can result in wealth redistribution even if there is no inflation. If inflation is expected, and the equilibrium r increases but no inflation actually occurs, wealth redistribution will occur from debtors to creditors in the form of the high price debtors must pay for borrowing. However, this cannot occur in (2.7) since when K = 0, the second term drops out and the wealth change of an economic unit does not depend on M, its net debt position.

In addition, some forms of wealth redistribution possible under the more general view of incorrect

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[5]B is the degree of anticipation of price level changes.

expectations in the debt instrument market, are denied by the restrictions on B. De Alessi restricts B to $0 < B \leq 1$, but according to the more general view, B can take on values outside this range.

The values of B can be positive, negative, or zero, according to various combinations of values of K^e and K (it is assumed below that $K_S^e = K_D^e = K^e$) with the economic meaning of the various values of B given as follows:

(a) $B = 0$, so $\frac{K - K^e}{K} = 0$ if and only if $K = K^e$. Inflation or deflation is correctly anticipated.

(b) $B = 1$, so $\frac{K - K^e}{K} = 1$ if and only if $K^e = 0$. Inflation or deflation is wholly unanticipated.

(c) $0 < B < 1$, so $0 < \frac{K - K^e}{K} < 1$ if and only if $0 < |K^e| < |K|$. Inflation or deflation is partially, but not completely, correctly anticipated.

(d) $B > 1$, so $\frac{K - K^e}{K} > 1$ if and only if $K^e < 1$ and $K > 0$, or $K^e > 0$ and $K < 0$. Individuals anticipate deflation when inflation actually occurs, or vice versa.

(e) $B < 0$, so $\frac{K - K^e}{K} < 0$ which could occur with negative values of K, deflation and $K^e < K$, or positive values of K with $K^e > K$. Individuals overestimate the rate of deflation or inflation.

Possibilities (d) and (e) are not included in the de Alessi view of the debtor-creditor hypothesis, but are included in a more general view. (a), (b), and (c) are possible under both views.

It can be seen from the above that wealth redistribution can occur for any case when $B \neq 0$, (a), and that for each other case, (b, c, d, e), wealth redistribution may occur from creditors to debtors, <u>or</u> from debtors to creditors, depending upon whether K is negative or positive (deflation or inflation occurs).

Expectations are a crucial part of the debtor-creditor hypothesis (either view) of wealth redistribution. Although expectations have, in previous studies, been treated as a sort of residual, emerging out of various values of the "degree of anticipation" coefficient obtained from various studies, it may be worthwhile at this juncture to depart from this path and venture some sort of hypothesis concerning expectations in the debt instrument market.

The question of how expectations are formed has been a question which several economists have attempted to answer with some type of plausible hypothesis.

Any number of hypotheses could be offered as to how expectations of future rates of inflation or deflation are formed. Ideally, it might be assumed that expectations of price level changes are derived from expectations of variables that influence price level changes: Federal Reserve actions, fiscal policy, productivity, the demand for money, etc. Shackle has suggested the concept of an "inflative" or "deflative" index of government actions.[6] One hypothesis which has gained support through its seeming consistency with observed data is the "adaptive expectations" hypothesis.[7] This hypothesis has been used by Nerlove[8] to study cobweb phenomena, Meiselman[9] to study the term structure of interest rates, and used in studies of the effect of inflation on the velocity of money by Cagan.[10]

The adaptive expectations model is basically this:

$$\frac{\partial K_t^e}{\partial t} = \alpha(K_t - K_t^e) \tag{3.24}$$

Expectations of any variable, here K_t^e, the expected rate of inflation at time t, change directly with errors in expectations $(K_t - K_t^e)$.

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[6] G. L. S. Shackle, Uncertainty in Economics (Cambridge: Cambridge University Press, 1955), pp. 194-214.

[7] David Meiselman, The Term Structure of Interest Rates (Englewood Cliffs, New Jersey: Prentice-Hall, 1962), pp. 18-19.

[8] Marc Nerlove, "Adaptive Expectations and Cobweb Phenomena," QJE, 72 (May 1958), pp. 227-240.

[9] David Meiselman, op. cit.

[10] Phillip Cagan, "The Monetary Dynamics of Hyper-inflation," in Studies in the Quantity Theory of Money, ed. by Milton Friedman (Chicago: University of Chicago Press, 1956).

The time path of change, $\frac{\partial K_t^e}{\partial t}$, is determined by $(K_t - K_t^e)$ and an adjustment coefficient, α.

To give an example of its applicability to the debtor-creditor hypothesis, suppose that the rate of inflation were a constant ($K_t = a$). We can solve the differential equation as follows:

$$(3.25) \qquad \partial K_t^e = \alpha(a - K_t^e)\partial t$$

or, after separating the variables

$$(3.26) \qquad \frac{\partial K_t^e}{(a-K_t^e)} = \alpha\partial t.$$

Both sides of (3.26) can be integrated to give:

$$(3.27) \qquad \ln \left|a - K_t^e\right| = \alpha t + c$$

where c is the constant of integration.

Multiplying both sides by -1 yields

$$-\ln |a - K_t^e| = -\alpha t - c$$

which is equivalent to

$$-(a - K_t^e) = e^{-\alpha t - c}$$

which is equivalent to

$$K_t^e - a = Le^{-\alpha t}$$

where $L = e^{-c}$, and

$$\lim_{t\to\infty} K_t^e - a = \lim_{t\to\infty} \frac{L}{e^{\alpha t}}$$

For any value of $\alpha > 0$, $\lim_{t\to\infty} \frac{L}{e^{\alpha t}} = 0$ and so $\lim_{t\to\infty} K_t^e - a = 0$.

With the rate of inflation or deflation constant, the adaptive expectations model predicts that in the limit, the expectational value of K will approach the actual value of K. This means that in the limit, no wealth redistribution will occur from the debtor-creditor hypothesis, since its existence depends on incorrect expectations of K.

The foregoing is included only as an example, since a constant rate of inflation is, in fact, most unlikely.

In difference equation form, the adaptive expectations model is:

(3.28) $$\Delta K_t^e = \alpha(K_t - K_t^e)$$

restricted here by $0 < \alpha < 1$. Since $\Delta K_t^e = K_{(t+1)}^e - K_t^e$,

(3.29) $$K_{(t+1)}^e - K_t^e = \alpha(K_t - K_t^e).$$

This difference equation may be manipulated so as to show how it implies that the anticipated rate of inflation at time t, (K_t^e), is a function of weighted past rates of inflation.

(3.30) $$K_{(t+1)}^e = K_t^e + \alpha(K_t - K_t^e)$$

Replacing α by $1 - \lambda$ gives:

(3.31) $$K_{(t+1}^e = K_t^e + (1 - \lambda)(K_t - K_t^e)$$

or

(3.32) $$K_{(t+1)}^e = K_t^e + (1-\lambda)K_t - (1-\lambda)K_t^e$$

$$= K_t^e + K_t - \lambda K_t - K_t^e + \lambda K_t^e$$

$$= (1-\lambda)K_t + \lambda K_t^e.$$

Since K_t^e is formulated in the same manner as $K_{(t+1)}^e$, that is:

(3.33) $$K_t^e = K_{(t-1)}^e + (1 -\lambda)[K_{(t-1)} - K_{(t-1)}^e]$$

We can substitute for K_t^e in (3.34) giving:

$$(3.34)\quad K^e_{(t+1)} = (1-\lambda)K_t + \lambda[K^e_{(t-1)} + (1-\lambda)(K_{[t-1]} - K^e_{[t-1]})]$$

which, after substituting for successive $K^e_{(t-n)}$ in the same manner, reduces to

$$(3.35)\quad K^e_{(t+1)} = (1-\lambda)K_t + (1-\lambda)\lambda K_{(t-1)} + (1-\lambda)\lambda^2 K_{(t-2)} + \ldots + (1-\lambda)\lambda^n K_{(t-n)}.$$

The expected rate of inflation in period t + 1 is a weighted average of past rates of inflation, the weights declining exponentially for successive periods so that $K^e_{(t+1)}$ is more heavily influenced by rates of inflation in more recent periods. The actual values of the weights (λ's) depend on the adjustment coefficient in (3.24), α, since $\alpha = 1 - \lambda$.

It is helpful at this point to interject a note on the relationship of the adaptive expectations model to the most generally used frame of reference in the field of expectations, the concept of the elasticity of expectations. A brief definition of this concept is given by Ozga.

> It is a measure of the responsiveness of prospects to changes in results, and has been defined as the ratio of the proportional change in the former to that of the latter. If, for instance, expectations are sure prospects of prices, the elasticity of expectations is the ratio of the proportional change

> in the expected future price to the proportional change in the price which has been observed in the past. If the elasticity of expectations is equal to unity, a 10% increase in the actual price leads to a 10% increase in expected price. Thus, if formerly the price was expected to remain unchanged, and then it increased by 10%, it is now expected to remain unchanged at the new, higher level. If the elasticity of expectations is greater than unity, an increase in the actual price gives rise to a prospect that it will increase still further.[11]

Since we are dealing in the rate of change of prices, not absolute prices, this definition must be modified a bit. This can be done by defining the object of expectations to be the rate of change in the price level. (K_t equals actual rate of change, and K_t^e equals expected rate of change.)

Now, if the elasticity of expectations is equal to unity, a 10% increase in the actual rate of price change leads to a 10% increase in the expected rate of price change. With the elasticity of expectations equal to unity, the rate of price change expected is exactly the rate of price change actually prevailing at the time the expectations are formed. This is equivalent to the special case of the adaptive expectations model with the adjustment coefficient equal to one. From equation (3.34), which is

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[11]S. A. Ozga, Expectations in Economic Theory (Chicago: Aldine Publishing Company, 1965), p. 149.

(3.34) $K^e_{(t+1)} = (1-\lambda)K_t + \lambda[K^e_{(t-1)} + (1-\lambda)(K_{[t-1]} - K^e_{[t-1]})]$

it can be seen that when $\alpha = 1$, and remembering that $\alpha = 1 - \lambda$, so $\lambda = 0$, the second term in (3.34) drops out and the weight attached to K_t would equal 1, and, in fact, $K^e_{(t+1)}$ would equal K_t.

More formally, according to the definition given by Ozga, the elasticity of expectations (σ^e) is given by the formula:

$$(3.36) \qquad \sigma^e = \frac{\dfrac{\partial K^e_{(t+1)}}{K^e_{(t+1)}}}{\dfrac{\partial K_t}{K_t}} = \frac{\partial K^e_{(t+1)}}{\partial K_t} \cdot \frac{K_t}{K^e_{(t+1)}}$$

Differentiating (3.34) with respect to K_t gives

$\frac{\partial K^e_{(t+1)}}{\partial K_t} = 1 - \lambda$ so

$$(3.37) \qquad \sigma^e = (1 - \lambda)\frac{K_t}{K^e_{(t+1)}} .$$

When $\alpha = 1$, we know that $\alpha = 1 - \lambda = 1$, so $\sigma^e = K_t/K^e_{(t+1)}$, and from (3.34) we know that when $\alpha = 1$, $K_t = K^e_{(t+1)}$, so $K_t/K^e_{(t+1)} = 1$ and $\sigma^e = 1$.

However, when α is not equal to unity, we cannot be as specific about the value of the elasticity of expectations in the adaptive model. This is because we were able to identify the value of $K_t/K^e_{(t+1)}$ since in the case where $\alpha = 1$, K_t equaled $K^e_{(t+1)}$, but when α is not equal to one we cannot identify the value of $K_t/K^e_{(t+1)}$ without a knowledge of other variables, specifically all past rates of price change, since when α is not equal to one, these rates contribute to $K^e_{(t+1)}$. It is only in the special case when α equals one that they do not contribute to $K^e_{(t+1)}$ and we can therefore establish the value of $K_t/K^e_{(t+1)}$ without them.

Some numerical examples of various weights attached to selected periods for different values of α are given below.

TABLE 1.--Weights given to periods in formulating K_{t+1}.

Value of α	K_t	K_{t-1}	K_{t-2}	$\sum_{n=0}^{2} K_{t-n}$
3/4	3/4	3/16	3/64	63/64
1/2	1/2	1/4	3/16	15/16
1/4	1/4	3/16	9/64	37/64

As α increases from its lower restriction [see (3.27)] of zero to its upper restriction of one, the relative weights placed on the three preceding periods $[\sum_{n=0}^{2} K_{t-n}]$ increases, and for all three examples shown the combined weights of the three preceding periods comprise well over one-half of the sum of all weights (the sum being equal to one).

Since, by assuming this expectations model we have obtained a solution for K_t^e in terms of past K_t's, we can make the appropriate substitution in the de Alessi model. Substituting (3.35) in (2.6) yields:

$$W(t+1) - W(t) = (r + K)W(t) + [K_t - (1-\lambda)\sum_{1}^{n} \lambda^n K_{t-n}]M(t) \tag{3.38}$$

What this means for the focus of this study, wealth redistribution due to changes in the price level, is that if the adaptive expectations hypothesis holds, with values of α substantially above zero, say over 1/4, then expectations about the rate of inflation or deflation in any period will be mostly influenced by what the actual rate of inflation was in periods immediately preceding. If this is indeed the case, then wealth redistribution, which according to the propositions advanced here results from incorrect anticipations ($K_t^e \neq K_t$), will be most acute when there are sharp changes in the rate of price level increase or decrease. For, when expectations about K_{t+1}^e are largely based on rate of inflation or deflation in the immediate past, and K_{t+1} is significantly different from these past rates, then K_{t+1}^e will differ significantly from K_{t+1}, and massive wealth redistribution will occur. It is interesting to note that this leads to the policy recommendation of avoidance of these sharp changes in the rate of inflation, rather than a policy recommendation of the avoidance of inflation, if the goal is to minimize wealth redistribution from this source.

CHAPTER IV

EMPIRICAL TESTING

A precise theoretical analysis of wealth redistribution due to incorrect expectations in the bond market has been presented in the foregoing chapters. Further work in this essay will be directed toward an examination of the empirical evidence relating to this topic.

This empirical work will follow two lines of approach. First, extensive testing will be conducted along the same lines used by de Alessi, Ando and Bach, Kessel, and Alchian and Kessel. This work will attempt to improve upon these studies by using more comprehensive data, more recent data, and somewhat different and hopefully more powerful testing methods.

The second method of approach assumes the adaptive expectations model outlined in Chapter III, and using this, together with the de Alessi model, tests for wealth redistribution from incorrect expectations.

The final model which de Alessi used as his regression equation, equation (2.10), is

$$(2.10)\quad \frac{P(t)}{P(0)} - \frac{I(t)}{I(0)} = a + b\left[\frac{I(t) - I(0)}{I(0)}\left(\frac{M'}{W'}\right)\right] + u(t)$$

This model includes one dependent variable and one independent variable. However, the independent variable is, itself, a multiple of two variables--$[\frac{I(t) - I(0)}{I(0)}]$, which is a time series variable, and $(\frac{M'}{W'})$, which is a cross-section variable.

De Alessi's model actually incorporates a pooled independent variable. The use of pooled data ordinarily is accompanied by special econometric problems which necessitate appropriately specialized techniques. However, de Alessi's tests cover only one period, so they are actually only cross-section studies. The rate of inflation $[\frac{I(t) - I(0)}{I(0)}]$ does not vary in each regression; only $(\frac{M'}{W'})$ varies. It is quite possible that de Alessi's time interval for stock prices changes, one year, was too short for the effects of inflation on wealth to appear in the data. An interval longer than one year may be a better one for testing purposes.

Ando and Bach, Alchian and Kessel, and Kessel all used longer periods, but avoided the pooled data problem by the simplification explained below.

The researcher is confronted with a three dimensional array of data. Time is represented by different periodic rates of inflation. Differences at any time in $(\frac{M'}{W'})$, which are the cross-section dimension, are scattered among various economic units. The remaining dimension is the dependent variable. Note in (2.10) that it is only when $\frac{I(t) - I(0)}{I(0)}$ is not equal to zero that the model

predicts any differences in changes in wealth caused by net debtor position. Excluding the use of pooled data, two approaches can be used in testing the model:
(a) Inflation can be held constant among all economic units while $\frac{M'}{W'}$ varies, or (b) $\frac{M'}{W'}$ can be held constant while inflation varies.

The latter could be done by picking economic units whose $\frac{M'}{W'}$ position remained relatively constant, and testing for different degrees of changes in wealth during various periods of varying price level changes. The former approach is the one used by the studies cited. It is also the one which will be used here. It seems to offer the more incisive testing method because it avoids some of the econometric problems of (b)--chiefly autocorrelation and other time series related problems--and it offers a stronger possibility of wider variation in the independent variable.

Once this method of testing is adopted, it is then necessary to select the time periods for which data is to be tested. A period of at least several years may be necessary before any wealth redistribution from the debtor-creditor hypothesis shows up in the data. This is due to the possibility of lags between changes in wealth and the time that the changes are recognized by the market, since market price data will be used in the study (see section on data used). The periods used here vary somewhat, but are all at least three year periods.

Which periods to use is the next problem. It is desirable to use not only periods of inflation, but also periods of at least relatively stable prices. This is due to the possibility of some excluded variable, highly correlated with net indebtedness, being a prime cause of changes in wealth. If the model were tested in periods of stable prices, and if we obtained results indicating net indebtedness significantly influencing changes in wealth, suspicion would be cast on the model.

TABLE 2.--Annual rate of inflation: 1949-1966.

Year	K_t*	Year	K_t
1949	1.00	1958	.79
1950	8.00	1959	1.58
1951	2.21	1960	1.07
1952	1.08	1961	1.15
1953	.43	1962	1.23
1954	- .32	1963	1.31
1955	1.50	1964	1.67
1956	3.48	1965	2.91
1957	2.76	1966	2.83

*K_t = annual rate of inflation (% increase in CPI).

The rates of inflation or deflation occurring in each year, 1949-66, are given in Table 2. These are percentage changes in the Consumer Price Index of the U.S. Bureau of Labor Statistics, $\frac{I(t+1) - I(t)}{I(t)}$.

The data seem to lend themselves most readily to classification into inflationary and non-inflationary three year periods. If we define as inflationary any three year period in which the rates of inflation in each year add to over 7.0%, then three non-overlapping periods fit this definition: 1955-57 (7.6%), 1949-51 (11%), and 1964-66 (7.3%). If we define as non-inflationary any three year period in which the rates of inflation in each year add to less than 3.5%, then two non-overlapping periods fit this definition: 1960-62 (3.3%) and 1952-54 (0.7%).

The population consisted of over 800 industrial companies for which data were available for the twenty year period extending from 1949 to 1969. All firms in the trucking, shipping, air transport and telephone industries were excluded due to the fact that they are regulated and this might bias the results.[1]

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[1]The bias is probably against accepting the hypothesis.

Suppose that regulated firms have relatively large amounts of debt in their capital structures. The debtor-creditor hypothesis predicts that shareholders of such firms may gain during periods of inflation, but the firm's need to appeal to a regulatory commission to adjust to inflationary conditions (i.e., to raise its rates) will slow the gains from inflation, in direct contradiction to

The actual source was the Standard and Poor's COMPUSTAT tape. This contains data which are found in Standard and Poor's annual corporation reports.

The population included large, small, and medium-sized firms, and firms in every major industry except the ones mentioned above.

Only firms for which data were available for every variable used in the test were included in each test. The number of firms used as a sample therefore varied somewhat from one period to another.

The selection of empirical data to which the model is fitted is as follows:

K_t, The Rate of Inflation

Three alternative overall indices confront the researcher: the Wholesale Price Index (BLS), the Consumer Price Index (BLS), and the Gross National Product price deflator (Office of Business Economics). Assuming that economic units attempt to maximize wealth for their owners--individual consumers--then nominal wealth is best deflated by a consumer price index to give an accurate measure of real wealth.

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the hypothesis. Alternatively, the rate increases might be granted in a post-inflationary period of stable prices. Since this represents a (lagged) optimizing adjustment, it will increase share prices without inflation being present, again in contradiction to the hypothesis.

In the subsequent studies involving individual industries, some consideration was given to using the Wholesale Price Index for the main commodity produced by the industry. Examination of these price indices indicated, however, that the periods of inflation and stable prices were almost identical, in most instances, to the periods defined by the use of the Consumer Price Index.

W, Wealth

The problem of finding a valid proxy for W is, in large part, the reason for restricting the scope of this study to one class of economic units, business corporations whose shares are publicly held and traded and about which data are readily available. Data on personal wealth in the U.S. are not sufficiently detailed for a study of this type, and the same reason prohibits the use of data for non-publicly held companies.

Shares or stock in business firms represent claims to wealth, whether that wealth be construed as book value or streams of income. It is reasonable to assume that these shares are bought and sold at a market price which, on the average, represents the public's assessment of the wealth of a firm to which the stock lays legal claim at the time of the exchange. The proportion of a firm's total wealth to which each share is a claim is inversely proportional to the number of shares outstanding.

Therefore, a measure of the total wealth of any firm at any time t can be gotten by multiplying the number of shares outstanding times the average share price in transactions occurring around time t, i.e., computing its market value.

Changes in wealth over any time period (represented in the model by W_{t+n}/W_t) may be measured by taking the ratio of firm wealth, as defined above, at time t+n to firm wealth at time t. This ratio may also be measured by taking the ratio of share prices, p, at various times, with these prices adjusted for changes in the number of shares outstanding. This ratio, that of p_{t+n}/p_t, was the one actually used.

M/W, Net Liability Position

Balance sheets published by firms include the information necessary to compute M. The formula for M is as follows:

M = current assets - inventories

less: current liabilities, long term debt, and preferred stock.

W is computed as previously indicated, but in order to rule out as much spurious correlation as possible, as well as to get a fair representation of liability position over a time interval, the average of yearly W's for the interval making up the sub-period and the average M for the sub-period were used. $[\frac{M'}{W'} = \frac{1}{n}(M_t/W_t + M_{t+1}/W_{t+1} + \ldots + M_{t+n}/W_{t+n})]$.

A difficulty involved in testing the de Alessi model can be easily recognized. It will be remembered from Chapter II that tests on the coefficient of expectations, B, were used to attempt to determine whether wealth redistribution had occurred or not. If no wealth redistribution was detected, it was assumed that expectations were correct, i.e., B was approximately equal to zero. The expected rate of inflation was approximately equal to the actual rate of inflation. If wealth redistribution was detected, it was assumed that expectations were incorrect. Various hypotheses can be tested using the de Alessi model. For example, the hypothesis that expectations were correct could be postulated. Testing could reveal whether or not the hypothesis was denied by the data. However, without a qualifying hypothesis of this kind, the de Alessi model itself cannot really be denied by the data. Testing only reveals something about whatever expectations hypothesis is used.

Wealth redistribution can, in theory, be detected by the de Alessi model. If the expectations coefficient, B, were significantly different from zero, this would constitute evidence supporting the existence of wealth redistribution. However, the interpretation of the results should the expectations coefficient be not significantly different from zero might pose a problem. The problem is basically does this result constitute a denial of the hypothesis that expectations were incorrect or does it constitute a denial of the validity of the de Alessi model itself? It is basically a question about the ability of the de Alessi model to detect wealth redistribution if it actually does exist.

In Section II of this chapter, an attempt will be made to remedy this problem by incorporating an expectations model in the de Alessi model. In this section, a derivation of the basic de Alessi model will be tested, postulating the null hypothesis that no wealth redistribution has occurred. The alternative hypothesis is that wealth redistribution has occurred during the three inflationary periods used.

The first test consisted of using linear regression techniques. The model tested was

$$\frac{P_{t+3}}{P_t} = a + B(\frac{M'}{W'}) + u.$$

This is derived from the de Alessi model [equation (2.10)] by holding the rate of inflation constant among all firms, as has been explained in this chapter. If wealth redistribution did occur, the expected sign of the coefficient of $(\frac{M'}{W'})$ would be negative.[2]

The results obtained were as follows:

Years: 1949-51 (inflationary) n = 348

$$\frac{P_{t+3}}{P_t} = 1.155 + - 0.151 \left(\frac{M'}{W'}\right)$$

St. errors of coefficients	(.032)	(.060)
Sig. levels of coefficients	<0.0005	.012

R^2 = .0179

Years: 1955-57 (inflationary) n = 415

$$\frac{P_{t+3}}{P_t} = .814 + .012 \left(\frac{M'}{W'}\right)$$

St. errors of coefficients	(.014	(.028)
Sig. levels of coefficients	<0.0005	.675

R^2 = .0004

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[2]It is instructive at this point to summarize the basic assumptions underlying least squares regressions. These are, as outlined in J. Johnston, Econometric Methods (New York: McGraw-Hill, 1963):

(a) The data are normally distributed with mean μ and variance σ^2.

(b) The error terms have an expected value of zero.

(c) The error terms have a constant variance.

(d) The error terms are independent of one another.

(e) The independent variable is non-stochastic.

Years: 1964-66 (inflationary) n = 870

$$\frac{P_{t+3}}{P_t} = .880 + .070 \left(\frac{M'}{W'}\right)$$

St. errors of coefficients (.012) (.022)

Sig. levels of coefficients <0.0005 .002

$$R^2 = .0111$$

Years: 1952-54 (non-inflationary) n = 381

$$\frac{P_{t+3}}{P_t} = 1.287 + -0.002 \left(\frac{M'}{W'}\right)$$

St. errors of coefficients (.025) (.038)

Sig. levels of coefficients <0.0005 0.91

$$R^2 = .010$$

Years: 1960-62 (non-inflationary) n = 701

$$\frac{P_{t+3}}{P_t} = .826 + .015 \left(\frac{M'}{W'}\right)$$

St. errors of coefficients (.027) (.057)

Sig. levels of coefficients <0.0005 .78

$$R^2 = .0001$$

The results do not disprove the null hypothesis that no wealth redistribution results from the debtor-creditor hypothesis. In only one of the three inflationary periods was the coefficient of $\frac{M'}{W'}$ significantly less than zero, at the 5% level of significance.

The second test is an attempt to utilize a more selective sample to increase the power of the test. Predictive differences in wealth changes between debtor and creditor firms will be larger if only firms having relatively large debtor or creditor positions with respect to firm wealth are used as the sample.

The sample was drawn from firms having $\frac{M'}{W'}$ values greater than .4 or less than -.4. Net monetary position was over 40% of firm wealth for each firm. Those having $\frac{M'}{W'}$ values greater than .4 were classified as net creditors, and those having $\frac{M'}{W'}$ values less than -.4 were classified as net debtors.

The testing periods used were 1949-51, 1955-57, and 1964-66, three inflationary periods.

The testing method used was the Wilcoxon two-sample test. Observations on the dependent variable were ranked; the highest P_{t+3}/P_t was given rank one. The sum of the ranks of net creditor firms and the sum of the ranks of net debtor firms were then computed. If wealth redistribution had occurred, the sum of the ranks of net creditor firms should be relatively high and the sum of the ranks of net debtor firms should be relatively low. The Wilcoxon test actually gives the significance level at which the null hypothesis that the observed sum of the ranks is not different from the expected sum of the ranks can be denied (the expected sum if the ranks were randomly distributed with respect to firm classification).

This test has the advantage of being non-parametric; the assumption that the data are normally distributed does not have to be made. It performs very well as compared to the Student's t test (which does assume normality) for efficiency.[3]

The results are as follows:

(a) Years: 1949-51. The rank sum of net debtor firms was significantly less than the expected rank sum at the .091 level of significance. n = 14.

(b) Years: 1955-57. The rank sum of net debtor firms was significantly less than the expected rank sum at the .436 level of significance. n = 16.

(c) Years: 1964-66. The rank sum of net debtor firms was significantly less than the expected rank sum at the .184 level of significance. n = 16.

In no case was the test statistic obtained significant at the 5% level or less. There was no evidence denying the null hypothesis of no wealth redistribution occurring from the debtor-creditor relationship.

The third testing method also is an attempt to increase the power of the test. The model to which the data were fitted in the first test is

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[3]M. G. Kendall and A. Stuart, The Advanced Theory of Statistics (New York: Hafner Publishing Co., 1961), Vol. II, p. 498.

$$\frac{P_{t+3}}{P_t} = a + B\left(\frac{M'}{W'}\right) + u$$

This is a derivation of the theoretical model

$$\frac{W(t)}{W(0)} = r[W(t)] + B\left(\frac{M'}{W'}\right) + u(t)$$

The constant term, a, actually is a proxy for r[W(t)], income derived from all other sources other than wealth redistribution in the bond market. This is assumed constant between economic units and replaced by a, the constant term.

In reality, this term is, of course, not constant, but is likely to vary greatly between firms. This variation can be attributed to two main factors. The first is differences in performance (wealth increases) between firms in different industries, and the second is differences in performance among firms in each respective industry. An attempt was made to remove the former source of variation by using samples of firms in only one industry and testing for evidence of wealth redistribution.

The industries chosen were the electrical equipment industry and the publishing industry. (SIC classifications 36 and 27). The prime reason was data availability. The sample included a relatively even distribution between large and small firms.

The periods used for testing were 1949-51, 1955-57, and 1965-67, inflationary periods.

The testing method used was rank correlation. This test is also non-parametric; the significance levels of the test are not postulated on the assumption that the data are normally distributed.

The result predicted by the debtor-creditor hypothesis of wealth redistribution would be a positive correlation between the ranks of P_{t+3}/P_t and the ranks of $\frac{M'}{W'}$. (Greatest net debtor given rank one.)

The results obtained were as follows:

Years: 1949-51

industry: electrical equipment

rank correlation coefficient: .0572

sig. level of coefficient: .42

$n = 15$

industry: publishing

rank correlation coefficient: .8608

sig. level of coefficient: <.005

$n = 15$

Years: 1955-57

industry: electrical equipment

rank correlation coefficient: -.2178

sig. level of coefficient: .23

$n = 15$

industry: publishing

rank correlation coefficient: .0179

sig. level of coefficient: .47

n = 15

Years: 1965-67

industry: electrical equipment

rank correlation coefficient: -.0937

sig. level of coefficient: .39

n = 15

industry: publishing

rank correlation coefficient: -.0821

sig. level of coefficient: .39

n = 15

In only one case, the publishing industry, years 1949-51, were the results inconsistent with the null hypothesis, that no wealth redistribution occurred, at a level of significance less than .10. In three out of a possible six cases, a negative coefficient was obtained, the opposite of the expected sign of the coefficient if wealth redistribution had occurred.

To summarize the results of this section, almost no evidence was found of wealth redistribution from the debtor-creditor hypothesis. This means that either it does not exist or none of the testing procedures used were capable of picking it up from the data. In the next section, another approach to testing this hypothesis will be attempted.

(II)

In this section a major shortcoming of the model used in section (I) will be dealt with. This shortcoming has already been discussed in the preceding section of this chapter. It is the lack of any value being assigned to K_t^e, the expected rate of inflation. Since wealth redistribution is due to differences between K_t^e and K_t, the model really does not predict even qualitative values of the regression coefficient. These predictions can only be made by assuming a sign of B. This can be done, for example, by postulating that B is between zero and minus one. This is equivalent to assuming that expectations are incorrect and wealth redistribution occurs. This hypothesis could, indeed, be tested, but without a qualifying assumption of this kind, the model really cannot be denied by empirical testing. What is needed to give the model predictive power is a theory of expectations.

Such a theory has been outlined in Chapter III. By using the adaptive expectations model to assign values to K_t^e in the wealth redistribution model, predicted changes in wealth are given. These predicted changes can then be tested against actual changes, observed from empirical data. The remainder of this section is concerned with these tests.

One step remains in order to prepare the adaptive expectations-wealth redistribution model for testing. This is to assign a value (or values) to α, the adaptive coefficient, in the adaptive expectations model, which is

$$\Delta K_t^e = \alpha(K_t - K_t^e)$$

It seems most appropriate to assign a relatively high value to α. This is because, in a highly complex economy such as the U.S. economy, information about endogenous variables and exogenous policy actions, which determine the rate of price change, is readily available. People would base their expectations mainly on the immediate past. From Table 1 in Chapter III,[4] it can be seen that values of α of 1/2 and 3/4 are appropriate choices. These two values of α will be used in this study.

Table 3 gives the actual rate of inflation in each year and the expected rate, using the adaptive expectations model with α equal to 1/2 and 3/4, respectively. The period covered is 1949-1967.

From these data, the $(K_t - K_t^e)$ values predicted by the model can be obtained. These differences are given in Table 4.

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[4]See p. 65.

TABLE 3.--Actual and expected rates of inflation: 1949-67.

Year	K_t	α=1/2 K_t^e	α=3/4 K_t^e
1949	1.00	4.16	1.43
1950	8.00	1.71	.95
1951	2.21	4.06	6.14
1952	1.08	3.29	3.23
1953	.43	2.61	1.63
1954	- .32	.90	.64
1955	1.50	.15	- .10
1956	3.48	.75	1.12
1957	2.76	2.05	2.85
1958	.79	2.54	2.81
1959	1.58	1.75	1.29
1960	1.07	1.51	1.47
1961	1.15	1.08	1.14
1962	1.23	1.14	1.14
1963	1.31	1.11	1.19
1964	1.67	1.19	1.27
1965	2.91	1.41	1.56
1966	2.83	2.12	2.57
1967	3.96	2.46	2.76

TABLE 4.--Predicted values of $(K_t - K_t^e)$: 1949-67.

Year	α=1/2	α=3/4
	$K_t - K_t^e$	$K_t - K_t^e$
1949	-3.16	- .43
1950	6.29	7.05
1951	-1.85	-3.93
1952	-2.21	-2.15
1953	-2.18	-1.20
1954	-1.22	- .96
1955	1.35	1.60
1956	2.73	2.36
1957	2.01	- .09
1958	-1.75	-2.02
1959	- .18	.29
1960	- .44	- .40
1961	.07	.01
1962	.09	.09
1963	.20	.12
1964	.48	.30
1965	1.50	1.35
1966	.71	1.26
1967	1.50	1.20

We want periods of large values of $(K_t - K_t^e)$--when wealth redistribution is predicted by the model. As a check, we would also like periods when the values of $(K_t - K_t^e)$ are small--when little or no wealth redistribution is predicted.

The four year period, 1951-54, fits the former requirement. The sums of the values of $(K_t - K_t^e)$ for these years are -7.48, for $\alpha = 1/2$, and -8.24, for $\alpha = 3/4$.

The four year period, 1959-62, fits the latter requirement. The sums of the values for this period are -.46, for $\alpha = 1/2$; and -.01, for $\alpha = 3/4$.

The model we are testing is, for regression purposes, the same as in section (I) of this chapter. However, now the theoretical model gives us the predicted sign of the coefficient of $(\frac{M'}{W'})$ without any qualifying hypotheses.

The model predicts wealth redistribution from debtors to creditors for the period 1951-1954, since overestimation of the rate of inflation is predicted. The model predicts virtually no wealth redistribution for the period 1959-1962, since expectations should have been correct.

Testing methods were the same as those employed in section (I): linear regression, the Wilcoxon test, and rank correlation.

The first test was linear regression. The model to which the data were fitted was

$$\frac{P_{t+4}}{P_t} = a + B(\frac{M'}{W'}) + u$$

The expected sign of B would be positive.

The results obtained were as follows:

<u>Years: 1951-54</u> $n = 398$

Regression coefficients	$\frac{P_{t+4}}{P_t} =$ 1.3048	+	.039 $(\frac{M'}{W'})$
St. errors of coefficients	(.032)		(.054)
Sig. level of coefficients	<0.0005		.479
	$R^2 =$ .0013		

<u>Years: 1959-62</u> $n = 469$

Regression coefficients	$\frac{P_{t+4}}{P_t} =$ .885	+	.174 $(\frac{M'}{W'})$
St. errors of coefficients	(.039)		(.102)
Sig. levels of coefficients	<0.0005		.085
	$R^2 =$ .0062		

The second testing method was the Wilcoxon two sample test, with the samples being net debtor firms and net creditor firms with $\frac{M'}{W'}$ ratios less than -.4 or greater than .4, respectively. The testing period was 1951-54, and the predicted test statistic--the rank sum of net creditor firms--would be small (the dependent variable observations are ranked from highest to lowest, the largest observation being assigned rank one).

The results obtained were as follows:

Years: 1951-54. The rank sum of net creditor firms was greater than the expected rank sum at the .36 level of significance. n = 12.

The observed sign of relative changes in wealth between debtor and creditor firms was that predicted by the model, but the significance level of the test statistic was too high to permit rejection of the null hypothesis.

The third testing method was rank correlation. The sample consisted of firms in the electrical equipment and publishing industries. The rationale for this method and sample is the same as that given in section (I). This time, however, since the model predicts wealth redistribution from debtors to creditors, we would expect a negative correlation coefficient if the data do not deny the model.

The coefficients obtained and significance levels are as follows:

Years: 1951-54

industry: electrical equipment

rank correlation coefficient: .2929

sig. level of coefficient: .15

n = 15

industry: publishing

rank correlation coefficient: -.2428

sig. level of coefficient: .17

n = 15

In one out of two possible cases, a sign of the coefficient was obtained which was the opposite of that predicted. In neither case was the significance level of the coefficient less than .10.

These results do not support the predictive accuracy of the adaptive expectations-wealth redistribution model. Although the sign of the coefficient in the period 1951-1954 was that predicted, the significance level of the coefficient was extremely high. In addition, the model predicted a value of the coefficient not significantly different from zero, for the period 1959-1962. The coefficient observed was, in fact, significantly different from zero at the .085 level of significance.

To summarize the results of the empirical work in this section, the adaptive expectations model did not appear to be a good predictor of the periods in which significant wealth redistribution could be found.

CHAPTER V

CONCLUSIONS

In Chapter I, the importance of securing information on the relative gains and losses to society from various policy actions was emphasized. It is the purpose of this work to provide such information on one aspect of this tradeoff, wealth redistribution due to inflation. This work concludes with this information.

The presence of any significant wealth redistribution from inflation in the bond market during the recent past has not been detected. In this respect, this study supports that of Ando and Bach. It does not support the studies of de Alessi, Kessel, and Alchian and Kessel. In the case of de Alessi, data from different countries could be the factor making for this divergence of results. In the cases of Kessel and Alchian and Kessel, different time periods and/or length of time periods could be the factor.

Several approaches to testing, various particular statistical tests, and various data samples have been used in this study. In only a very few cases was there any evidence at all indicating the presence of significant wealth redistribution. The overall conclusion that no significant wealth redistribution has occurred is backed by a preponderance of the evidence obtained here.

This work has embarked upon a new approach to the analysis of wealth redistribution. This approach incorporates some theory of expectations and attempts to give predictive power to a theory of wealth redistribution from inflation. It is hoped that further work, using expectations models in this context, will result in a model of wealth redistribution with better predictive ability.

The major limitations of the model and of the empirical work used in this study should be noted. Any and all of these limitations could be the cause of the failure of this study to detect significant wealth redistribution if, in fact, it actually is a significant phenomenon.

(1) The rates of price level change may not have been great enough for wealth redistribution to show up in the testing.

(2) The data may have been too limited. It is quite reasonable to assume that large corporations, which furnished the data for this study, are not affected by wealth redistribution in the bond market as much as other segments of the economy. Because of superior entrepreneurship, these corporations may be better at anticipating price level changes than individuals, smaller businesses, and local, state, and even the Federal government. If this

is true, then even if this study has detected no significant wealth redistribution, it actually is significant in the economy as a whole.

(3) The wealth redistribution model itself may be inadequate. It may be necessary to use a complete multivariate model of changes in wealth. This would be a very large undertaking.

It seems clear that further research is needed in the area of wealth redistribution occurring from price level changes, especially since inflation is at present of great concern to U.S. society. If the object of this further research is to be the development of models of predictive accuracy, then further experimenting with wealth redistribution models, and various expectations models would seem to be called for. This type of research would constitute a valuable addition to the body of knowledge about inflation. This body of knowledge should be of vital importance to policymakers, but at the present time is of woefully small magnitude.

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