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INFLATION AND INTEREST:
THE FISHER THEOREM REVISITED *)

by

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CONTENTS

"... the rate of interest is always relative to the standard in which it is expressed" (Irving Fisher 1930).

Introduction

Towards the end of the nineteenth century, Irving Fisher undertook a theoretical and empirical examination of the general relationship between interest rates, expressed in different standards, and expectations of changes in the value of these standards. He formulated specifically the hypothesis of an immediate, direct and full adjustment of nominal interest rates on financial assets to expected changes in the purchasing power of money. This hypothesis implied constant real interest rates that were not influenced by inflationary expectations.

In the period since the end of the Second World War, the Fisher theorem has been "rediscovered". The renewed interest has been due in particular to the modern debate on monetarism and the similar "rediscovery" of the quantity theory of money, and to the phenomenon of persistent inflation in Western industrialized countries. The relationship between "Appreciation and Interest" (the title of Fisher's pioneering work in 1896) has become a central element of modern monetary theory in the form of long-term "neutrality" of money and inflation in relation to real variables (such as output and employment); this "neutrality" implies constant real interest rates.

The Fisher theorem has thus been incorporated into major areas of modern economic theory as applied to the inflation phenomenon. It is used in analyzing individual financial markets in a national and international context; it is part of microeconomic, intertemporal price theory and part of the macroeconomic theory of investment and fluctuations in the business cycle; and it quite generally underlies the practical and economic policy calculation of real interest for individual markets or economies, using real variables adjusted for price changes.

Yet the way in which the Fisher theorem (or Fisher equation) has hitherto been received reveals some confusion and analytical shortcomings. The restrictions applying to the original, complete Fisher theorem are given scant attention in the literature; the expectation formation hypothesis ascribed to Fisher is a scarcely tenable assumption; the two-way link between interest and inflation, which Fisher emphasized from the outset, is consistently ignored. This "list of sins" could be extended, as this paper will show.

Any critical review of past theoretical and practical interpretations of the Fisher theorem must start from an historical-analytical examination of Fisher's original writings. Chapter 1 therefore describes the original theorem and gives an outline of Fisher's concept of interest (Annex to Chapter 1). Chapter 2 traces Fisher's three-stage, empirical procedure and summarizes his findings. A crucial point here is that leaving aside basic methodological and empirical questions, Fisher's factual evidence quite clearly falsifies his original theorem. The conclusions which Fisher drew from his factual evidence are examined in Chapter 3; they relate to Fisher's explanations of the Gibson paradox and of the long time lags he had detected, to his statements on the reversed causality between interest and inflation and interest rate policy.

1. Fisher's original theorem

1.1 Starting point and focus

The starting point of Fisher's investigations into the subject of "interest and inflation" was the bimetallism controversy, i.e. the monetary policy argument in the last quarter of the ninetinth century over how international reserve assets should be defined[(1)]. Because of the appreciation of gold, which meant a fall in prices, the bimetallists claimed that debtors had been robbed, since, on the gold standard, the rising purchasing power of gold was tantamount to discrimination against debtors of contractually fixed amounts of money (gold) payable in the future. Fisher attempted to settle the controversy which arose with the monometallists (the advocates of a pure gold standard as opposed to a gold and silver standard) by pointing out in his monograph "Appreciation and Interest" (1896) that the essential element in a loan contract was not (as the bimetallists asserted) the scaling of the (principal) sum owed (for example in the standards gold or silver), but the interest rate agreed between debtor and creditor. For, so Fisher argued, an expected appreciation of gold would change the interest rate reckoned in that standard such that only the nominal amounts of money, but not the quantities of goods represented by the amounts of money would be affected[(2)], given certain ideal assumptions (see next section).

The idea of (market) interest rates adjusting to expected changes in the value of the relevant standard (unit of account) was developed by Fisher from suggestions put forward earlier by J.S. Mill, de Haas and Clark[(3)]. This basic idea is also evident in Fisher's agio concept of interest, whereby the interest rate is seen as the percentage premium on present goods when exchanged for future goods of the same kind and number[(4)]. However,

(1) For an early survey of the main points of the controversy, see Jevons (1884), Wicksell (1922) or Rist (1940).

(2) "To alter the mode of measurement does not alter the actual quantities involved but merely the numbers by which they are represented", Fisher (1896), p. 1.

(3) J.S. Mill (1848), pp. 644-649 ("The rate of interest, how far and in what sense connected with the value of money"), de Haas (1889), Clark (1895).

(4) For further details see Annex to this Chapter.

the nature of the goods (like the timespan between present and future) influences this percentage premium. Consequently, interest rates in different standards (for different types of goods) differ basically from one another.

On the basis of this idea, Fisher saw his first task in formulating in exact theoretical terms the relationship between those inherently different interest rates and expected changes in the value of the various standards. He concentrated on the relationship between two particularly interesting "typical" interest rates, namely a nominal interest rate in the monetary standard (unit of account "money") and a "real" interest rate in commodity standard (unit of account "goods", based on a specified basket of commodities). It is above all this relationship between nominal and real interest rates which was then investigated empirically by Fisher and applied to economic policy issues.

1.2 Assumptions and definitions

Fisher's theory on the relationship between interest and inflation is based on a number of highly simplified assumptions about expectations, market behaviour and the way in which financial markets operate. These assumptions sketch an idealized world in which there are no risks or uncertainties.

Assumption 1: On all financial markets, expectations are formed in respect of the future relationship between the value of money and the value of goods. A change in the future value relationship between money and goods is uniformly expected by all market participants: they anticipate a specific rate of price change p^* (e.g. a specific inflation rate).

Assumption 2: The future rate of price change p^* (the asterisk denotes an expectation variable) is anticipated with "perfect foresight": market participants are never mistaken in their price expectations. Since they all possess perfect foresight, they also form the same inflationary expectations.

Assumption 3: Financial markets are characterized by perfect transparency and the absence of any risk considerations or transaction costs. There is, for example, certainty as to payment and repayment of loans and monetary assets at pre-determined points in time. All market interest rates are therefore "pure" interest rates in the sense that they contain neither a risk premium nor a transaction cost component.

Assumptions 1 and 2 show that Fisher's theory relates to expected changes in the price level and hence to expected real interest rates. The way in which expectations are formed and the foresight associated with these expectations are, therefore, a main focus of theoretical and empirical attention. If, like Fisher, one assumes perfect foresight, expectations can never be wrong: there are no unexpected rates of price change, because the actual rate of price change is always predicted correctly. Consequently,

$$p^* = p.$$

Obviously, the assumption of perfect foresight, implying $p^* = p$, means considerable abstraction from economic reality, one main feature of which is, after all, uncertain price expectations. On the lines of Fisher's work on the quantity theory of money [(5)], perfect foresight corresponds to the situation of long-term market equilibrium; this contrasts with disequilibrium transition periods where there are imperfect or uncertain expectations (see Chapter 3 below).

Fisher's theory on "interest and inflation" embraces positive and negative expected rates of change in the price level, i.e. inflationary and deflationary expectations. The following definitions and terms are tailored to the existence of inflationary expectations in the sense of an expected rise in the value of goods relative to the value of money. The units of goods in a particular shopping basket (e.g. the basket for all private households) are measured using the price index P:P indicates the value of the shopping basket in units of money (the "price level"). The expected price index (for example one year hence) is written as P^*_1, and the present price index as P_0. The expected relative (percentage) change in the price index in the coming year, i.e. expected inflation rate p^*, is accordingly

(5) Fisher (1922).

defined as

$$p^* = (P^*_1/P_0) - 1 \ ^{(6)}.$$

The symbol p^* thus denotes the expected change in value, measured in units of money, of the goods in a particular shopping basket. Where there are inflationary expectations ($p^* > 0$), the value of the goods rises relative to the value of money, and vice versa where there are deflationary expectations ($p^* < 0$).

The situation $p^* > 0$ can also be expressed using the "purchasing power of money" concept, which is inverse to the price index or price level: if there are inflationary expectations, it is anticipated that money will lose value relative to goods, so that a decline in the purchasing power of money is expected. This loss in the value of money, or expected rate of change in the purchasing power of money π^*, is measured in units of goods[7].

Fisher's theory could therefore be formulated both in terms of the expected relative change in the value of goods in units of money p^* and in terms of the expected relative change in the value of money in units of goods π^*. The first formulation is opted for below, the rate of change of the price index in units of money being easier to capture statistically. The expected inflation rate p^* is written in decimal notation (e.g. $p^* = 0.04$ to denote an expected inflation rate of 4 %).

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(6) Or $p^* = (P^*_1 - P_0) / P_0$, or $p^* = P^*_1/P_0$.

(7) Generally, $(1 + p^*) (1 - \pi^*) = 1$, i.e. the relative appreciation of goods and the relative depreciation of money counterbalance one another. Thus, $\pi^* = 1 - (1 / (1 + p^*)) = p^* / (1 + p^*)$.

The actual nominal interest rate, i.e. the interest rate measured in units of money, which prevails or is agreed today and is to remain unchanged (for one year) is referred to as i; it is also, synonymously, called the market interest rate or money interest rate. Nominal interest rates are agreed between creditors and debtors on financial markets, particularly on the money market, the credit market and the securities market(8). The agreements relate to the future contract period, for example to the agreed duration of a loan contract. The nominal interest rate as quoted on the financial markets is consequently an ex ante interest rate. Such an ex ante interest rate is, as it were, forward-looking: it has a time horizon set in the future. Nevertheless, it is not denoted below as an expectation variable (by an *), since it represents a contractually agreed variable fixed in the present. The expected nominal interest rate i^*, by contrast, is a variable whose contractual determination will take place only in the future(9). "Expectation" is used here not as a contractual, but as a psychological notion, defined as "..... attitudes, dispositions, or states of mind which determine our behaviour, or at least accompany it"(10).

Accordingly, the (ex ante)real interest rate is an expected magnitude, i.e. a variable that can be established only through future expected rates of change in the price level. This ex ante expected real interest rate may be expressed as r^*. For the purposes of Fisher's theorem, r^* must be seen as the "true" or "real" interest rate, i.e. the interest rate adjusted for price changes (measured in terms of the units of goods in a particular shopping basket) which is at present expected with perfect foresight (but not expressly agreed) for the coming year. Because of the congruence in time

(8) For a definition of the general insitutional arrangements, see for example Deutsche Bundesbank (1980), Chapter I, and, specifically on the money market, Gebauer (1981).

(9) Cf., for example, "forward rates" in the expectation theory of Hicks (1946) and Lutz (1940) concerning the term structure of interest rates.

(10) Ozga (1965), p. 23.

between expected inflation and the (implied) ex ante time horizon of the interest rate, the terms "ex ante" and "expected" can be used synonymously here. Given perfect foresight, the expected interest rate r* is, because of the implication p* = p, always the same as the real interest rate r actually observed; i.e.

$$r^* = r.$$

Accordingly, the distinction, in terminology and symbols, between expected and observed inflation rates and real interest rates would seem to be superfluous. However, it is emphasized here from the outset, since it is of prime importance later in the interpretation of Fisher's factual evidence and in the reformulation of his original theorem.

1.3 Derivation

In deriving the theorem, let us assume, according to Fisher[11], a time horizon of one year with given nominal interest rates and perfect inflationary expectations. Now let us suppose that a certain sum of money D (currency units) and the quantity of goods W (units of goods) are lent today for one year. In one year's time, the repayment of D (1 + i) Dollars will be due on the sum of money D lent today; at the same time, the repayment of W (1 + r*) units of goods will be due on the quantity of goods lent today. The symbols i and r* stand for the nominal and real interest rates defined above. When the loan contract is concluded, the sum of money D is worth just as much as (equivalent to) the quantity of goods W, i.e. "today"

$$W \hat{=} D.$$

To derive the theorem, we have to consider explicitly an interest rate aspect and an inflation aspect of the one-period loan.

Interest rate aspect

To maintain equivalence between the sum of money D and the quanti-

(11) Fisher (1896), Chapter II.

ty of goods W after one period, the relative increase in quantities due to interest rate payments must be the same, i.e.

(0.1) $$D\ (1 + i) \mathrel{\hat{=}} W\ (1 + r^*).$$

Inflation aspect

In the course of the year, the quantity of goods W is certain to rise in value relative to money, i.e. by the inflation rate p* of goods W in terms of money. After one year, therefore, a sum of money increased by the inflation rate, i.e. $D\ (1 + p^*)$, is necessary in order to be able to buy the same quantity of goods as initially, namely

(0.2) $$W \mathrel{\hat{=}} D\ (1 + p^*)$$

or extended, for better comparison with (0.1), by (1 + r), we obtain

(0.3) $$W\ (1 + r^*) \mathrel{\hat{=}} D\ (1 + p^*)\ (1 + r^*).$$

The left-hand side represents the quantity of goods and the right-hand side the sum of money which, with a given inflationary expectation, is necessary to redeem the debt after precisely one year. This sum of money was already identified above as $D\ (1 + i)$.

Corollary

Hence, if we look for the relationship between i and r* which assures equivalence between money D and goods W, we can directly derive, by comparing (0.1) and (0.3), the equation

$$D\ (1 + p^*)\ (1 + r^*) = D\ (1 + i).$$

After reduction by D, Fisher's original and complete theorem is obtained:

(1.1) $$\boxed{(1 + i) = (1 + r^*)\ (1 + p^*) \quad \Big| \quad p^* = p.}$$

Transforming (1.1) gives directly the original, complete nominal interest theorem (1.2) and the original, complete real interest theorem (1.3):

(1.2)	$i = r^* + p^* + r^*p^*$	$p^* = p$	(nominal interest theorem)
(1.3)	$r^* = (i - p^*)/(1 + p^*)$	$p^* = p$	(real interest theorem)

In accordance with (1.2), the nominal interest rate i is determined by the ex ante expected real interest rate r^*, by the inflation rate p^* expected with perfect foresight and by the product of these two variables r^*p^*, which is to be interpreted as the expected change in the money value of interest payments (interest credited). The expected real interest rate r^* is determined, in accordance with (1.3), by the difference between nominal interest rate i and perfect, certain inflationary expectations p^*, adjusted by the inflation expectation factor $(1 + p^*)$.

1.4 Results and implications

1.4.1 Time, scope and basic findings

The theorem (1.1) is derived for a single period in which neither interest rates nor inflationary expectations change[12]. It contains no explicit indication of time and is accordingly static in character. Nor does the Fisher theorem differentiate expressly between different time horizons (short and long term). However, it is long-term in nature to the extent that, because of the assumption of perfect foresight, it relies on a state of equilibrium, attainable in the long run, from a purely theoretical angle (see above). In such a situation of equilibrium, expected and observed variables coincide. As explicitly noted, it follows for all the expressions (1.1) to (1.3), because of the assumption of perfect foresight, that there is equality of expected and actual inflation rates ($p^* = p$). From this again, it follows that there is equality of real interest rates observed ex post and real interest rates expected ex ante, i.e. $r^* = r$.

The expression (1.1) also gives no indication of any restriction to apply it, for example, to a closed economy or, within a national economy, to a specific financial market (in the literature, reference is usually made to the market for long-term bonds). In point of fact, the theorem (1.1) is also applicable to (international) exchange markets[13].

All the expressions (1.1) to (1.3) formulate, on the basis of the underlying assumptions, the "law" of translating an interest rate from one standard into another. In other words, they represent a formalization of Fisher's key sentence: "The rate of interest is always relative to the standard in which it is expressed[14]. None of

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(12) For a detailed analysis of the time aspect, see Annex below.

(13) See Fisher's explanation on his facts (Chapter 2) and its modern extention to an open economy. At Fisher's original assumptions (see above), the "Fisher-open" theorem is identical with the Keynesian theorem of interest rate parity in arbitrage equilibrium. For an exposition, see Gebauer (1982), p. 81-87.

(14) Fisher (1930), p. 41.

the expressions (1.1) to (1.3) in itself determines an interest rate in any standard, whether a nominal interest rate or a real interest rate: "These rates are mutually connected, and our task has been merely to state the law of that connection. We have not attempted the bolder task of explaining the rates themselves"[15]. For, as the derivation showed, the above formulae are consistently based on the assumption that the interest rate is already known in one standard. Thus, for example, the nominal interest rate in (1.2) can be determined only if the level of the real interest rate (together with the level of inflationary expectations) is known a priori (for numerical examples, see figure 1.1 below).

1.4.2 Equation versus identity

Under the basic assumptions postulated, the above formulations of the theorem are identities: they have the character of conditional equations which formulate the "law" of the connection between three variables - nominal interest rate, inflation rate and real interest rate. This fact has been of major importance in the practical application of the theorem, particularly the real interest theorem (1.3). Since the real interest rate is not directly observed statistically, the definition (1.3) provides the means of translating observed nominal interest rates into ex post real interest rates.

Nevertheless, the expressions (1.1) to (1.3) are not written as identities, but as equations. This is not an oversight, but is intentional, for Fisher's theorem would not be properly understood if it were characterized as a definitional relation. Together with the assumption of perfect foresight, a certain type of behavior is postulated: in a situation of equilibrium (with given ideal market conditions), market participants always adjust nominal interest rates perfectly to inflationary expectations (which are always correct). This behavior linked to the expectation hypothesis, robs the theory of the quality of a true identity: it can be falsified if the expectation hypothesis, and hence the theoretically postulated adjustment of nominal interest rates to inflationary expectations should prove to be inconsistent with the facts. This question of the theoretical and actual adjustment of nominal interest rates is

(15) Fisher (1896), p. 92.

central to the literature which followed on from Fisher's work. This is also why references to the "Fisher relation" are usually references to the nominal interest theorem in the form of equation (1.2). In accordance with the double nature of the theorem, all the formulae (1.1) to (1.3) can be regarded both as definitions and as (empirically sound) behavioral equations; all possess the abovementioned ambiguity.

1.4.3 Restrictions and simplifications

For the nominal interest rate i in (1.1) to (1.3), we have the restriction

$$i \geqslant 0.$$

The interest rate in a money which can be hoarded (in the future) without risk (which does not "spoil") cannot fall below zero: otherwise it would be preferable to hoard money than to lend it ex ante, that is to say consciously, at a loss. Expressed in interest theory terms, time preference for the present and the possibility of productive resource allocation generate a positive interest rate ex ante, given a constant or rising price level.-There is another, and more important, restriction on the nominal interest rate, which has direct consequences for the real interest rate. As perfect foresight is assumed, the interest rate on money will never be smaller than any expected reduction in the purchasing power of money. That is, the rate of interest i is restricted to be equal to or larger than the expected inflation rate,

$$i \geqslant p^*.$$

In Fisher's terminology: The depreciation of money relative to goods cannot be greater than the interest rate expressed in the standard "money".[16]

From the two restrictions it follows, according to the theorem, that the real interest rate is non-negative:

$$r^* \geqslant 0.$$

In summary: With perfect foresight, time preference (for the present) and possibilities of productive allocation of resources, market participants will not permit a negative expected real interest rate.[17]

The complete theorem (1.1) implies an indication of the spread between real and nominal interest rates. Where there are inflationary expectations, the real interest rate - cf. (1.3) - must obviously differ from the nominal interest rate by somewhat more than these expectations. In other words, the nominal interest rate - cf. (1.2) - must exceed the expected real interest rate by more than the expected inflation rate. This implies

$$i - r^* > p^* \quad \text{and} \quad i > r^* + p^*.$$

Let us take a numerical example. Given a nominal interest rate of $i = 0.10$ (10%) and inflationary expectations of $p^* = 0.05$ (5%), we have, in accordance with (1.3), an expected real interest rate of $r^* = 0.045$ (4.5%). This figure is obviously different from the 5%

(16) Fisher (1896), p. 30.

(17) Time preference for the present and the productive allocation of resources are basic determinants of interest rates in the modern theory of interest, which essentially goes back to Böhm - Bawerk (1888) and Fisher (1930). These determinants are not sufficient as a condition for non-negative interest rates if the generation aspect and institutional factors are explicitly taken into account; see Samuelson (1958).

produced by the popular,[18] simplified formula "real interest equals nominal interest minus inflation rate". The difference between the nominal interest rate and the expected real interest rate (5.5%) is greater than inflationary expectations (5%); and the sum of the expected real interest rate and inflationary expectations (9.5%) is smaller than the nominal interest rate (10%).[19]

In formal terms, the simplified nominal interest theorem is:

(1.2')

$i = r^* + p^*$	$p^* = p,$

and accordingly the simplified real interest theorem is:

(1.3')

$r^* = i - p^*$	$p^* = p.$

(18) The simplified formula has gained widespread currency not only in practical economic policy, but also in modern academic writing. See, for example, the textbook by Dornbusch and Fisher (1981), Chapters 6 and 13. Exceptions are Richter, Schlieper, Friedman (1978), p. 136.

(19) Where the values of i and p* are high, the difference between the complete and simplified theorems is very obvious: if, in the above example, the decimal point is moved one figure to the right (inflation rate 50%, nominal interest rate 100% - admittedly a very hypothetical situation), the correct value of the expected real interest rate applying (1.3) is 33% and not 50%.

Both formulations can be regarded as correct only if continuous compound interest is assumed: in that case, the phenomenon which constitutes the difference between (1.2) and (1.2') does not occur.[20] The longer the time intervals at which interest is credited, and the higher the expected inflation rate, the clearer is the numerical discrepancy between the complete and simplified versions of the theorem, i.e. the more the spread between the nominal and real interest rates will differ from the value of inflationary expectations.

As already noted, the use of the simplified formulae (1.2') and (1.3') has become established in the literature. Only occasionally is reference made to the necessary assumption of continuous compound interest.[21] However, even then no mention is made of the fact that continu-

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(20) The correctness of (1.2') and (1.3') in the event of continuous compound interest is easy to demonstrate in formal terms. If the annual rate of interest is i, 1 dollar will grow to 1 + i dollars over one year. If interest is credited quarterly, 1 dollar will have grown to $(1 + (i/4))^4$ dollars by the end of the year, and at any other interest payment interval z to $(1 + (i/z))^z$ dollars by the end of the year. If interest crediting is continuous, occurring every second as it were, z will tend towards infinity; therefore:

$$\lim_{z \to \infty} (1 + (i/z))^z = \lim_{z' \to \infty} ((1 + i/z'))^{z'})^i, \quad z' = z/i.$$

Now, $(1 + i/z'))^{z'}$, with $z' \to \infty$, is equal to the natural number e. One dollar therefore grows to e^i dollars by the end of the year assuming continuous compound interest. Therefore, the theorem (1.1) is now

$$(1.1') \qquad e^{r*} + e^{p*} = e^i.$$

By taking the logarithm of (1.1'), we arrive at (1.2') directly. For the derivation, see Fisher (1906) and (1907) and, more recently, Hirshleifer (1980).

(21) For example, by Sargent (1976).

ous compound interest payment virtually never occurs in practice.[22]

1.4.4 The theoretical adjustment of nominal interest rates to inflationary expectations

If inflationary expectations rise by Δp^*, nominal interest rates will immediately rise by the full amount of $\Delta p^* + r^* \Delta p^*$ in accordance with the complete version of theorem (1.2), or by the amount, in principle lower, of Δp^* in accordance with the simplified version of theorem (1.2'). Generally speaking, with a given real interest rate, rising inflation rates result in a proportional increase in nominal interest rates, and falling inflation rates in a proportional decrease in nominal interest rates; if there is no change in inflationary expectations, the nominal interest rate remains unaffected, all other things being equal. Where price stability is expected ($p^* = 0$), nominal and real interest rates coincide - a situation which Fisher precluded for the derivation of his theorem[23]. A continuously rising price level (i.e. a constant positive inflation rate $0 < p^* = $ const.) is in theory associated not with continuously rising nominal interest rates, but with continuing high nominal interest rates. Under the terms of the theorem, the necessary adjustment of nominal interest rates occurs directly, completely and promptly.

This perfect theoretical relationship is illustrated in simplified form in Figure 1.1 for various hypothetical inflation rates and for a given "normal" real interest rate of 5 %. Since here it is essentially to demonstrate the directions of movement and not the exact scales, it is sufficient in Figure 1.1 to take the simplified nominal interest theorem (1.2') as the basis[24]. The upper section of the diagram shows the assumed expected rates of change in the price level, roughly indicated by the slope of the line representing prices. The lower section shows the

(22) Usually, interest in the case of fairly short-term financial assets (with a maturity of under one year) is calculated and paid upon maturity of the capital sum; in the case of long-term financial assets, interest is generally credited annually.

(23) See above Assumption 1. By contrast, Fisher used the assumption of price stability as the basis for his interest theory proper, which seeks to establish the "fundamental" determinants of the interest rate; see Fisher (1930), p. 46 and p. 494.

(24) I am using here, in slightly adapted form, the chart produced by Fisher (1930), p. 412.

theoretical effects of various inflationary expectations on nominal interest rates.

The starting point of the curves plotted in Figure 1.1 is a situation of stable prices with $p^* = 0$ and consequently equality of nominal and real interest rates at 5 %. If at the beginning of the first period there is a general expectation of a rise in the price level amounting to a constant annual 5 %, the nominal interest rate "jumps" immediately to 10 % according to Fisher's theorem and remains at this higher level so long as the price level is expected, with perfect foresight, to rise by a constant 5 %. If in period 2 price stability is restored (at a higher

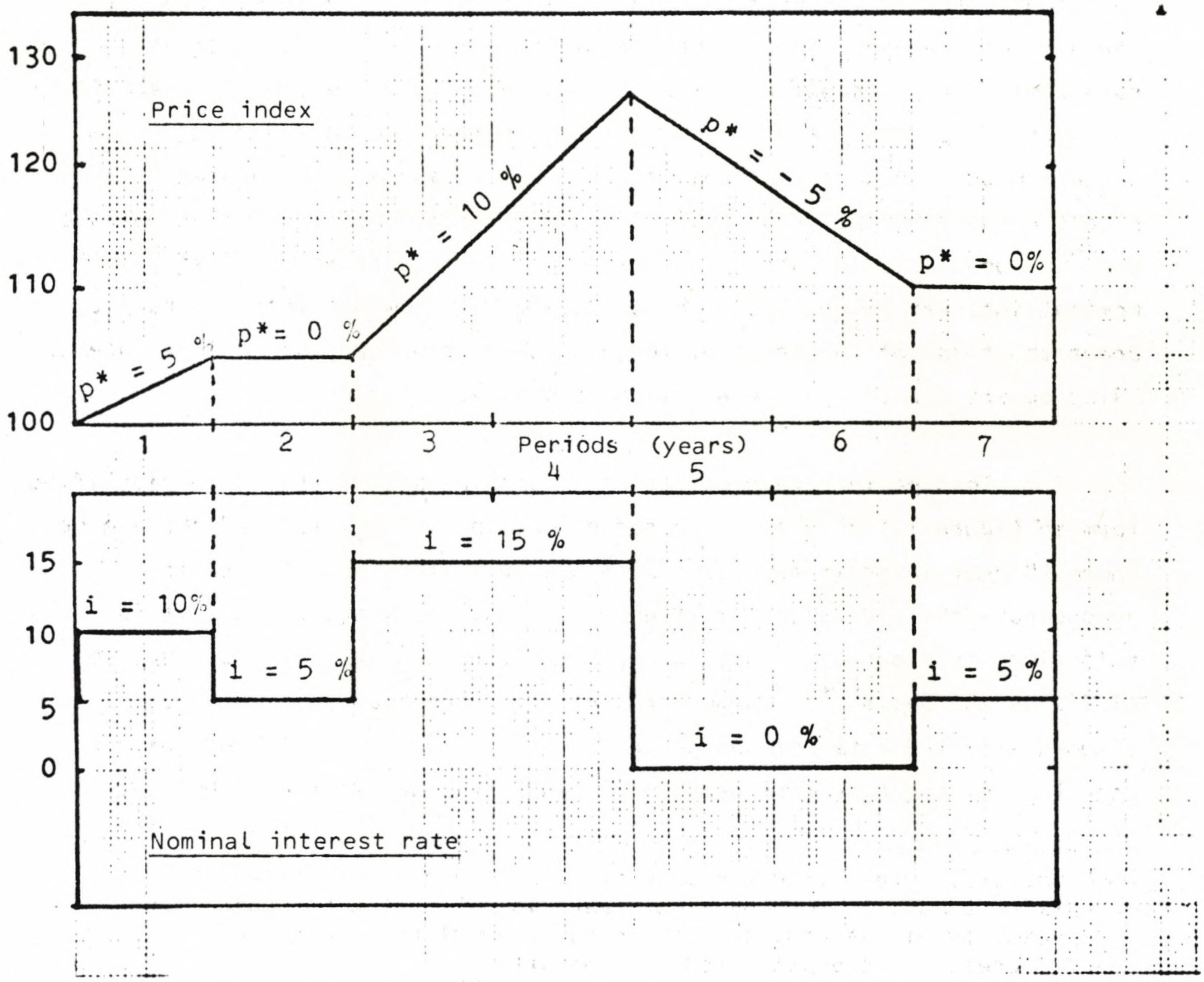

Fig. 1.1 Theoretical, simplified relationship between inflationary expectations p* and nominal interest rate i assuming a constant real interest rate of 5 %.

level), the nominal interest rate will fall immediately to its initial level and remain there so long as there is price stability. If the expected price level rises by a constant 10 % in the following periods 3 and 4, the nominal interest rate will rise immediately, at the beginning of period 3, by 10 % to reach 15 % and will remain there. If subsequently there are deflationary expectations (period 5), the nominal interest rate will fall immediately, to below the real interest rate; in the extreme case plotted, the nominal interest rate falls drastically, by 15 percentage points, to zero. The unchanged positive real interest rate of 5 % and the deflationary expectations also of 5 % counterbalance one another in periods 5 and 6 in accordance with the simplified theorem[(25)]. Finally, in period 7, the nominal interest rate returns to its initial level of 5 %, since there is price stability, albeit at a higher level.

It is quite legitimate to describe the upper curve in Figure 1.1 alternatively as the expected or as the actual rate of price changes: since it is consistently assumed that there is perfect foresight, the expected and actual rates of price changes are the same, as shown above, i.e. $p^* = p$. In his explanatory comments, therefore, Fisher can afford for much of the time to refer only to observed changes in the price level.

As Figure 1.1 shows, a feature of Fisher's original theorem is that nominal interest rates react promptly and fully to prevailing inflationary or deflationary expectations. Consequently, where there are marked fluctuations in inflationary expectations, nominal interest rates will also show marked fluctuations. By contrast, the expected real interest rate typically remains constant under the original theorem, that is to say it remains completely unaffected (or "neutral") by the perfectly anticipated, future rates of inflation. In other words, nominal interest rates adjust fully to price expectations : "If men had perfect foresight, they would adjust the money interest rate so as exactly to counterbalance or offset the effect of changes in the price level, thus causing the real interest rate to remain unchanged at the normal rate"[(26)].

(25) If one were to apply the complete nominal interest theorem (1.2) here, the nominal interest rate would have to become negative in the numerical example given, a situation which would be inadmissible.

(26) Fisher (1930), pp. 414-415.

This "normal" real interest rate is evidently the interest rate obtaining in a situation of price stability (see Fig. 1.1), where the nominal interest rate and the real interest rate are at the same level [27].

Lastly, a typical feature of Fisher's theorem, though one which is largely ignored in the literature, is the fact that the absolute spread between the (theoretically constant) real interest rate and the (theoretically fluctuating) nominal interest rate differs from p^*: rising inflation rates mean (assuming perfect foresight) that the absolute spread between nominal and real interest rates will become greater than the inflation rate p^*, since the product of r^*p^* in (1.2) increases. Conversely, falling inflation rates will, through falling nominal interest rates, lead to a narrowing in the spread. This phenomenon is, as already stated, not reflected in Fig. 1.1. There, the basis used was rather the simplified version of the Fisher theorem (1.2'), so that the spread between the two interest rates is always precisely as great as the expected inflation or deflation rate.

(27) Fisher does not give any further explanation of what he means by a "normal" interest rate; however, there is some suggestion of an affinity with Wicksell's "natural" interest rate.

Annex: On Fisher's concept of interest

A1 The agio concept: interest rates as intertemporal relative prices

Fisher uses Böhm-Bawerk's view of interest. Under this concept, the interest rate is seen as the premium (agio) on goods (assets) available in the present when exchanged for similar goods available in the future.(28) "Goods" may mean all kinds of durable assets, particularly money, but also a specific good or the (weighted) quantity of goods in a particular basket. The subject of Fisher's theorem is, as has been shown, the "translation" of a given percentage premium on money available in the present, i.e. a nominal interest rate, into the percentage premium on the quantity of goods available in the present, i.e. a real interest rate, assuming given inflationary expectations. Since the nature of the particular asset in question influences the premium, i.e. the interest rate, there are generally different interest rates for different assets; consequently, the interest rate must always be seen in relation to the asset or standard in which it is expressed. In accordance with the concept, therefore, there are any number of nominal and real interest rates in the sense that a percentage premium is paid on goods available in the present in exchange for goods available only in the future: thus, for example, one can say that there is a (real) interest rate for non-monetary assets such as wheat, machinery, houses, etc. Similarly, there are any number of nominal interest rates if the premium on immediate availability relates to financial assets (money, securities). Variable periods, maturities, interest payment intervals or risk considerations increase the range of interest rates which may actually exist.

In microeconomic terms, on the basis of the premium concept of interest, an annual rate of interest characterizes the exchange relationship between an individual good G_o available in the present ("today", "currently") and the same good G_1 available only in one year's time. (The indices denote the time of availability). Today's present value price of good G_o (for delivery now) is written as P_{Go}, and the present value price of the future good (for delivery at time 1) is written as P_{G1}. If the availability of the

(28) Böhm-Bawerk (1888), Book IV; Fisher (1930), Chapter I.

present good is sacrificed for one year (G_o is lent for one year), the right to 1 + J future goods is acquired in exchange; J denotes the interest rate in accordance with the definition

(A 1.1) $$1 + J = P_{Go}/P_{G1}$$ or

(A 1.1') $$J = (P_{Go}/P_{G1}) - 1; \quad P_{Go} > P_{G1}.$$

The definitional equations embody a general equilibrium approach, suitable for macroeconomic as well as microeconomic issues. The symbol J has been chosen to show that there is no determination of a nominal interest rate i or a real interest rate r. Depending on whether the good G denotes a physical asset or a financial asset, J is a real or a nominal interest rate.

The premium concept of interest very generally stresses only the time aspect of the interest phenomenon. Obviously, the interest rate can also be described here as an intertemporal relative price [29]. Terminologically, this is expressed by denoting P_{Go} as the cash or spot price and P_{G1} as the forward price [30].

The identities (A 1.1) and (A 1.1') can also be interpreted as expressing the interest rate for any asset or good in the price of that good. Accordingly, J also denotes the own-rate of interest of a good [31]. The own rate of interest of money can therefore be called money interest and the own-rate of interest of a basket of goods as real interest, in accordance with Fisher's theory.

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(29) See Hirshleifer (1980), Chapter 16.

(30) See Richter, Schlieper, Friedman (1978), pp. 135-137. The forward price has the dimension of "dollars payable today per unit of goods available in one year's time".

(31) For discussion of this concept, see, for example, Keynes (1936), pp. 222 et seq.

The concept of the own-rate of interest brings out particularly the basic idea underlying the theorem, i.e. that interest rates must always be seen in relation to the unit of goods or money in which they are expressed. The concept of the own-rate of interest stresses the relevant "standard", and the premium concept of interest the underlying time aspect of the interest phenomenon. Both are entirely compatible with each other.

The formulation of the premium concept of interest in (A 1.1) is in line with the usual presentation. However, it is incomplete to the extent that it is based on an implied assumption, namely that the time interval Δt for which an intertemporal relative price is expressed is irrelevant. In practice, this assumption may be justified insofar as interest rates are mostly annual interest rates, i.e. $\Delta t = 1$ year. Yet there are also exceptions, such as the setting of interest rates per month ($\Delta t = 1$ month) in the case of instalment loans(32). It is therefore more correct to include the time element Δt expressly in the formulation of the premium concept of interest. Accordingly,

$$\text{(A 1.2)}\quad J = (P_{G0} - P_{G1}) \,/\, (P_{G1} \cdot \Delta t);\; P_{G0} > P_{G1}$$

or implicitly

$$\text{(A 1.2')}\quad P_{G0} = P_{G1} \cdot e^{\Delta t(1 + J)} \qquad \text{(continuous time).}$$

(32) See, for example, the statistics on the lending and deposit rates of credit institutions, regularly published in the Monthly Reports of the Deutsche Bundesbank, Table V.6 (statistical section).

The obvious dependence of an interest rate on the reference period is reflected in the dimension[33] of the interest rate as an abstract number per time. This statement of dimension applies to all interest rates, irrespective of the standard in which they are expressed. For there is, it is true, an abundance of real interest rates, which, in line with the time premium concept (agio concept), are conceived of as the own-rate of interest for a quite specific non-monetary good or for a quite specific basket of goods - just like the distinction between nominal interest rates on financial assets in accordance with the nature of assets. However, Fishers' theorem cannot be taken as a formal expression of the dimension of real interest and nominal interest, even though the core substance of his theorem[34] has an apparent similarity with his general definition of dimension[35].

Fisher's theorem is essentially suited to translating the interest rate from any unit of money into any unit of goods, and vice versa; as already stated, it formulates the "law" of the inner relation between two interest rates that are expressed in different units. In his empirical examination of the theorem (see Chapter 2 below), however, Fisher allowed this microanalytical aspect to recede into the background. From the abundance of physical assets, he takes a composite physical asset, namely a basket of goods, which then stands for the non-monetary, macro-economic asset "goods". This means that the focus is shifted to the movement in value, as specified in a given price index, of a macroeconomic sum of goods relative to money. Hence, the Fisher theorem should be assigned to the theory of money rather than to the theory of interest. From a practical point of view, however, it is quite appropriate to disaggregate the calculation of real interest using different price indices.

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(33) The original work on this point stems from Jevons (1871), pp. 247-250.

(34) "The rate of interest is always relative to the standard in which it is expressed"; Fisher (1930), p. 41.

(35) "Dimension - The kind or species of any magnitude as indicated by its measurement in terms of another magnitude"; Fisher (1906), p. 331.

Overall, interest concept and dimension imply that the interest rate expressed in units of goods (in a particular basket of goods) does not show any particular characteristics as compared with any other interest rate expressed in units of money. Each theoretical interest formula too can basically be expressed in different standards, with the inner relation between the relevant interest rates being described by Fisher's theorem. For example, the Keynesian marginal efficiency of capital (an interest rate) could be expressed not only in the standard "money" but also in the standard "basket of goods for a representative price index": To quote Keynes: "If there were some composite commodity which could be regarded strictly speaking as representative, we could regard the rate of interest and the marginal efficiency of capital in terms of this commodity...[36].

Conversely, a "marginal efficiency of money" can also be used to formulate a nominal interest (money interest) concept based on the time premium view. To quote Keynes once again: "Interest on money ... is simply the premium obtainable on current cash over defferred cash, so that it measures the marginal preference (for the community as a whole) for holding cash in hand over cash for deferred delivery. No one would pay this premium unless the possession of cash served some purpose, i.e. had some efficiency. Thus we can conveniently say that interest on money measures the marginal efficiency of money measured in terms of itself as a unit"[37].

A 2 <u>The concept of interest in terms of capital theory: the interest rate as a link between capital stock and income flow</u>

The premium concept of the interest rate is independent of annuity, i.e. of the concept of a constant, annual payment flow (income flow) from capital. Because of this independence, the premium concept must as a matter of principle be distinguished from the capital theory concept of interest, which is based on the concept of annuity. The capital theory concept of interest focusses on the relationship between income Y, flowing from the

(36) Keynes (1936), p. 224. If this composite commodity appreciates relative to money by y % annually, the marginal efficiency of capital (defined as x % in units of money) is equal to (x - y) % in units of the composite commodity.

(37) Keynes (1937), p. 145; for a critical examination, see Robertson (1940).

use of a given amount of "eternal" capital assets K', and the value of these assets PK'. This relationship is defined, in respect of a constant income (net) flow of indeterminate (infinite) duration, as the capital theory concept of interest J', where

(A.1.3) $J' = Y/PK'$.

PK' = Value of the capital assets at a specified point in time;

Y = Income flow from the use of physical capital assets K' during a specified time interval;

J' = capital theoretic rate of interest.

In accordance with the definition (A 1.3), the interest rate is simply the relationship between income and capital value. It could therefore also be described as the earnings price (user's price, income price) of capital.[38]

The distinction between the premium concept of interest and the capital theory concept of interest follows directly from the relevant underlying time element. Under the capital theory concept, the interest rate (J') applies for an infinite number of (annual) periods, because of the underlying concept of an annuity not limited in time. Under the premium concept, the interest rate (J) always applies only for the (annual) period or periods specified.[39] The two concepts of interest are interchangeable only where there are numerical constancy in interest rates[40] and infinite time periods. Otherwise, the two concepts will each produce differing results.[41]

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(38) The reciprocal expression 1/J' denotes the rate of capitalization in years. The lower the interest rate, therefore, the longer the time span of capitalization, and vice versa.

(39) Here we can see the connection with the derivation of the Fisher theorem on the basis of one year (see above).

(40) For fuller treatment of this subject, see Fisher (1906), pp. 363-364.

(41) See Fisher's calculations (1906), p. 198 and p. 362.

The value of capital assets[42] is, in accordance with (A 1.3), always related only to future, discounted (capitalized) income. The definition (A 1.3) therefore contains the general statement, in interest theory terms, that the value of the stock of capital assets lies solely in its value as a source of an income flow. This value is found by discounting the expected income flow to the present.

The present value of capital assets can be determined, in accordance with (A 1.3), from the value of the expected future flow of income from them; there is therefore the connection

{ Value of future income from capital assets } ——(capitalization)——→ { Present value of capital assets }

In this relationship, the initial variable (income value) lies in the future and the result (capital value) in the present; the sequence accordingly runs counter to usual conceptions. The explanation for this lies in the distinction between physical entities and the values (prices) of these entities. Income in the sense of a physical flow of goods is, conversely to the relationship formulated above, the result of the use of physical capital goods: expenditure on goods ultimately always results from the combined remunerations of capital assets like human capital, physical capital, financial capital and land. A simple scheme representing both "directions of causation" might therefore look as follows:

Capital goods ————————→ Flow of services (income)

Capital value ←———————— Income value ←┘

(42) "Capital assets" is used here to include generally all physical and non-physical, economically relevant goods. Non-physical capital assets have been introduced into monetary macroeconomics through the concept of "human capital" used by Friedman (1957). The argument, which has been going on for decades, as to whether the term "capital" should not be used instead of "wealth", is not taken into account here, as analytically the theory of interest does not necessarily require a theory of capital; see, for example, Solow (1963).

This scheme devised by Fisher[(43)] shows that, for example, the wheat crop (real income) "naturally" depends on the land which yields it. But the value of the crop does not depend on the value of the land. On the contrary, the present value of the land depends on the value of the (expected future) crops. Therefore, in order to determine the present value of the land, or of any other capital asset, two variables must be known: the future income from the asset and the interest rate by means of which the future income is translated into a present value.

Since the rate of interest is thus the bridge or link between a future income flow and a present capital asset, all income (applying a wide concept of capital) is ultimately to be interpreted as a stream flowing from the source "stock of capital assets". Accordingly, any analysis of income determination and development is necessarily confronted with the task of taking account of the stock-flow relationship, i.e. the abovementioned relationship between stock and flow variables. Consequently, conventional textbook approaches in which changes in the capital stock are not explicitly taken into account, inevitably ignore significant capital asset effects. Even if one defines capital assets more narrowly to mean "physical capital plus financial capital", the formation of physical capital (and hence the central role of investment in the economic process) forces us to take a stock-flow view. The Keynesian theory of investment was accordingly criticized on precisely this point at an early stage.[(44)]

Modern macroeconomic equilibrium theory has in recent decades, by almost universal consent (despite differences in detail), chosen the course of constructing models with stock and flow equilibria that influence one another mutually.[(45)] It may be said, though the statement may at first

(43) Fisher (1930), p. 15.
(44) See Lerner (1944).
(45) See, for example, the models of Brunner and Meltzer (1976) and of Tobin (1969).

sight appear too presumptious, that modern macroeconomic theory has in the past two decades developed anew from a classical interest-theory nucleus (Wicksell)[46], namely from the time aspect that lies at the heart of interest rates (including the associated formation of expectations), from the necessary consideration of the interactions between stocks and flows and, lastly, from the analysis of the interplay of specific interest rates themselves.

The definition of the concept of interest set out in (A 1.3) leads ultimately to the traditional, classical distinction of the production factors "land", "labour" and "capital" and to the functional incomes "rent", "wages" and "interest" deriving from these production factors. Leaving aside differences of dimension between interest and rent[47], the concept of interest (J') does not lead to classical "pure interest" in the sense of a pure income on the allocation of a specific factor referred to as physical capital. Rather, interest, on any production factor, is the relation between the price for the use of the factor and the price (value) of the source of those factor uses[48].

In summary, it has to be borne in mind that, of the two basic ways of interpreting the interest rate, Fisher applied the time premium ("agio") concept for the purposes of his theorem. The literature which followed on from Fisher did not, in pursuing his theorem, take up the distinction between that interpretation of the interest rate and the alternative interpreation in terms of capital theory. Although reference is made to the existence of two concepts of interest in modern writings on the theory of interest and the theory of prices[49], such references are made in isolation and are not linked up with the concept of interest used in Fisher's theorem. The particular appropriateness of the premium concept of interest to the time horizon underlying Fisher's theorem is not analyzed in the literature, nor is account taken, even on a narrow view, of the numerical discrepancy that may arise from the two different concepts of interest.

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(46) See, for example, the analysis of Leijonhufvud (1979).

(47) "Rent" is the ratio of the payment to the physical object, e.g. dollars per acre of land. "Interest" in the sense of interest yield is the ratio of payment to the value of physical objects, e.g. dollars per present value (in dollars) of a house.

(48) Hishleifer (1980), Chapter 15.

(49) For example, in Hirshleifer (1980), pp. 500/501 or in Lutz and Niehans (1980), pp. 530/531.

2. Fisher's factual evidence

"No problem in economics has been more hotly debated than that of the various relations of price levels to interest rates. These problems are of such vital importance that I have gone to much trouble and expense to have such data as could be found compiled, compared, and analyzed"(50). This, the opening sentence of the famous Chapter XIX entitled "The relation of interest to money and prices" in Fisher's "Theory of Interest", reveals the major importance which he attached to the empirical analysis of his theorem.

Fisher's initial concern was obviously an empirical test of his original theorem assuming perfect foresight Because of the implied equality of observed and expected rates of price changes in the original theorem, we should not be surprised that Fisher now refers to the (observed) price level and not expressly to price expectations. Moreover, prior to his empirical work, Fisher had emphasized, in his writings on monetary and interest theory, the existence and importance of expectations in the economy, however they might be formed. As early as 1896, for example, he wrote: "It is important to emphasize the broad fact that, in general, business foresight exists ..... . It is the practical man's business to foresee"(51). Even after several decades of continued work on questions relating to the theory of money, interest and business cycles, he made the following statement: "And today especially, foresight is clearer and more prevalent than ever before. The business man makes a definite effort to look ahead not only as to his own particular business but as to general business conditions, including the trend of prices"(52). Today, more than half a century later, this statement can only be said to apply with greater force, given the large number of forecasts of all kinds which are available.

In view of these statements by Fisher and the equality $p = p^*$ assuming perfect foresight, it may be supposed that Fisher wanted to test his original theorem systematically, even if he started out by tailoring

(50) Fisher (1930), p. 399.

(51) Fisher (1896), pp. 36/37.

(52) Fisher (1930), p. 400.

the problem to observed (and not expressly to expected) inflation rates[53]. Yet he realized from the outset that perfect foresight was a highly simplified assumption of price expectations, and one which he certainly did not a priori claim to be the case in practice. Contrary to what is maintained in the secondary literature[54], Fisher did not expressly comment on the way in which expectations are formed. We will see later whether it can be claimed that he attempted to quantify inflationary expectations with the help of a distributed lag model.

2.1 Comparisons of yields

As a first step in testing his theorem, Fisher concentrates on comparing the yields on bonds issued and quoted in two different standards[55]. He analyzes two specific cases: fixed-interest US coin and currency bonds in the period 1870-1896 and fixed-interest gold bonds and rupee (silver) bonds in the period 1865-1906. Fisher calculates in detail the actual ex post yields realized on the market in the relevant currencies and compares these interest rates with the ex post observed movement in the price of gold and in the exchange rate between rupee and sterling[56].

(53) After the introductory remarks quoted from Chapter XIX in his "Theory of interest" (1930), Fisher continues: "The main object of this chapter is to ascertain to what extent, if at all, a change in the general price level actually affects the market rates of interest" (p. 399). There is no mention of expectations. Again, by way of introduction to his correlation analysis, he states that "... the theory being investigated is that interest rates move in the opposite direction to changes in the value of money, that is, in the same direction as price changes ..." (p. 416).

(54) Recent exceptions are Rutledge (1977) and B. Friedman (March 1980); see also Gebauer (1976) for a critique of the usual interpretation of Fisher.

(55) Fisher (1896), pp. 38-53; Fisher (1930), pp. 401-407.

(56) The interest payments and redemptions in the case of the rupee bonds were made in London in sterling; the amount payable in sterling therefore depended on the exchange rate relationship between sterling and the rupee.

The data show that yields on both bond issues were mostly different; changes in the relative value of the standards, in which interest rates were quoted, apparently played a role. Fisher sees the reason for the yield spread between the (otherwise largely homogeneous) bonds as being expectations, hopes and fears on the currency and security markets with regard to the relative trend in value of the different standards; in so doing, he expressly makes reference to his theorem. In 1870, for example, investors in US gold bonds realized 6.4 %, while investors in US currency bonds were willing to accept a return of only 5.4 %. Fisher puts forward the following explanation: paper had at that time depreciated significantly relative to gold in the United States, so that there was increasingly the expectation that it would in future rise again in value as compared with gold, perhaps even reaching parity with the hoped-for (or feared) resumption of the gold standard (official conversion of gold)(57). Fisher argues that, because it was expected that paper dollars would appreciate, the demand for currency bonds was relatively stronger than that for gold bonds, resulting in higher prices for and correspondingly lower yields on currency bonds relative to gold bonds(58).

Fisher goes on to observe that after 1879, when there was a resumption of officially guaranteed equality in value between paper money and gold, the two bond rates remained very nearly equal for several years. It was not until there was talk of fundamental monetary changes (i.e. restoring free coinage of silver), which could have led to a preference for gold bonds, that the original yield differential was reversed; the yield on gold bonds fell below the yield on comparable bonds in the paper currency standard, in respect of which there was a fear of inflation.

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(57) Fisher, 1930, pp. 401/402. Obviously, Fisher is assuming here that there is in the eyes of market participants a "normal" or "appropriate" value ratio between the two currency units. Such an assumption is characterized today by the term "regressive expectation formation". For a more specific or formal description of this idea see Keynes' liquidity preference theory (1936) and the "prefereed habit" theory of yield curve analysis by Modigliani and Shiller (1973).

(58) In fact, the price of gold fell from almost 120 dollars per unit of gold in 1870 to parity at 100 dollars in 1879, when the Greenback period ended and specie payments in gold were officially resumed. Gold did in fact, as obviously expected by the market, loose value relative to paper currency.

It should be noted here, that in contrast to the (modern) adaptive expectation hypothesis Fisher evidently did not derive expectation formation solely from past price or exchange rate changes, but took other factors into account as well. Fisher's expectation formation hypothesis implied here might accordingly best be described as "weak-form rational"[(59)].

In the comparison of yields on Indian gold bonds and silver ("rupee paper") bonds, the absolute differences in yields show a connection with exchange rate expectations (as supposed by Fisher) of the Indian currency relative to the British gold currency[(60)]. In interpreting the observed yield spread, Fisher once again assumes the basic validity of his theorem in the sense that market fears of a decline in the exchange rate of the rupee relative to sterling are considered as the main explanatory factor.

Fisher expressly mentions however, that the perfect foresight assumed in his theorem cannot exist in practice; rather, there are vague, underlying suppositions, hopes or fears as regards future yields and exchange rates:"Of course investors did not form perfectly definite estimates on the future fall, but the fear of a fall predominated in varying degrees over the hope of a rise"[(61)]. He indirectly infers the formation of such expectations, with the similarity of the two bonds being a significant factor: "Inasmuch as the two bonds were issued by the same government, possessed the same degree of security, were quoted side by side in the same market, and were similar in all important respects except in the standard in which they are expressed, the results afford evidence that the fall of exchange (after it once began) was, to some extent, discounted in advance and affected the rates of interest in those standards"[(62)]. Fisher therefore explicitly notes that there was incomplete adjustment of nominal interest rates.

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(59) See Fama (1970) and Fischer (1980).

(60) As already stated, the level of the interest and redemption payments actually payable depended on this exchange rate relationship.

(61) Fisher (1930), pp. 405/406.

(62) Fisher (1930),p. 405 (underlining not in the original).

All in all, Fisher's comparison of observed yields was meant to establish some first, rough evidence for his original theorem (in the simplified version); the role of expectation formation was expressly, albeit indirectly, examined(63). Fisher intended to use the results of his yield comparisons only in very general terms - to support his basic thesis that an expected divergence in the relative values of two standards influences the relevant interest rates in these standards. It was not possible to determine an exact measure of this influence by means of yield comparisons; the evidence obtained was insufficient for a falsification of the theorem. Although on the basis of this evidence Fisher stated as early as 1896: "The adjustment of interest to price movements is inadequte"(64), he was more self-critical in his later publication "The Theory of Interest" in which he stated that his attempts to quantify the influence of inflationary expectations on market interest rates on the basis of yield comparisons were methodologically unsatisfactory: "The preceding comparisons offer not exact measure of that influence ... Somewhat unsatisfactory attempts to do this ... were made in my 'Appreciation and Interest' but are not reproduced here"(65). In his later evaluation of his overall evidence, Fisher places greater emphasis on the results which he obtained using other statistical methods (see blow).

2.2 Comparison of observed nominal and real interest rates

In the second stage of his empirical investigation, Fisher turns to a comparison of simultaneously observed money interest rates (nominal interest rates) and real interest rates(66). On a superficial view, the comparisons of yields described above could also be fitted in here, for example by expressing the yield on gold bonds as the "real interest rate"

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(63) In his introductory remarks to these comparisons, the subject of investigation was indicated as follows: "Evidence that an expected change in the price level does have an effect on the money rate of interest may be obtained from several sources ....."; Fisher (1930), p. 400.

(64) Fisher (1896), p. 75.

(65) Fisher (1930), p. 407.

(66) Fisher (1896), pp. 54-57; Fisher (1930), pp. 407-416. Later calculations in Fisher's "Theory of Interest" (1930) combine, with some additions and amendments, the initial factual evidence set out in "Appreciation and Interest". I therefore refer below essentially to the relevant passages in Fisher's "Theory of Interest" (1930).

and the yield on currency bonds as the "money interest rate" (which Fisher avoided doing). However, the relative change in the standard would then consist not in national price level movements, but would consist directly in (relative) exchange rate movements. Ultimately, this would mean transposing or adapting the original Fisher theorem to explain the connection between international interest and exchange rates.

However, when nominal and real interest rates are compared, emphasis is generally placed on a contrast which specifically characterizes the focus of Fisher's theorem, namely the movement of nominal domestic interest rates in relation to the expected domestic rate of change in the price level, or, implicitly, in relation to expected real interest rates (expressed in the units of goods of a specified shopping basket). It is this distinction which leads to the typical question as to the influence of expected relative changes in the value of the (domestic) commodity price level - or of the (inverse) purchasing power of money - on nominal interest rates.

As regards Fisher's comparisons between nominal and real interest rates, the typical data problem arose: Fisher now could not resort to actually observed contracts under which interest rates in different standards (currencies) were agreed and quoted. He had to confine himself to comparing time series of nominal interest rates with deflated interest rates (i.e. interest rates adjusted ex post for prices changes): "All we can do is to note the changes in the price level, translate the actual rates in terms of money into real rates, and compare successive periods"[67]. The comparison is therefore between observed nominal and real interest rates. The real interest rates are calculated in accordance with the original, simplified therem: "The real interest rates are obtained by subtracting from the money rate for any period the rate of annual change in the price level for the same period"[68].

Fisher uses two kinds of short-term nominal interest rates, namely "bank rates" and "market rates" in various national money markets[69]

(67) Fisher (1930), pp. 407/408 (underlining by Fischer).

(68) Fisher (1940), p. 526.

(69) London, New York, Berlin, Paris, Calcutta and Tokyo.

and in various periods[70]. He deflates these money market interest rates by the respective national wholesale price index[71].

The periods investigated are conceived of as sub-periods of varying lengths (between three and twelve years) which together form a total observation period[72]. The sub-periods were each selected in such a way that they should show a significant change in the rate of price change as compared with the preceding and following sub-periods: they were not selected with any reference to the results (i.e. whether these would show any consistency between the implications of the theory and the facts).

For each sub-period, Fisher calculates a (multi-year) average value for the nominal interest rate, the observed rate of price change and the observed real interest rate. For the period 1825-1834 on the London market, for example, he calculates nominal interest rates of an average of 4.2 % (bank rate) and 3.4 % (market rate), an average annual 3 % decline in the price level and,consequently, real interest rates of 7.2 % (real discount rate) and 6.4 % (real market rate on three-month bills)[73].

All in all, the second stage of Fisher's empirical procedure may be characterized as follows:

(70) The longest time series (yearly data for Great Britain) spans a full century, and the shortest time series (yearly data for Japan) 40 years. See Fisher (1930), Appendix, pp. 520-529.

(71) More suitable price indices such as the implicit price deflator for GNP or the cost of living index for all private households were not available to Fisher. More recent calculations, for example, for the Federal Republic of Germany, mostly use such indices; see Gebauer (1976).

(72) For example, the total observation period for British data (London capital market) covers the years 1824-1927; the time series is then broken down into successive sub-periods of varying length, beginning with a ten-year period 1825 -1834, followed by a five-year period 1834-1839, then a twelve year period 1839-1852, etc.; Fisher (1930), Appendix, p. 527.

(73) Fisher (1930), p. 527, Tab. VII.

- the simplified original theorem, in versions (1.2') and (1.3'), is applied;

- calculated real interest rates are ex post observed rates;

- the real interest rate figures are calculated for the average of several years; the simplified theorem is therefore applied over an extended time period;

- the multi-year averages of the ex post observed real interest rates are based on deflation of quite short-term nominal interest rates, which means that multi-year averages of short-term real interest rates are calculated.

From the outset, Fisher himself was, from a macroeconomic point of view, critical of this procedure and pointed out that interest rates in the individual sub-periods were probably influenced not only by changes in the price level, but also, to widely varying degrees, by other more fundamental factors: "Such comparisons are not very satisfactory, since no two periods ... differ only as to the state of the monetary standard ... Of course, influences other than changes in money affect interest rates"[(74)]. An isolated, partial comparison of nominal and real interest rates ignores these other influences.

During the second stage of the investigations, the theoretical question is no longer stated expressly in terms of the role of expected changes in the price level. As in the introduction to Chapter XIX, Fisher refers only to "the" price level: "... support the theory that money interest rates move in the same direction as the price level"[(75)]. Fisher's argument contains the following methodological and operational train of thought here:

- because the theorem assumes perfect foresight, the comparison of nominal and real interest rates in one and the same period does not require any explicit distinction between the observed and the expected rate of price changes ($p^* = p$);

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(74) Fisher (1930), p. 408; on the macroeconomic interpretation of the Fisher theorem, see Chapter 3 below.

(75) Fisher (1930), p. 410.

- if the factual evidence is inconsistent with the implications of the theorem (in particular if real interest rates are found to be variable), then the adjustment of nominal interest rates does not take place with perfect foresight;

- if market participants are found to have imperfect foresight, the reasons for this must be sought. The question of how to modify accordingly the (original) theorem is left open.

Fisher indeed comes up with results which falsify[(76)] the implications of his theorem. Although he finds that there is an underlying positive link between money interest rates and the rates of change in the price level,[(77)] the adjustment of nominal interest rates to rates of inflation and deflation takes place only partially and slowly: "The adjustment is imperfect and irregular... When prices begin to rise, money interest is scarcely affected. It requires the cumulative effect of a long rise to produce a definite advance in the interest rate... The adjustment is very slow."[(78)]

This result calls into question the constancy of real interest rates implied in the original theorem: as a result of the slow and partial adjustment of nominal interest rates to the movement of prices, real interest rates (as calculated by Fisher) do not remain constant. They actually fluctuate to a significantly wider extent than nominal interest rates[(79)], and indeed partly show negative values (which are theoretically impossible). Fisher rightly calls the fluctuations in real interest rates "erratic": for example, the real short-term rate of interest on the London money market fell from an average of + 1.2 % in the period 1896-1913 to an incredible - 10.1 % in the (inflationary) period 1914-1920, only to soar again to + 15.7 % in the subsequent (deflationary) period 1920-1927[(80)]. Fisher summa-

(76) In the sense of Popper (1976). See also Carmichael and Stebbing (1983).

(77) "The evidence obtained ... indicates that there is a very apparent, though feeble, tendency for the interest rate to be high when prices are rising, and the reverse". Fisher (1930), p. 411.

(78) Fisher (1930), pp. 411 and 416 (underlining by Fisher).

(79) For example, standard deviations of real interest rates are between seven and thirteen times higher than the standard deviations of the corresponding nominal interest rates; Fisher (1930), p. 415, Table 14.

(80) Fisher (1930), Appendix p. 527, Table VII.

rizes, with reference to the theoretically required constancy of real interest rates: "What we actually find, however, is the reverse - a great unsteadiness in real interest when compared with money interest"[81].

This result is explained as being due to the discrepancy between theoretically perfect foresight and the imperfect foresight which actually exists among market participants: "... men are unable or unwilling to adjust at all accurately and promptly the money interest rates to changed price levels ..., there is very little direct and conscious adjustment through foresight"[82]. Fisher attributes the inability of market participants to undertake promptly the theoretically "correct" adjustments in interest rates to widespread money illusion: "Most people are subject to what may be called 'the money illussion'... The erratic behavior of real interest is evidently a trick played ... by the 'money illusion' when contracts are made in unstable money"[83].

Fisher does not say anything more about the definition and origin of money illusion. However, we may suppose that Fisher had in mind the concept which he had put forward in general terms earlier, namely the difficulty to perceive that the value of a monetary standard is constantly changing[84]. In other words, market participants are acting under money illusion when they are misled, despite the constancy of all real variables, to "adjust" real behavior to price level changes.

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(81) Fisher (1930), p. 413.

(82) Fisher (1930), pp. 415 and 494.

(83) Fisher (1930), pp. 399/400 and p. 415.

(84) Fisher (1928). For a discussion of the concept, see, for example, Badura (1977), pp. 88 et seq.

Conversesely, expressed in technical terms, there is freedom from money illusion when the supply and demand functions of market participants are homogeneous of degree zero in prices[85]. Accordingsly, for the purposes of Fisher's theorem, money illusion means in quite specific terms that, despite changes in the price level and hence an unstable value of money (fluctuating purchasing power of money), market participants act as if the equation dollar = dollar remained unaffected in real terms: they react by "adjusting" the real interest rate rather than the nominal interest rate. If there were, by contrast, "freedom from money illusion", real interest rates would not react to fluctuations in the purchasing power of money[86].

It should be noted here that Fisher lateron considerably reduced the emphasis on money illusion as an explanation for his evidence, putting forward a macroeconomic explanation in terms of a specific transmission mechanism. Similar to earlier remarks[87], he suggests that there is an indirect adjustment of nominal interest rates to inflationary expectations via business profits volume of trade and the demand for loans: "The indirectness of the effect ... comes largely through the intermediate steps which affect business profits and the volume of trade, which in turn affect the demand for loans and the rate of interest"[88]. Fisher also relies on business cycle considerations in explaining the extremely long time lags which he found for the (slow) process of interest adjustment (see below).

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(85) Which is, interestingly enough, the definition of the "classical dichotomy" or "neutrality of money". For more recent definitions of the "money illusion", see, for example, Dornbusch and Fisher (1981), p. 214, or Richter, Schlieper and Friedman (1978), p. 124.

(86) On further macroeconomic analysis and application, see, for example, Sargent (1979).

(87) Fisher (1896), pp. 76-79 and Fisher (1922), pp. 55 et seq.

(88) Fisher (1930), p. 494.

2.3 Correlation of nominal interest rates with lagged inflation rates

Fisher applied a third empirical test procedure in order to quantify more precisely the closeness of fit between nominal interest rates and inflation rates, including the implied speed of adjustment. He correlated nominal interest rates with lagged rates of change in the price level. It is above all this procedure that has been focussed on in the subsequent discussion of Fisher's analysis and, as already indicated, has been interpreted as attempt to quantify inflationary expectations.

2.3.1 Focus

Fisher's intention is to examine whether there is a positive link between nominal interest rates and rates of price changes: "... the theory being investigated is that interest rates move ... in the same direction as price changes"(89). There is no reference to the cause and effect relationship underlying Fisher's original theorem. Nevertheless, Fisher's formulation of the question quite clearly falls within the overall context of empirically testing his theorem (and its implications); the apparently vague statement of the problem in the above quotation may be said to be a correct statement of a correlation approach that does not comprise causality (but only a two-way cause and effect relationship). Given the assumption of perfect foresight, with $p^* = p$, one might again regard Fisher's statement as an operational formulation for testing the original nominal interest theorem. However, this would be to overlook two facts: firstly, the preceding tests (sections 2.1 and 2.2) had led Fisher expressly to reject the original assumption of perfect foresight as being inconsistent with facts and to reject the associated implication of perfectly adjusting nominal interest rates. Secondly, in his correlation estimates, Fisher replaces the earlier postulate of an immediate adjustment in interest rates by the concept of a lagged, gradual adjustment. The assumption of perfect foresight is, however, inconsistent with this concept. We must now examine what this means for the formulation of the theorem.

(89) Fisher (1930), p. 416.

2.3.2 Modification of hypothesis

Fisher postulates a priori time lags, i.e. the existence of time intervals between price level changes and subsequent nominal interest changes. As an initial, preliminary test, he first questions the causality p → i implied in his original theorem, i.e. the effect of (expected) inflation rates on nominal interest rates: he also examines the reversed causality i → p. In specific terms, correlation coefficients relating to discrete points in time are calculated for the relationship between observed rates of price changes and observed nominal interest rates, with Fisher assuming alternatively a lead or a lag of one to six years (in steps of one year) for the nominal interest rates. The data used consist of long time series for price changes and of long-term nominal interest rates (in the form of nominal bond yields) in the United States and Great Britain(90).

The results (91), whether with a lead or lag, show virtually no relationship between price changes and nominal interest rates: "These results suggest that no direct and consistent connection of any real significance exists ..."(92).

Fisher reacts to this outcome by introducing an additional statistical concept relating to the causality p → i (and only to this causality), borrowed from his earlier theoretical and empirical studies on the business cycle. It is the assumption that the postulated influence of price changes on nominal interest rates is distributed in time. The influence of price changes is therefore assumed not to exhaust itself in a single period, but to continue over several periods, with the intensity of the influence diminishing arithmetically as time passes by.

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(90) The British yearly data span more than a century, i.e. from 1820 to 1924, and the US yearly data run from 1900 to 1927; see Fisher (1930), Appendix, pp. 530/531.

(91) Fisher (1930), p. 418, Chart 45.

(92) Fisher (1930), p. 418; the correlation coefficients in Fisher's Chart 45 (p. 418) are very low and are in some cases nearly zero.

Assuming a distributed lag pattern, Fisher correlates current nominal interest rates with a weighted sum of past inflation rates. The latter is intended to measure length and intensity of the distributed influence of price changes on nominal interest rates. Fisher specifies the time profile of the distributed influence on the basis of arithmetically decreasing weights such that these taper off from the highest value at the beginning of the lag distribution to zero at the end of the distributed lag. The total number of periods n over which the influence is distributed is empirically determined, with successive extension of the (assumed) time horizon, according to the criterion of maximum correlation coefficient. Formally, the cumulative influence of past price changes is given as arithmetical average $\bar{p}$ at an assumed distributed lag over $\ell = 1, 2, \ldots n$ periods (years) and arithmetically decreasing weights w_ℓ :

(2.1) $$\bar{p} = \sum_{\ell=1}^{n} w_\ell \, p_{t-\ell} .$$ (93)

By correlating nominal interest rates with $\bar{p}$ for different lag figures n, the prompt adjustment of interest rates (which it was possible to assume in the first two tests procedures on the basis of the original theorem) is from the outset replaced by the assumption of a time consuming and gradual (i.e. lagged) process of adjustment of nominal interest rates to past inflation rates, among other relevant variables; that is,

(2.2) $$i_t = f(\ldots, \bar{p}, \ldots), \; f'(\bar{p}) > 0.$$

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(93) Division by the sum of the weights, which is normally necessary, is not carried out because of the specification $\sum w_\ell = 1$. A numerical example may clarify Fisher's use of (2.1): with an assumed distributed lag of n = 8 years from $\ell = 1$ to $\ell = 9$ and arithmetically decreasing weights $w_1 = 8/36$, $w_2 = 7/36$, ..., $w_8 = 1/36$, $w_9 = 0$, we have $\sum_{\ell=1}^{9} w_\ell = 1$; the weighted average $\bar{p}$ is obtained from summing $(8/36)\, p_{-1} + (7/36)\, p_{-2} + \ldots + (1/36)\, p_{-8} = \sum_{\ell=1}^{9} w_\ell p_{t-\ell} = \bar{p}$.

The dots in (2.2) indicate that Fisher did not in any way regard this relationship monocausally, but that he confined himself empirically to the analysis of one variable (i.e. $\bar{p}$) influencing nominal interest rates[94].

It should be noted here that Fisher conceived of and carried out only correlation calculations and not regression calculations[95]. Equation (2.2) must not be misinterpreted in this way. The question as to what are the usual statistics and parameter values of Fisherian regression analyses[96] is accordingly understandable, but must remain unanswered[97].

There is no mention of inflationary expectations: Fisher's underlying formulae (2.1) and (2.2) contain only ex post observable variables. His correlation calculations are to be understood not as the subject of an isolated study, but as the final empirical and, as will have to be shown later, also theoretical treatment of "interest and inflation", to which he devoted himself again and again in the course of more than three decades. An interpretation problem now arises here: the factual evidence already available to Fisher (Section 2.2) called into question his original theorem, pointing in particular to extremely imperfect or indeed non-existent price expectations, attributable to money illusion and/or time consuming tansmission processes. Thereupon, Fisher carried out an empirical and statistical modification of his original 1896 theorem by introducing distributed lags (2.1). But he never expressly described the use of distributed lags as a method for an (approximate) quantification of inflationary expectations.

However, the literature which followed on from Fisher has designated both together (the modification and the expectation-theory interpretation) as "the" Fisher hypothesis or Fisher relation without ever stating

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(94) For a broader macroeconomic interpretation of Fisher, see Chapter 3 below.

(95) For example, Sargent (February 1973), p. 387, tests a regression formula and explains misleadingly: ... which is the equation that Fisher implemented in his empirical work".

(96) As put forward, for example, by Neumann (1977).

(97) The connection between regression and correlation analysis may be used only to translate Fisher's correlation coefficient into the coefficient of determination of a -hypothetical- regression formula, and Fisher's method of handling the weights in (2.1) may be enlisted as the (necessary) identifying restriction for a parameter estimated by regression analysis; see Yohe and Karnosky (1969), p. 20.

clearly the interpretative character of such a secondary-literature assertion[98]. With reference to Fisher's original theorem it is simply assumed that $p = p^*$, and this 'perfect foresight' implication gives, in conjunction with and in contradiction to the distributed lag (2.1), the <u>expectation formation hypothesis</u>

$$(2.3) \quad p^*_t = \sum_{\ell=1}^{n} w_\ell p_{t-\ell}$$

(Symbols as previously).

Hypothesis (2.3) has been unhesitatingly and rather unanimously praised as Fisher's great pioneering contribution to expectation theory, being a sort of forerunner of the modern variants of adaptive expectation formation, as formulated by Cagan and Friedman[99]. It was only rarely[100] pointed out that (2.3) differs distinctly from the implication of perfect foresight $p^*_t = p_t$[101]; for example, in the simplest case where $n = 1$, (2.3) yields $p^*_t = p_{t-1}$.

As regards justification of hypothesis (2.3), it may be pointed out (in the framework of a partial analysis confined to capital markets) that Fisher's distributed lag investigations were carried out in connection with an empirical test of his theorem. Fisher had already come to the conclusion that "perfect adjustment through foresight" could not exist, but he did not abandon his general emphasis on the role of expectations. This might indicate, together with his concluding interpretations

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(98) Early examples are the interpretations by Hamburger and Silber (1969), Yohe and Karnosky (1969), Gibson (March 1970) and (June 1970), Feldstein and Eckstein (1970), Sargent (1972) and (February 1973), who a decade ago gave expression to the renewed interest in Fisher's theorem and the distributed lag idea in connection with the debate on modern monetarism.

(99) Cagan (1956) and Friedman (1957). A typical extract: "Anticipating the work ... of Cagan and Friedman by about twenty-five years, Fisher posited that people form expectations by taking a weighted sum of current and past actual rates of inflation ..."; Sargent (February 1973), p. 386. Moreover, Sargent's reference to "current rates of inflation" is incorrect; Fisher ignored the current period; in formula (2.1) the time index runs from 1 to n, and not from 0 to n.

(100) Such exceptions are, for example, Mundell (1963) and, more recently, Dornbusch and Fischer (1981).

(101) The time index t denotes the current period; it was superfluous in the original theorem, which describes a static situation of equilibrium, and was omitted by Fisher (and likewise in the above presentation in Section 1.2).

(see Chapter 3 below) that he only changed the specific assumption on the way expectations are formed. However, Fisher was never explicit on this point. In addition, his macroeconomic perspective justifies serious doubts as to the usual interpretation of his theorem in terms of expectation theory (see Section 2.3.3 and Chapter 3 below).

If we posit the additional assumption $p^* = \bar{p}$, then the originally postulated dependence of nominal interest rates on expected price changes remains, and the modified nominal interest theorem (in its simplified version) can be formulated as

$$(2.4) \quad i_t = r^*_t + \sum_{\ell=1}^{n} w_\ell \, p_{t-\ell}$$

with the "modern" interpretation that the summary term in (2.4) represents, together with (2.3), a hypothesis on the formation of inflationary expectations - a hypothesis which postulates a gruadual, time-consuming, cumulative adjustment of nominal interest rates to these inflationary expectations. Because of this new thesis of only a gruadual adjustment of i_t to p^*_t, the original implication of a constant, expected real interest rate r^* no longer applies; rather, it is implied that $r^*_t \neq$ const: as long as the rise in nominal interest ($+\Delta i$) lags behind an increase in inflationary expectations ($+\Delta p^*$), the expected real interest rate r^* must fluctuate inversely to inflationary expectations: rising inflationary expectations (where $\Delta i < p^*$) necessarily mean a decrease in the real interest rate ($-\Delta r^*$). Within the framework of an expectation formation hypothesis like (2.3), we have - in respect of the (simplified) original theorem (1.2') - the implication

$$(2.5) \quad (+\Delta p^* \longrightarrow -\Delta r^* \quad | \quad +\Delta p^* > +\Delta i)^{(102)}.$$

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(102) A numerical example: let us assume that $i_t = 10\ \%$, $r^* = 5\ \%$ and $p^*_t = 5\ \%$. Let us also assume that in the next period t + 1 inflationary expectations of 5 % rise to 7 %. If the nominal interest rate is now adjusted initially only imperfectly because of (2.3), for example by $+\Delta i = 1$ % point, the real interest rate must fall by $-\Delta r^* = 1$ % point, so as to comply with equation (1.2'). In period t + 1, the following equation then applies:

$$i_{t+1}\ (11\ \%) = r^*_{t+1}\ (4\ \%) + p^*_{t+1}\ (7\ \%).-$$

The variability of real interest rates is limited to that "transition period" within which the adjustment process of i to p occurs. Consequently (2.3) and (2.4) describe the movements of the real interest rate in a situation of disequilibrium, in the transition period - in complete contrast to the original theorem assuming perfect foresight. And consequently (2.4) describes the "short-term" process of imperfect adjustment of nominal interest rates to price changes in the disequlibrium transition period, again in contrast to "long-term" equilibrium, when the adjustment process has been completed(103). The real interest rate implication (2.5) was later reintroduced into modern writings, in a macroeconomic context and assuming perfect foresight, as the "Mundell effect"(104).

The modification of the theorem in accordance with (2.4) implies as already indicated that the "neutrality" of expected price level changes is suspended in the transition period, and that expected real interest rates vary (inversely) with p^*. At the same time, this modified Fisher theorem is of far greater practical relevance, since iy applies to precisely those (successive) situations of disequilibrium which characterize the practical reality of (cyclical) economic processes. All in all, this means that a central part of modern monetary theory, i.e. the neutrality of money, is banished into a politically irrelevant, distant and practically unattainable utopia in which equilibrium exists (see Section 1.1 above). Lastly, the modern debate on monetarism and its concept of a macroeconomic transmission mechsnism are directly affected by this conclusion.

In view of such serious consequences, it is astonishing how unanimous the literature after Fisher has interpreted his theorem along the lines of (2.4), without weighting it against the original formula. Keynes is the only well-known author to have expressly drawn attention to the lack of clarity resulting from the contrast between Fisher's original theorem assuming perfect foresight and Fisher's use of distributed lags in the context of his (third) empirical test procedure: "It is difficult to make sense of this theory as stated, because it is not clear whether the change in the

(103) An interpretation emphasizing the time horizon may be found in Rutledge (1974) and (1977), Bomberger and Makinen (1977) and Dornbusch and Fischer (1981).

(104) Mundell (1963) and (1971), chapter 2.

value of money is or is not assumed to be foreseen"[105]. This criticism would not have been possible if Fisher had stuck to his original, explicit assumption of perfect foresight - or if he had expressly rejected the original theorem, in view of the test results, in favor of the modified theorem (2.4). Yet Fisher expressed himself clearly enough in business cycle investigations to allow us to understand and interpret his theorem (in the light of his factual evidence) as part of a disequilibrium analysis of macroeconomic transition periods; this is shown by the discussion of his results (below) on distributed lags (see Chapter 3).

2.3.3 Results

Fisher's concluding calculations using distributed lags for the above-mentioned American and British yearly data lead to striking results: the maximum correlation between nominal yield i and the weighted average of lagged inflation rates $\bar{p}$ is obtained for a distributed lag of altogether 28 years (mean lag[106]: about 9 years) with a correlation coefficient of almost one (+ 0.98) in the case of the British data (for the sub-period 1898-1924); and for a total distributed lag of 20 years (mean lag: about 7 years) with a correlation coefficient of + 0.86 in the case of the US data[107]. As far as the closeness of fit is concerned, these results are in stark contrast to the previous results relating to <u>points</u> in time (see above). Fisher does not hesitate to accept the new results: "By assuming a distribution of effect of price changes over several years ..., the relationship between price changes and interest rates ... is clearly revealed. The high correlation coefficients ... show that the theory tested ... conforms closely to reality ..."[108]. Fisher explains directly

(105) Keynes (1936), p. 142.

(106) The mean lag is simply the weighted average lag; it shows the time which elapses until half of the influence of the independent variables (in this case, past inflation rates) on the dependent variable (in this case, nominal interest rate) has taken place. Since in Fisher's calculation method the weights add up to one, he was able to calculate the mean lag L in accordance with the simple formula L = (n-1)/3 or approximately L= n/3. For a basic definition of the mean lag, see Griliches (1967), p. 31.

(107) Fisher (1930), Charts 46 and 47, pp. 421/422.

(108) Fisher (1930), pp. 423/425.

after this statement what theory it is that was being tested: "Our investigations thus corroborate convincingly the theory that a direct relation exists between P' and i /̄ observed inflation rate and nominal interest rate, W.G. 7̄, the price change usually preceding and determining like changes in interest rates"[(109)]. This is clearly the "theory" described in (2.1) and (2.2); once again, no mention is made of any expectational interpretation along the lines of (2.3).

Taking quarterly data for short-term interest rates (money market rates for 4 to 6 month commercial paper) and quarterly rates of price changes in the United States (total investigation period I/1890 to IV/1927)[(110)] Fisher essentially reaches the same results. Once again, correlations at certain points in time between rates of price change and leads or lags in nominal interest show little or no relationship, and once again the introduction of distributed lags changes the picture drastically: for example, in the sub-period 1915-1927, the correlation coefficient reaches a maximum value of + 0.74 only when a total of 120 quarters (30 years) is included in the distributed-lag period - suggesting that a price change spreads its influence on nominal interest rates over no less than three decades.

From these results (regarding the influence of lagged price changes on nominal long-term bond yields and on short-term market interest rates) Fisher concludes that his basic idea of a positive relationship between nominal interest rates and inflation rates is independent of the length of period: "It would seem ... that price and interest fluctuations are governed by <u>one</u> law, not, as has been suggested, by two different opposing laws, for short and for long periods of time"[(111)]. Evidently, Fisher himself here confuses the time horizon of his theorem with the term (or maturity) of the interest rates considered. It is correct that this "one law" applies in <u>principle</u> to short and long time periods -

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(109) Fisher (1930), p. 425.

(110) Fisher (1930), pp. 425-429 and Appendix, pp. 532/533.

(111) Fisher (1930), p. 428 (underlining by Fisher).

if it is understood as the expression of the general basic idea of the theorem, whereby each interest rate must be seen in relation to the standard in which it is expressed (see above). In specific, quantitative terms, however, the "law", by Fisher's own results, comes into operation only gradually, in the course of a long adjustment process.

3. Fisher's evaluation of evidence

3.1 Explanation of the Gibson paradox

The time series used by Fisher for the nominal yields of British long-term securities (consols) was derived from investigations carried out by A.H. Gibson, who had earlier established a close positive correlation between the price level and nominal interest rates (specifically, nominal yields on consols)[112]. Keynes termed this empirical phenomenon the "Gibson paradox"; he regarded it as a paradox because it contradicted classical interest theory under which "the" interest rate, though determined by fundamental real factors such as saving (or time preference) and capital productivity (or opportunity to invest), is independent of "monetary" factors such as the quantity of money and the price level[113].

At the same time as Keynes, Fisher was also examining the empirical findings presented by Gibson. Fisher's main concern was to make clear empirically and theoretically the connection or difference between the Gibson paradox and his own theorem. His starting point was the basic distinction between the price level and the rate of price change (inflation rate), i.e. between the absolute level of a (price) series and its first derivation: The Gibson paradox relates to the observed (positive) relationship between nominal interest rates and the price level; the Fisher theorem (in whatever formulation) relates to the (positive) relationship between nominal interest rates and rates of change in the price level (inflation rates). Fisher does not stress the fact that his theorem relates to expected inflation rates, as these can be linked up theoretically and empirically with observed inflation rates only if an expectation formation hypothesis is introduced; instead, he argues throughout on the basis of observed rates of change in the price level.

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(112) Gibson (1923).

(113) Keynes (1930), pp. 198-210. The Gibson phenomenon was in the last analysis regarded as a paradox, because it was consistent with the facts, but not with the theoretical "classical dichotomy".

Fisher first reproduces the facts of the Gibson paradox by calculating correlation coefficients for the long series of British and American yearly bond yields and price indices (see above). The correlation coefficients are highest for a lag of about one year in nominal interest rates. The values of the correlation coefficients fluctuate, with one exception, around + 0.9 and consequently show a very close positive relationship in accordance with the Gibson paradox. This factual evidence is confirmed with quarterly data and short-term market interest rates. Fisher summarizes as follows: "These highly significant correlations seem to establish definitely that over long periods of time high or low interest rates follow high or low prices by about one year"(114).

Fisher also checks this result statistically against possible trend influences. Detrended series (consisting only of cyclical, seasonal and irregular components) show similarly high correlation coefficients between 0.7 and 0.8, when interest rates are lagged by one year(115). In periods of marked fluctuations in the price level, the relationship with nominal interest rates is particularly close if the short lag of one year is applied.

Fisher summarizes as follows: "It is quite definitely demonstrated that ... the effects of price movements are felt rather quickly upon the rates of interest, even in the case of long term bond yields"(116).

The empirical evidence of the Gibson paradox whereby high nominal interest rates are accompanied by high price levels and low nominal interest rates by low price levels is explained by Fisher as an "accidental consequence"(117) of the empirical relationships that he was able to determine in investigating his theorem; these empirical relationships were:

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(114) Fisher (1930), p. 430.

(115) Fisher (1930), pp. 431-438.

(116) Fisher (1930), p. 438.

(117) Fisher (1930), p. 440.

(1) nominal interest rates tend to be high when the price level is rising (inflation) and low when the price level is falling (deflation);

(2) there is a time lag in the adjustment of nominal interest rates to rates of price change, with the adjustment being distributed over a period of almost three decades.

From a theoretical point of view, Fisher equates the long period referred to in (2) (defined by the distributed lag corresponding to a maximum correlation coefficient) with his concept of a transition period; he is evidently resorting here to a basic reasoning which he developed earlier in analyzing the quantity theory of money. The transition period is therefore (despite its length) denoted as a "short-term" period of adjustment, in contrast to a "long-term" state of equilibrium once the adjustment processes have been completed, including real interest rate adjustments[118].

In the transition period, there is a cumulative adjustment of nominal interest rates to (expected) rates of price change in accordance with Fisher's (technical) distributed lag assumption. If a large part of the cumulation has taken place towards the end of the transition period, then precisely because of the adjustment process, a high interest level will correspond to a high price level. However, Fisher argues that this phenomenon, i.e. the Gibson paradox, would undoubtedly disappear if the high price level were to remain unchanged: for, given a zero rate of price change, i.e. a constant, albeit high price level, nominal interest must according to Fisher's theorem fall again to the level of the real interest rate. The chart in Chapter 1 (see page 15 above) demonstrates this clearly.

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(118) Fisher (1911). The distinction between a "short-term" transition period and a "long-run" state of equilibrium is of crucial importance in Fisher's reformulation of the quantity theory of money: this theory and the famous quantity equation associated with it apply <u>only</u> in a state of long-term equilibrium.

In fact, however, the price level is found not to be stable over time (e.g. in the long periods observed by Fisher and Gibson for Great Britain and the United States), but to be constantly changing. Consequently, there is literally no time for nominal interest rates to react fully, in accordance with Fisher's theorem, and to fall to the level of the real interest rate in any situation of price stability.

The Gibson paradox is thus attributed to the combined effect of the lack of price stability and the adjustment dynamics of the modified (simplified) Fisher theorem. Fisher summarizes: "Thus, at the peak of prices, /̲ nominal, W.G. /̲ interest is high, not because the price level is high, but because it has been rising and, at the valley of prices, interest is low, not because the price level is low, but because it has been falling"[119].

The empirical relation described by the Gibson paradox is therefore an "accidental consequence" of the Fisher theorem to the extent that, without the ("accidental") fluctuations in the price level, i.e. lack of price stability , it could not occur in the long run, i.e. in a situation of equilibrium. Fisher thus clearly bases his argument on the classical dichotomy: he quite explicitly regards it as inconceivable that, in a state of long-term equilibrium, a high price level, resulting for example from preceding monetary expansion, should be accompanied by a higher nominal interest level than that (lower) interest level which had obtained before the inflationary rise in prices: "The price level as such can evidently have no permanent influence on the /̲ nominal, W.G. /̲ rate of interest except as a matter of transition, from one level or plateau to another"[120]. In a situation of long-term equilibrium, therefore, the price level is neutral in relation to nominal interest rates.

After the Second World War, the Gibson paradox has been 'rediscovered' as a result of persistent inflation problems facing the Western industrialized countries[121]. In connection with empirical discussions of the

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(119) Fisher (1930), p. 441 (My underlining).

(120) Fisher (1930), pp. 440/441. As an example, Fisher refers to the "absurd" idea that nominal interest could rise to a higher level "if ... we were to call a cent a dollar and thereby raise the price level a hundredfold" (op. cit.)

(121) See, for example, Meiselmann (1963), Friedman and Schwartz (1976) and Shiller and Siegel (1977) for the United States, Badura (1977) and Sauer (1977) for the Federal Republic of Germany and Fase (1975) for the Netherlands. The list could be continued for other countries.

more recent documentation on the long-term relationship between price level and nominal interest rates, criticism was expressed of Fisher's explanation of the phenomenon(122). We will not enter into this debate in detail.

However, a general point should be made: a number of authors have obviously not taken note, or have not taken full note, of Fisher's theoretical and empirical arguments as described above: emphasizing the extremely long time lags detected by Fisher, they interpret the (modified) Fisher theorem itself as a reformulation of the Gibson paradox. In fact, in purely empirical terms, an average of rates of price change over a number of decades is an approximative indicator of the price level itself. Consequently, under this interpretation, the Fisher theorem and the Gibson paradox are regarded virtually as synonymous expressions(123). In view of Fisher's theoretical and empirical arguments outlined above, this identification of the two as equivalent is incorrect, since it fails to give a true reflection of Fisher's point of view; equating the Gibson paradox with the Fisher theorem is a misinterpretation. This can be seen most clearly if one assumes a stable price level; in such circumstances, Fisher's theorem and the Gibson paradox are not consistent with each other (cf. Chapter 1 and Chart 1.1).

3.2 Long lags and the transmission mechanism

Even to Fisher, it seemed fantastic, at first glance, to ascribe to price changes which occurred two or even three decades ago any influence affecting the rate of interest today(124). He nevertheless tried to find precise economic reasons for this long lag phenomenon(125). He first draws analogies on the long-term economic effects of natural disasters to substantiate the phenomenon of an extremely long period of impact as such. There-

(122) For example, by Shiller and Siegel (1977).

(123) I am thinking here of Shiller and Siegel (1977), pp. 896 and seq, and Sargent (February 1973), pp. 386/387. A typical statement is: "However, it is possible to argue that Fisher's explanation of the Gibson Paradox is really only a redefinition of it" (Sargent, February 1973, p. 387).

(124) Fisher (1930), p. 428.

(125) Fisher (1930), pp. 429 et seq, in particular pp. 439/440.

after, Fisher tries to explain his long lags within the framework of business cycle theory, emphasizing theory and evidence of the transmission of price changes to nominal interest rates. The deeper significance of Fisher's analysis here lies in the theoretical incorporation of the modified theorem into a structural, macroeconomic disequlibrium model. Fisher's discovery of the "Phillips curve" should also be noted in this connection (see below).

At a very early stage of his research, Fisher envisaged a causal relationship running from price rises via increased macroeconomic activity (more trade, greater demand for capital goods) and hence increased demand for money and credit, to higher nominal interest rates[(126)]. Later, he refined his view on the business cycle effect by including profit expectations of businessmen: "Rising prices increase profits both actual and prospective, and so the profit taker expands his business. His expanding or rising income stream requires financing and increases the demand for loans"[(127)]. Fisher's argument here must be seen as a "concentrate" of his previous analyses of the transmission process in the context of the quantity theory of money[(128)]. In his "Purchasing Power of Money", he presents a dynamic analysis of nominal interest adjustment in the disequilibrium of the transition period from one (theoretical) state of equilibrium to the next[(129)]. Fisher describes a monetary business cycle theory of Wicksellian provenance, the main item of which is the effects of discrepancies between a "normal" or "natural" interest rate and the nominal interest rate; in so doing, he equates his real interest rate with this normal interest rate. The discrepancies result from money illusion and lead amongst other things to cyclical changes in credit demand. When the role of the banks is included, the analysis produces a sequence which Fisher summarizes as follows:

"1. Prices rise ...

2. The rate of interest rises, but not sufficiently.

3. Enterprises, encouraged by large profits, expand their loans.

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(126) Assuming a given amount of reserves in the banking system; see Fisher (1896), pp. 76-79. The argument is obviously along the lines of Wicksell (1898) and (later) Keynes (1936).

(127) Fisher (1930), p. 439.

(128) Fisher (1922).

(129) See in particular pp. 56-60.

4. Deposit currency ... expands relatively to money /‾notes and coins, W.G._7.
5. Prices continue to rise ..."(130).

An initial price rise therefore triggers a chain reaction which tends to repeat itself. This thesis, which has regained relevance today, is based on the inadequate adjustment of nominal interest rates to the "normal" or "natural" rate: "Rise of prices generates rise of prices, and continue to do so as long as the interest rate lags behind its normal figure"(131).

The significance of this statement by Fisher (who might be described as a quantity theoretician here) would be only incompletely grasped if it were seen solely, or primarily, as an argument to justify his long lag evidence. Rather, the transmission concept just sketched is to be understood as a theoretical basis for the modified Fisher theorem itself, i.e. as a disequilibrium framework incorporating precisely those fluctuations in real interest rates which Fisher diagnosed as a consequence of the gruadual and incomplete adjustment of nominal interest rates. We must not be misled here by Fisher's own evident confusion of real interest and interest on capital, which can be assumed to be identical only in a situation of equilibrium (e.g. as in the original theorem): it must be remembered that the monetary business cycle theory adduced means that a precise distinction must be made between Fisher's original and modified theorems.

It is further evident that, while Fisher's expectations do play a role in the cyclical model described, it is not inflationary expectations, but firms' profit expectations which are the relevant expectation factor (see above). Although the modified nominal interest theorem is incompatible with this, the way in which it interprets expectations is not. Some signs that this is coming to be realized have begun to emerge recently in the literature. For example, B. Friedman makes the following statement: "Somewhat astonishing to the modern reader, Fisher's suggested interpretation followed Knut Wicksell in noting that higher prices usually meant a greater nominal volume of trade, which in turn increased

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(130) Fisher (1922), p. 60. For a recent presentation and analysis of Fisher's monetary business cycle theory, see Bomberger and Makinen (1977); on the interaction of nominal and real interest rate effects, see Carr and Smith (1972).

(131) Fisher (1922), p. 60 (underlining in the original).

the demand for money, and hence increased nominal interest rates for given bank reserves. What is surprising about this interpretation is that, as rendered by Fisher, it has nothing whatever to do with /‾price, W.G._7 expectations"[132].

The "Phillips curve" relationship which is built into the cyclical framework as postulated by Fisher[133] results, according to Fisher, in a temporary (or, in modern terms, transitory) decrease in unemployment if (observed) inflation rates are rising: "When the price level is rising, a businessmen finds his receipts rising as fast, on the average, as this general rise of prices, but not his expenses ... The businessman, therefore, finds that his profits increase ... Employment is then stimulated ... for a time at least"[134]. The short-term inverse relationship between inflation and unemployment, which has recently been "rediscovered" in a series of investigations and was examined in connection with Friedman's "natural rate hypothesis"[135], therefore complements the described cyclical effects by affecting business profits.

Fisher's thinking on transmission theory cannot be pursued further in detail here. The business cycle framework and the Fisher-Phillips curve cannot, as qualitative considerations, be taken to indicate any specific (long) period of duration of interest adjustment processes. Fisher therefore supplemented his theoretical considerations on the (macroeconomic) transmission process with quantitative results taken from earlier investigations[136].

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(132) Friedman (March 1980), p. 32; see also Rutledge (1977).

(133) It should be noted that in 1926, i.e. long before A.W. Phillips (1958), Fisher postulated and provided statistical evidence of the relationship which has been named after Phillips. Fisher postulated the relationship as a short-term disequilibrium phenomenon. It would therefore be more correct to call the short-term relationship between inflation and unemployment the "Fisher-Phillips curve".

(134) Fisher (1926), p. 786; reprinted in the Journal of Political Economy (1973), pp. 497 et seq. (quotation from p. 498). Fisher continues: The ultimate effects of a long-continued inflation are doubtless bad all round ..." (my underlining).

(135) Friedman (1969); for a survey, see Gordon (1976) and (1978), Frisch (1980) and Dornbusch and Fischer (1981). One of Friedman's key sentences, in concurrence with Fisher, is as follows: "... there is always a temporary trade-off between inflation and unemployment; there is no permanent trade-off"; Friedman (1969), p. 104.

(136) Fisher (1925) and Fisher (1926).

According to these, the lag with which the volume of trade (in present-day terms, an approximation of total gross national product) affects price changes is distributed over about two years. By adding the evidence (at Fisher's time) of a lag of nominal interest rates behind the volume of trade amounting to some 14 months, Fisher only obtained a combined lag between inflation and the nominal interest rate responses of just over three years[(137)].

The extremely long distributed lags calculated by Fisher could not therefore be substantiated through evidence in transmission theory terms. Fisher simply noted this failure and left it at that. The inconsistency between Fisher's distributed lag calculations, which he interpreted as a quasi "reduced form" of his monetary business framework, and the structural transmission lag results remains an unresolved issue.

3.3 Reversed causality and interest rate policy

In his explanation of the Gibson paradox, as in the context of his business cycle theory, Fisher took account of the role of the banking system and the "reversed" causality: nominal interest rate → price level. In any inflation process, the question arises of how far the banking system is willing and able to finance it. The scope for appropriate monetary expansion (e.g. loan expansion by credit institutions) is generally restricted by institutional conditions and central bank policy. During Fisher's time, monetary rules governing gold currency were among the factors limiting the expansion potential of a (national) banking system including the central bank.

If at some stage during a continuing inflationary process, national monetary expansion comes up against a quantitative limit, then, according to Fisher, excess demand arises on the money and security markets, which the banks resist by further raising nominal interest rates. The rise in interest rates will ultimately reach a point where contractive quantity and price effects are triggered in the economy.

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(137) Fisher (1930), p. 440.

The reversed causality: nominal interest rate → price level therefore depends on explicit account being taken of nominal interest rate policy of banks. Accordingly, Fisher's causal relationship : higher inflation → higher nominal interest rates is supplemented by the further consideration that high nominal interest rates are initially accompanied by a rising price level (Fisher theorem) and then by a falling price level (credit restriction, reversed causality with reversal of the algebraic sign), and vice versa. Consequently, nominal interest rates are high before, during and after the "peak of prices" and low before, during and after the "valley of prices".

Hence we have a positive correlation between nominal interest rates and the price level, i.e. the Gibson paradox[138]. It should be noted that Fisher's argument here is relevant from a present-day monetary point of view, for example with regard to the Bundesbank policy of high interest rates in the period 1979-1981.

We can see from this reasoning that Fisher clearly accepts the thesis of a mutual relationship between nominal interest rates and inflation: both directions of causation must therefore be taken into account analytically[139]. In addition, he accepts the causality between nominal interest rates and inflation as the real focus of any central bank policy aimed at stability: according to Fisher, an (exogenous) increase in nominal interest rates by the central bank will always tend to pull down the price level, and vice versa in the case of a decrease in nominal interest rates[140]. He states that this inverse causal relationship between nominal interest rates and the price level is a fact which has been quite well established and that it is made use of by central banks in formulating their banking and credit policies[141]. Quite clearly, this is once again a position which is relevant with regard to the modern controversy surrounding "money supply" theory. One can justifiably argue that Fisher anticipated by 50 years the basic idea of money stock control through interest rates, as explicitly

(138) Fisher (1930), p. 442.

(139) Fisher (1930), p. 443 and footnote 21.

(140) "In fact, an arbitrary increase in i at any time does tend to pull down the level of general commodity prices, while a decrease in i tends to increase P"; Fisher (1930), p. 443; see also the passages from Fisher's "Purchasing Power of Money" mentioned in the previous section.

(141) Fisher (1930), p. 443.

applied, for example, by the Deutsche Bundesbank[142] and the British monetary authorities[143] in recent years[144].

The mutual causation between nominal interest rates and rates of price change does not represent any inconsistency in Fisher's view. In support of his argument, he refers to the different time horizons involved in the various directions of influence: in contrast to the very long lags of influence with regard to his modified theorem, he points to a very short lag in the reversed direction of causality nominal interest rates → inflation: a decrease in nominal interest rates for example, will initially produce a rapid increase in economic activity and in prices. After a few months, increased prices will have a feedback effect on nominal interest and will pull the interest rate up[145]. Quite clearly, Fisher's analysis here again anticipates a modern monetarist's proposition, namely Friedman's rejection of nominal interest rates a appropriate "indicators" of central bank policy[146].

The present-day relevance of Fisher's discussion and application of his modified theorem is not confined to his general references to the interactions between nominal interest rates and rates of price change. Through detailed consideration of the conditions governing monetary expansion by banks, particularly of the reserve position of credit institutions and its importance for money market conditions, Fisher has something specific to say on the rôle of banks in the monetary expansion process[147].

His point of departure is the practical observation of an inverse relationship (significant negative correlation) between the level of bank reserves and (short-term) money market rates[148]. From this, in view of national and international liquidity flows, he concludes that there is

(142) See Ehrlicher and Oberhauser (1978) and the further bibliographical references given there.

(143) Monetary control (1980).

(144) On the controversy surrounding money stock control, see Federal Reserve Bank of Boston (1980) for an American point of view.

(145) Fisher (1930), p. 444.

(146) Friedman (1969).

(147) Fisher (1930), pp. 444-450.

(148) In a German context, bank reserves can be taken here to mean "credit institutions' balances at the central bank" (and not the central bank money stock target at constant reserve ratios).

quite a powerful economic influence exerted by the "banking machinery",[149] which may quite considerably interfere with the "normal" economic transmission mechanism. In particular, the way in which banks behave (i.e., in more modern and more precise terms, their portfolio behaviour) is largely responsible for business cycles - an argument to which Fisher returned again and again.[150] His proposition that the banking system has a potentially destabilizing influence corresponds to a basic tenet of modern monetarism.[151] Fisher traces this proposition back to the chain of causation: bank reserves → nominal interest rates → business cycle → inflation. If the "interlink" nominal interest rates → money stock development is also inserted, and if one "rounds off" with Fisher's theorem as a feedback relationship inflation → nominal interest rates, one obtains a self-contained sequence of effects which is consistent with modern macroeconomic theory.[152]

Lastly, from Fisher's consideration of the relationship between bank reserves and (short-term) nominal interest rates, we can make a distinction with regard to the relation between money stock and nominal interest rates: the relationship bank reserves → money market interest rates must not be confused with the very different, and generally incorrect, assertion that money interest rates are high when money is scarce, and low when there is an abundant quantity of money. The assertion is incorrect because, according to Fisher, the nominal interest rate is not to be understood as the "price of money".[153]

(149) "Banking thus becomes... a most powerful independent influence"; Fisher (1930), p. 448.
(150) See, for example, Fisher (1925).
(151) If one regards the central bank as the control institution with responsibility for the banking system; see Friedman (1959).
(152) The complete chain of causation is then: bank reserves → nominal interest rates → money stock → business cycle → prices, price expectations [→ credit demand → bank reserves] → nominal interest rates ...
(153) Fisher (1930), pp. 46/47 and p. 447. Without specifying or indeed taking full account of Fisher's original contribution, the question of the "price of money" has recently been taken up by monetarists and introduced into the debate; see the argument between Friedman and Tobin in Stein (1976). Generally speaking, Fisher felt that such oversimplifications were misleading rather than enlightening.

The conceptual discussion of the rate of interest as price of money, price paid for the use of money, marginal efficiency of money or purchasing power of money (as inverse of the price level) is, however, misleading in the present context.(154) Rather, Fisher's position points to his earlier findings on the quantity-theory relationship between money stock and price level: During long transition periods, an abundant quantity of money does not necessarily raise the price level proportionately (if at all). Hence, monetary expansion, inflationary developments, and reactions of nominal interest rates are quite loosely connected phenomena in transition periods. Therefore, in reality, we may witness monetary expansion without significant interest rate effects in the "short run".

On the basis of the theory of interest, one can at most speak of a relationship between a relative price (i.e. the interest rate) and the purchasing power of money.(155)

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(154) The reader is referred to the Annex to Chapter 1 above.

(155) See Annex to Chapter 1 above.

3.4 Practical application

On the basis of a scenario of incomplete, time-consuming and indirect adjustment of nominal interest rates to inflation or inflationary expectations, accompanied during long transition periods by imperfect foresight, money illusion and marked inverse fluctuations in real interest rates[(156)], Fisher draws conclusions on the applicability of his original theorem in theory and practice: since, e.g. when the price level is rising, interest rates increase slightly in nominal terms, but fall sharply in real terms (and vice versa when the price level is falling), it is in practice of the greatest importance to have regard to movements in the price level. This is because the very imperfect adjustment of nominal interest rates to (expected) inflation rates leads, in the case of financial assets with a fixed nominal interest rate, to an unforeseen loss for lenders and an unforeseen gain for borrowers: "It is consequently of the utmost importance, in interpreting the rate of interest statistically, to ascertain in each case in which direction the monetary standard is moving and to remember that the direction in which the interest rate apparently moves is generally precisely opposite to that in which it really moves"[(157)].

Fisher thus addresses the practical business man. He refers him to the currently observed rates of price change as the main basis for distinguishing true, i.e. real, from apparent, i.e. nominal, interest movements[(158)]. In view of the obvious falsification of his original theorem because of the ultimate imperfectness of expectations and foresight, Fisher logically refrains from any extensive theoretical evaluation of his theorem and instead places the emphasis on its practical relevance: "If the money

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(156) "... changes in the purchasing power of money tend ... to affect the nominal rate of interest in one direction and the real rate of interest in the opposite direction"; Fisher (1930), p. 505.

(157) Fisher (1930), p. 494.

(158) "The business man supposes he makes his contracts in a certain rate of interest, only to wake up later and find that, in terms of real goods, the rate is quite different"; Fisher (1930), p. 44.

rate of interest were perfectly adjusted to changes in the purchasing power of money - which means, in effect, if those changes were perfectly and universally foreseen - the relation of the rate of interest to those changes would have no practical importance but only a theoretical importance. As matters are, however, in view of almost universal lack of foresight, the relation has greater practical than theoretical importance"[159]. The literature has not followed Fisher in this approach. Rather, in partial and macroeconomic analyses, the theoretical aspects have been emphasized. This might be justified, at least partially, by the steady disappearence of "money illusion' in recent years. Nevertheless, detailed practical investigations into the calculation and application of real interest rates at financial markets are still urgently needed.

(159) Fisher (1930), pp.43/44.

Summary

1. Fisher's original theorem in complete form is as follows:

$$(1 + i) = (1 + r^*) \quad (1 + p^*)$$

i = nominal interest rate,

r^* = expected real interest rate,

p^* = expected inflation rate (rate of price change).

It is based amongst other things on the assumption of perfect foresight. From this it follows that there is equality of expected and actual variables, i.e.

$$p^* = p$$

and

$$r^* = r.$$

The theorem can be considered as a static equilibrium condition. It does not a priori contain any restrictions as to its scope. By multiplying out and transforming, we obtain the original nominal interest theorem

$$i = r^* + p^* + r^*p^*$$

and the original real interest theorem

$$r^* = (i - p^*) / (1 + p^*).$$

All the formulations are interpretable as equilibrium definitions and as empirically testable behavioural equations, with the restrictions

$i, \ r^* \geqslant 0,$ such that, by assumption,

$i \geqslant p^*.$

When inflationary expectations change, the spread between the nominal interest rate and the real interest rate does not remain equal to inflationary expectations; instead, we have

$$i - r^* > p^*.$$

The reason for this is, technically speaking, the absence of continuous compounding (i.e. discontinuous time). In terms of economic interpretation, the inequality arises due to the forces behind changing inflationary expectations.

Anyway, the nominal interest rate must exceed the expected real interest rate by more than the expected inflation rate. We can delete "more than", in the simplified versions of the original nominal interest theorem

$$i = r^* + p^*$$

and of the original real interest theorem

$$r^* = i - p^*.$$

The simplified versions ignore expected changes in the purchasing power of interest payments, i.e. the corrective terms r^*p^* and $(1 + p^*)$ in the above, complete formulations. The simplification yields a precise statement in the case of continuous, infinitely frequent interest payments (compound interest). If the corrective terms r^*p^* and $(1 + p^*)$ are close to zero and close to 1 respectively, the simplification may be justified empirically.

Because of the assumption of perfect foresight, the original theorem in all its versions implies a prompt and complete adjustment of nominal interest rates to inflationary expectations. Hence, in theory, expected real interest rates are constant: they are not influenced by (changes in) inflationary expectations ("neutrality", i.e. homogeneity of degree zero in prices).

The original theorem formulates in general terms the "law" of the mutual interrelationship between (two) interest rates which are expressed in different standards. It does not in any way claim to explain the interest rates themselves, whatever the standard in which they are expressed. Fisher dealt with an explanation of interest rates in his interest theory proper - on the assumption of a constant price level, i.e. equality of nominal and real interest rates.

2. Fisher proceeds in three stages in carrying out an empirical investigation of his theorem. In the first two stages (comparison of yields and comparison between nominal and real interest rates calculated ex post), Fisher tests the simplified versions of his original theorem.

Fisher's evidence (on long-term bond yields and short-term money market and bank rates) suggests that nominal interest rates and expected inflation rates broadly move in the same direction. However, nominal interest rates adjust only slowly, incompletely and indirectly to expected inflation rates. Real interest rates are consequently not constant, but fluctuate, and indeed actually fluctuate to a far greater extent than nominal interest rates.

Fisher attempts to explain the factual evidence firstly on the basis of the existence of money illusion, which prevents perfect anticipation of inflation (prevents "perfect foresight"). Secondly, he puts "indirectness" down as a dynamic macroeconomic transmission mechanism: The chain of events from inflation → expected business profits → employment and overall economic activity (Phillips curve!) → loan demand → nominal interest rates explains "indirectness" and suggests a time-consuming pattern of adjustment.

In response to the factual evidence which contradicts his theorem, Fisher concentrates lastly on quantifying as precisely as possible the relation between nominal interest rates and observed inflation rates and the time lag involved. For this purpose, as the third stage in his empirical investigation, he calculates correlation coefficients to determine the closeness of link between nominal interest rates and distributed lags in inflation rates. The original assumption of perfect foresight together with the associated implication of perfect nominal interest adjustment is dropped. Specifically, Fisher tests the relationship between the present nominal interest rate i_t and the weighted average $\bar{p}$ of the distributed lags of inflation rates $p_{t-\ell}$, i.e. $\bar{p} \rightarrow i$, with arithemetically declining weights w_ℓ, i.e.

$$\bar{p} \rightarrow i, \ \bar{p} = \sum_{\ell=1}^{n} w_\ell p_{t-\ell}.$$

Lagged past inflation rates show a very close, positive correlation with current nominal interest rates, with the lags extending over two to three decades. These results explain and quantify, in an extreme way, the evidence found earlier that nominal interest rates do not adjust perfectly to inflation rates.

3. Fisher's correlation cannot be regarded as an empirical investigation of his original theorem. Rather, in view of the apparent lack of foresight found earlier, they serve only to test the basic idea of the theorem: that interest rates are always relative to the standard in which they are expressed. Consequently, Fisher tests specifically the relation between money interest rates and observed lagged changes in the purchasing power of money (or in the price level). In a macroeconomic disequilibrium discussion, Fisher describes this relationship in terms of the "transition period" of an economy from one state of equilibrium to another. Nowhere did Fisher expressly designate his distributed lag approach as an approximation for inflationary expectations.

The modified nominal interest theorem which Fisher analyzed using correlation methods is as follows:

$$i_t = r_t + \sum_{\ell=1}^{n} w_\ell \, p_{t-\ell} \, .$$

(Symbols as above; r_t is the observed real interest rate).

In the secondary literature, the summary term has been interpreted as Fisher's hypothesis of a gradual, adaptive formation of inflationary expectations, i.e.

$$p^*_t = \bar{p} = \sum_{\ell=1}^{n} w_\ell \, p_{t-\ell} \; .$$

The justification of this interpretation must be questioned in view of Fisher's macroeconomic transmission mechanism for the "transition period", which emphasizes not inflationary, but profit expectations (of businessmen).

The modified version is a dynamic formulation. In the "short-term", i.e. for the duration of a transition period covering roughly a decade, it implies an incomplete, slow,and cumulative adjustment of nominal interest rates to past rates of price change. Consequently, in such periods a (fairly considerable) variability in real interest rates is implied: real interest rates fluctuate inversely to the change in inflation rates. Since fairly long historical phases of price stability (rates of price change = zero) cannot be observed, we have in practice a series of transition periods following and overlapping one another. Theoretically speaking, there exists a sequence of (price) disequilibria: the modified nominal interest theorem denotes practically a permanent state of incomplete and lagged adjustment of nominal interest rates to observed rates of price change.

4. The parallel (positive) causation: inflationary expectations → nominal interest rates is consistent with the reversed causality of a Wicksellian relationship: nominal interest rates → inflation. "Fisher" is consistent with "Wicksell". Fisher expressly emphasizes the interactions between "interest and inflation". However, he estimates that there is a considerably shorter time lag for the causality interest rates → inflation than for the reversed causality within the framework of his modified theorem.

Fisher's explanation of the Gibson paradox is based on the evidence which the modified nominal interest theorem suggests for "short term" transition periods plus the complementary proposition of interest rates affecting business and prices: Given a variable price level, the Gibson paradox results from the interaction between slow and incomplete adjustments of nominal interest rates to inflation and the fluctuating price level itself. Where there is long-term stability in the price level, the (modified) nominal interest theorem and the Gibson paradox are not compatible with one another.

The modified nominal interest theorem is consistent with quantity theory statements on the long-term determination of the price level by the quantity of money only on the basis of the "classical dichotomy" between monetary and "real" economic phenomena. However, "neutrality" of monetary changes in relation to physical "real" economic magnitudes applies without restriction only to the original Fisher theorem, which implies a corresponding constancy of real interest rates. The modified nominal interest theorem is in line with the classical postulate of neutrality only in a situation of long-term equilibrium. In fact, however, that long-term situation of equilibrium in which complete adjustment of nominal interest rates to changes in price level occurs is, because of a time-consuming interest adjustment process and recurring changes in the price level, only a theoretical and not a practically attainable state. Consequently, the modified nominal interest theorem is, in view of economic reality, incompatible with the classical postulate of neutrality put forward in monetary theory: even in the longer run, the (expected) real interest rate continues to be influenced in fact, by (expected) price level changes and any monetary changes that lie behind them.

5. Fisher stressed generally the practical significance of his theorem, combined with a number of detailed statements on the (potentially destabilizing) role of the banking system and of central banks. In particular, he sees a connection between changes in bank reserves (bank balances at the central bank) and inverse changes in nominal market interest rates. Central bank policy can make use of this connection and, via changes in bank reserves, induce interest rate effects which - according to Fisher and Wicksell - have a stabilizing impact on the price level.

Implied here is a modern, interest-orientated concept of money stock control (money "supply" theory). In this connection Fisher also stresses reverse causality: nominal interest rates → price level. Because of the "feedback" relationship described in his theorem (inflation → nominal interest rates), he holds that nominal interest rates cannot <u>on a long-term view</u> serve as indicators for central bank policy. From Fisher's observations, we can construct a closed macroeconomic chain of effects running from bank reserves via interest rate effects to changes in the price level, with repercussions on nominal interest rates in accordance with his modified theorem.

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