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THE NOTIONS OF HORIZON AND EXPECTANCY IN DYNAMIC ECONOMICS[1]

By J. Tinbergen

In a theory of economic dynamics, the ophelimity function of individuals must be supposed to depend on the quantities of goods consumed and the sacrifices brought, not only at the moment considered, but also at later moments. Their offer and demand schemes for each moment then depend not only on the prices governing at that moment, but also on the *price expectances* the individuals have for the future. Among those expectances, those relating to the near future will be of more importance than those relating to a further period. As a first approximation it might be supposed that only the expectances relating to a certain time period (the "*horizon*") are of importance, and all of the same importance. That means that the subject is at every moment t making a definite plan for the period from t to $t+\tau$, and then realizes certain parts of that plan. Before other parts could be realized, the subject makes a "revision" at the moment $t+1$, say, for the period from $t+1$ to $t+\tau+1$, etc.

The purpose of the present paper is to discuss, with the help of these notions, some results of statistical analysis, which cannot be explained by static theory, and which seem to teach something about horizon or expectances.

I

RELATION BETWEEN TOTAL ANNUAL SUPPLY OF NON-PERISHABLE CROPS AND AMOUNTS HANDLED

The amount handled is always smaller than the total supply (crop plus carry-over), the difference being the next year's carry-over. The static theory does not yield us a principle to calculate the proportion of sellings to total supply. I suggested a very much simplified scheme —in which the above-mentioned notions appear—to solve the problem, in *Zeitschrift für Nationalökonomie*, III (1931), p. 169.

In this paper I assumed that

1. demand has the form

$$v_t = f(p_t) + \alpha t$$

p_t being the average price during year t, α a constant;

2. cost of carrying over may be neglected;

[1] I am indebted to Prof. Th. Limperg, of the University of Amsterdam, for several critical remarks, and to the Netherlands' Central Bureau of Statistics for lending the clichés.

3. expectances of further crops and demand may be "reasonable," which means that (A) crop expectances are supposed to be equal to the average crop falling on the acreage and to increase every year with α; (B) demand expectance is supposed to be in the same relation with price expectance as actual demand with actual price.

I reached the conclusion that[2]

$$v_t = \bar{e}_t + \frac{1}{\tau}(E_t - \bar{e}_t) \tag{1}$$

$\bar{e}_t$ being the normal (average) drop for each year; E_t being the actual supply at beginning of crop year; τ being an average horizon of sellers.

This result may be generalized by assuming that apart from the carry-over considered in the above formula and the paper mentioned, there exists a certain stock to meet with the risks of unexpected changes; this supply may be supposed to be proportional to $\bar{e}$,and so the total real supply measured will be

$$s_t = E_t + \beta\bar{e}_t. \tag{2}$$

Formula (1) now turns into:

$$v_t = \bar{e}_t + \frac{1}{\tau}[s_t - \beta\bar{e}_t - \bar{e}_t] = \gamma\bar{e}_t + \frac{1}{\tau}s_t. \tag{3}$$

It is possible to test statistically this relation and to determine τ, as soon as a series of annual figures on v_t and s_t are available—$\bar{e}_t$ assumed to be equal to the trend value of v_t. Such data are indeed available for several important crops; those for coffee, cotton, wheat, and sugar, are given in Tables I and II. From the theoretical deduction it is clear that as supply we shall have to consider the sum of crop and carry-over as far as the latter is in the possession of producers and of dealers. Stocks held by consumers should not be taken account of. It is, however, difficult to tell, and perhaps interesting to discuss at a later opportunity, whether, for instance, importers' stocks should be included or not. When the situation is such that the great bulk of stocks is held by importers, as is the case for coffee before the war, it is clear that those stocks should be included; for our deduction relates especially to those economic subjects that bear the risk of carrying over. The figures for coffee given in Table I therefore include those stocks. The figures for wheat and cotton do not include them; for

[2] As other results of this analysis, one finds two relations that are in good accordance with facts, viz., (1) equality of prices and price expectances for next year except in case of a very short crop; (2) inverse correlation between average price during crop year and carry-over at end of crop year.

TABLE I
TOTAL SUPPLY AND DELIVERIES OF COFFEE, 1884–1913 AND 1920–1931
(Millions of Sacks)

Year	v_t a. World Deliveries	s_t b. Total Supply	e_t c. Trend of Deliveries	C in % of c	a in % of c
1884	9.4	14.8	8.7	170	108
1885	10.6	15.7	9.0	174	118
1886	10.1	14.1	9.3	152	109
1887	10.0	14.3	9.6	149	104
1888	8.1	11.4	9.9	115	82
1889	9.2	12.1	10.2	119	90
1890	9.4	12.2	10.5	116	89
1891	8.7	11.1	10.8	103	81
1892	10.8	13.5	11.1	122	97
1893	10.9	14.0	11.4	125	96
1894	10.6	13.0	11.7	111	91
1895	11.2	13.9	12.0	116	93
1896	11.1	14.7	12.3	120	90
1897	12.2	16.2	12.6	129	97
1898	14.6	21.0	12.9	165	113
1899	13.5	20.1	13.2	152	102
1900	14.0	21.6	13.5	160	104
1901	14.3	25.2	13.8	183	104
1902	15.9	28.7	14.1	204	110
1903	16.0	29.8	14.4	207	111
1904	16.1	29.7	14.7	202	109
1905	16.2	28.8	15.0	192	108
1906	16.7	30.5	15.3	200	109
1907	17.5	34.2	15.6	219	112
1908	17.5	33.3	15.9	210	110
1909	18.6	35.2	16.2	217	115
1910	18.2	32.4	16.5	197	110
1911	17.2	30.8	16.8	184	102
1912	17.5	30.9	17.1	180	102
1913	17.1	30.8	17.4	177	98
1920	14.4	23.1	17.5	132	82
1921	18.1	27.5	18.0	153	100
1922	17.9	25.9	18.5	140	97
1923	19.8	24.3	19.0	128	104
1924	20.7	30.7	19.5	158	106
1925	19.0	28.5	20.0	142	95
1926	20.6	31.5	20.5	154	100
1927	21.6	39.9	21.0	190	103
1928	21.8	40.5	21.5	188	102
1929	21.7	46.7	22.0	212	99
1930	22.6	51.9	22.5	230	100
1931	23.8	58.2	23.0	254	104

Sources and Method of Calculation: World Deliveries from: Roth, *Die Übererzeugung der Welthandelsware Kaffee, 1790–1929*. Total Supply calculated by adding Stock at end of year to World Deliveries during year. Trend of Deliveries: free-hand straight line trend. Even rather important variations in constants of Trend do not affect materially the result for our purposes.

wheat this makes only a small difference in the result for τ; for cotton, however, the difference is of more importance; and τ is larger when importers' stocks are included.

TABLE II

SUPPLY AND DISAPPEARANCE, WHEAT, AMERICAN COTTON, AND SUGAR, 1921–1931

Crop year begin-ning	Wheat		American Cotton		Sugar	
	Supply, million bushels	Disappear-ance	Supply, million bales	Disappear-ance	Supply, million tons	Disappear-ance
1921	3485	3164	13.28	10.78	20.0	18.8
1922	3477	3112	12.26	11.33	19.6	18.3
1923	3867	3449	11.10	10.30	21.4	20.4
1924	3499	3184	14.44	13.72	24.7	23.1
1925	3654	3315	16.84	14.44	26.2	23.6
1926	3759	3382	20.15	17.80	26.3	23.9
1927	3977	3548	15.13	13.64	27.7	25.2
1928	4340	3676	15.79	14.59	29.6	26.8
1929	4095	3459	15.75	12.48	29.6	25.4
1930	4435	3674	17.03	11.69		
1931	4465					

Sources and method of calculation: *Wheat:* Wheat Studies of the Food Research Institute, July 1932, p. 422. From the supply, however, stocks in hands of European importers have been deducted, and to disappearance has been added the increase of those stocks. *Am. Cotton:* Bulletins on Cotton Production and Distribution of the Department of Commerce. Supplies are calculated from crops by adding stocks in public storage in the U. S. and stocks elsewhere in the U.S.; disappearances by subtracting from crops the increases in those stocks. 1921 and 1922 figures approximated from other sources. *Sugar:* "Studies in the Artificial Control of Raw Materials: Sugar"; by J. W. F. Rowe, *London and Cambridge Economic Service.*

To calculate τ it is necessary to make some assumption about $\bar{e}$. As already mentioned above, I have supposed $\bar{e}$ to be equal to the trend value of v_t. In the case of coffee a straight line has been taken as trend, drawn by hand, as it was of no importance to reach great accuracy. The slope of the trend for the pre-war period was chosen as 0.3 millions of bales, for the post-war period as 0.5. (See Table I.) To eliminate further long-run influences, v_t as well as s_t were calculated as percentages of the trend. From Fig. 1 it is seen that there exists a fairly good correlation between those two trend percentages, which enables us to evaluate τ. There seem to be three distinctly different periods in any of which τ has a different value. By rough graphical calculation—a more accurate method seems to have no significance—I find:

for the period 1884–1898: about 2 years.

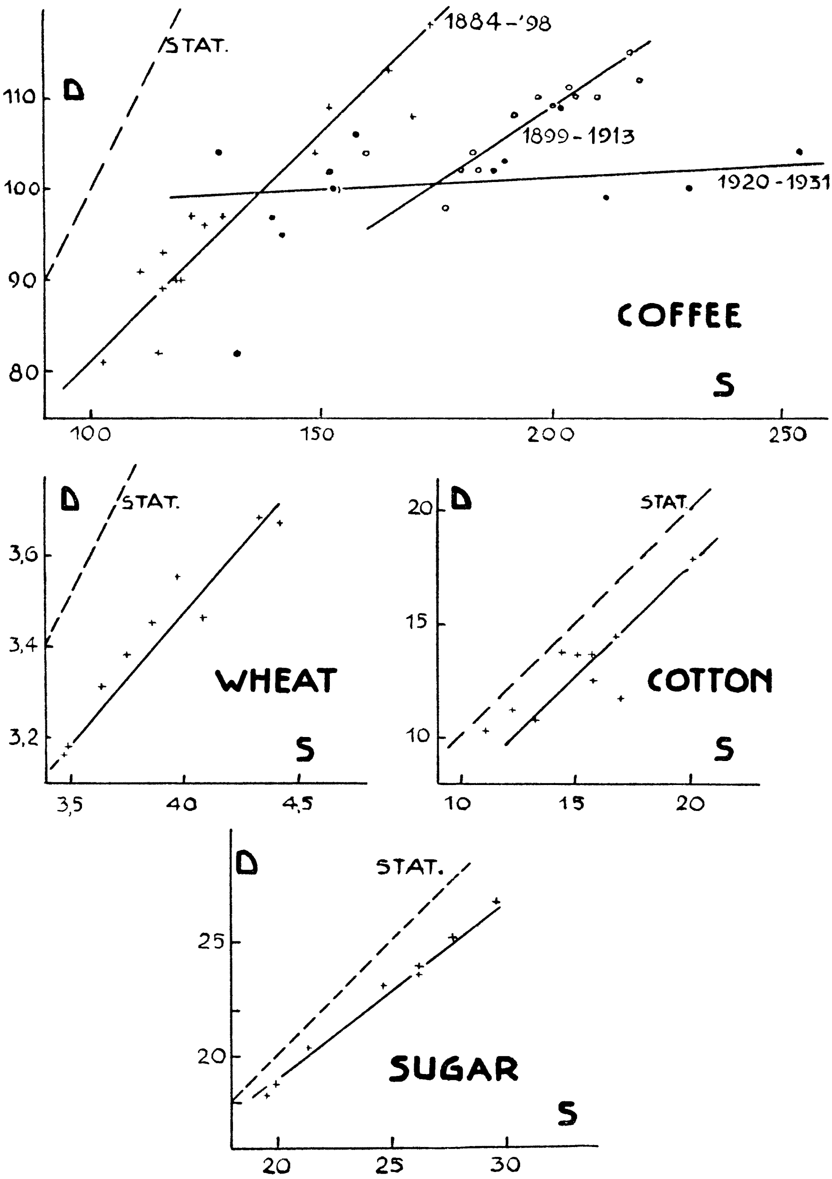

FIGURE 1.—Relation between supply (=carry-over+crop) S and disappearance D during crop year. Coffee: 1884–1913 and 1920–1931; wheat: 1921–1931, cotton: 1921–1930 and sugar: 1921–1929. For data see Tables I and II. The dotted line "Stat." indicates the relation demanded by static theory without taking account of "risk-stocks"; when those latter are included, the direction of the dotted lines still remains characteristic for the "static relation."

for the period 1898–1914: about 3 to 4 years.
for the period 1921–1931: more than 10 years.

It is interesting to remark that Roth[3] indicates 1898 as the year in which the period of market equilibrium existing since 1887 was changed into a period of overproduction lasting until 1908. We can add that before the war a considerable decrease of stocks did not take place; and after the war, especially after 1925, overproduction grew still more serious. Our results may therefore be formulated: that in times of overproduction sellers in a still higher degree behave as if their horizon were widening.

For the cases of wheat, cotton, and sugar, only post-war figures were studied. It was not necessary here to eliminate trends, and it was supposed that $\bar{e}$ was simply a constant. Also, here there seems need for further detailed research. The provisional results found for τ were (cf. Table II and Fig. 1):

wheat: 1.7 years,
cotton: about 1 year,
sugar: 1.3 years.

II

RELATION BETWEEN DIVIDEND PAID ON CERTAIN STOCKS AND THEIR "WORTH"

By worth will be meant, in this paper, the product of a stock's price and the yield of state bonds. This product indicates the fixed interest to which the stock's yield is supposed to be equivalent. The relation between dividend really paid at a given moment (D) and worth (W) can only be established by static theory in the case the absolute certainty exists that the dividend will always remain the same; and then it is simply: $D = W$.

In the case of variable dividend, static theory cannot be applied. As a first approximation we can assume now, in accordance with the notions introduced above, that marginal buyers in the stock market have a definite horizon τ; then a stock's worth will be determined by the dividend expectances during this horizon. This approximation will hold true especially for other than "highly speculative" buyers; for the latter will take account of, and probably take most account of, price expectance for the moment of re-selling. Supposing we have not to do with such speculative stocks, the question arises on what factors dividend expectancies will depend. Indications to the answer are given in the statistical material represented in Charts 2–6 and Tables III–VI.

[3] H. Roth, *Die Übererzeugung in der Welthandelsware Kaffee im Zeitraum von 1790–1929*, Jena, 1929.

TABLE III
DIVIDEND (D) PAID IN THE YEARS 1921–1932 AND WORTH (W) OF THE STOCKS IN QUESTION IN THE QUARTERS (QU) OF PAYMENT

Enterprises		Qu.	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932
1. Werkspoor	D		8	8	6	5.5	6.6	6.6	6	6	7	7.5	7	0
	W	2	4.8	3.9	4.2	4.3	4.0	4.0	4.4	4.0	4.2	4.5	3.6	1.3
2. Ned. Scheepsbouw Mij.	D		8	8	5	0	0	0	0	0	5	6	6	0
	W	2	4.6	3.5	3.7	3.3	2.0	1.9	3.6	3.7	3.9	3.5	2.7	1.4
3. Scholtens A'meelfabr.	D		0	0	0	4	4	0	0	0	0	0	0	0
	W	4	[1]6.1	3.5	3.9	4.3	4.3	3.4	3.3	2.4	2.3	1.4	0.7	1.5
4. Stork	D		11	7	5	0	6	6	6	6	5.5	0	0	
	W	4	4.4	4.1	4.1	3.4	3.9	3.9	4.0	3.8	3.3	2.0	0.9	
5. Feijenoord	D		10	10	10	10	10	10	10	5	7	10	10	0
	W	2	4.8	4.3	4.5	5.2	5.7	6.6	6.8	5.6	5.8	[2]		
6. Heemaf	D		—	0	0	0	0	0	2	5	5	6	5.25	0
	[3]W	2	—	2.0	1.6	1.4	1.5	3.2	3.7	5.2	4.6	3.6	2.6	1.1
7. Van Gelder	D		14	0	9	4	9	15	15	15	15	15	0	0
	W	2	5.2	3.8	5.0	4.2	5.4	6.7	7.1	9.0	8.8	6.9	3.8	2.1
8. Scheepvaartunie	D		14.75	7.2	8	7.3	8.9	10.5	11.4	12.6	12.7	11.3	6.9	0
	W	2	8.1	4.9	5.2	5.8	6.2	7.1	7.9	8.3	8.8	6.8	4.2	1.8
9. Cult. Mij. der Vorstenl.	D		45	12	10	12.5	17	15	7	14	12	10	0	0
	W	2	9.0	7.2	8.1	8.3	7.1	6.9	7.3	7.5	6.4	5.2	3.1	1.4
10. Ned. Handelmij.	D		12	7	6	6	7	7.5	8	10	10	10	6.5	0
	W	2	8.9	5.9	6.1	6.5	5.6	5.9	6.5	7.5	7.4	6.6	4.9	2.3
11. R'damsche Droogd.	D		25	25	15	7	10	10	10	10	12	15	12	6
	W	2	10.8	10.0	7.8	7.8	6.7	6.4	7.1	7.4	11.1	10.3	7.3	3.4
12. v. Nievelt, G. en Co.	D		30	15	5	5	0	0	7	7	0	0	0	0
	W	2	11.7	6.5	4.8	4.5	5.1	3.4	5.0	4.6	4.1	2.5	1.6	0.3
13. N. I. Suikerunie	D		—	15	16	22.5	33.5	22.5	20	20	19.5	19.5	0	0
	W	2	8.0	8.1	11.8	11.8	10.2	9.2	11.5	11.8	9.6	8.6	5.0	2.4

TABLE III, *continued*

14. Kolon. Bank	D		20	8	11	20	20	17	10	17	15	10	0	0
	W	3	6.6	5.6	6.4	7.9	7.1	7.8	11.0	9.9	9.2	6.0	3.6	2.4
15. Jurgens	D		15	0	0	0	0	[4]15	10	10	10	10	10	10
	W	2	7.4	3.5	3.1	2.8	4.2	6.6	7.2	11.3	17.7	11.7	6.5	4.0
16. Ned. Kunstzijdefabr.[5]	D		15	12	12	20	25	25	16	18	18	0	0	0
	W	2				12.2	17.6	13.0	13.8	21.3	14.6	4.2	2.7	1.1
17. Philips Gloeil	D		31	11	11	11	16	16	16	21	21	21	6	4
	W	2	16.4	11.3	11.6	13.6	17.0	14.4	16.0	28.7	30.0	16.6	6.2	2.6
18. H.V.A.	D		60	25	30	35	40	35	30	30	30	30	15	5
	W	3	19.7	16.7	18.3	23.0	20.9	25.7	28.9	26.9	25.5	15.5	10.4	7.1
19. Kon. Petroleum	D		40	31	26.5	25	[6]23	23	23.5	24	24	24	17	6
	W	3	22.5	20.3	15.2	15.0	15.2	15.2	13.4	16.5	15.6	14.4	7.2	5.9
20. Wood trade (4 ent.)	D			2.7	6.4	6.8	9.4	9.3	9.3	9.2	7.9	3.7		
	W			3.4	3.3	4.2	4.3	4.8	5.2	4.8	4.7	(3.2)	(2.0)	(0.8)
21. Big banks (4 ent.)	D			7.3	6.0	6.4	4.4	5.3	6.6	6.9	7.4	7.5	6.5	
	W			5.3	4.6	5.0	4.2	5.2	5.3	5.4	5.7	5.2	4.8	(2.6)
22. Rubber plantations (3	D			0.7	4.7	9.7	8.2	25.7	23.9	17.2	11.8	10.7		
enterprises)	W			2.3	4.4	5.3	6.0	13.1	11.8	8.4	8.3	(3.9)	(1.7)	(0.6)
23. All Dutch enterprises	D			6.0	5.2	5.3	5.2	5.8	7.0	7.5	8.3	7.7		
considered (69 ent.)	W			4.1	4.2	4.5	4.3	4.8	5.7	7.1	7.9			
24. All colonial enterpr.	D			9.1	8.2	11.3	15.5	16.5	15.2	15.7	15.4	13.5		
considered 23 ent.)[7]	W			6.6	6.9	8.0	8.3	9.5	10.6	10.3	9.7	(6.5)	(4.0)	(1.8)

[1] 1st quarter.

[2] Amalgamation with Wilton's Shipbuilding Yard.

[3] Up to 1926 W is given for the 4th quarter. Since, change of five year.

[4] Combined dividend for 3 years.

[5] Since 1929 Algemeene Kunstzijde Unie.

[6] Old stocks only.

[7] Without Petroleum Company. The "worth" of a stock is calculated by multiplying its price by the yield of 3 percent Dutch State Bonds.

TABLE IV.
STOCK PRICES (K), DIVIDENDS PAID (D), AND WORTH (W) FOR EIGHT DUTCH ENTERPRISES 1892–1919

Enterprise	Month		1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905
Amsterdamsche Bank	June	K	151	152	154	208	186	193	199	204	199	185	185	187	192	195
		D	7.5	7	7	7.5	9	8.5	8.5	9	9	8.5	8.5	9	9	8.5
		W	4.8	4.6	4.6	6.2	5.6	5.9	6.1	6.4	6.6	5.9	5.8	5.8	6.1	6.2
Cultuurmij. der Vorstenlanden * No data available	June	K	80	86	88	60	58	51	*	*	53	51	34	41	71	102
		D	4.5	4	5	0	0	2.5	0	2.5	2	2	0	0	3.5	5.6
		W	2.6	2.6	2.6	1.8	1.7	1.5	*	*	1.7	1.6	1.1	1.3	2.2	3.3
Handelsvereeniging "Amsterdam"	July	K	102	90	100	100	100	103	98	111	114	111	103	107	113	154
		D	8.5	6	6.5	6	6.5	7	7	8	9	8	7	7	8	10
		W	3.2	2.8	3.0	3.0	3.0	3.1	3.0	3.5	3.8	3.5	3.2	3.3	3.5	4.9
Intern. Crediet- en H.V. "Rotterdam"	May	K	88	90	91	83	80	70	68	76	81	80	76	80	101	119
		D	4.4	4.4	4.4	4	3.2	3.2	3.2	4.2	3.2	3.2	3.2	3.2	3.2	4.4
		W	2.8	2.7	2.8	2.5	2.4	2.1	2.1	2.4	2.7	2.6	2.4	2.5	3.2	3.8
Javasche Bank	July	K	171	184	178	175	170	161	163	172	175	176	171	179	165	170
		D	3.3	7	9	8	8.1	6.6	6	7.5	7.7	9	8.5	9.3	9.3	9
		W	5.4	5.6	5.3	5.2	5.1	4.9	5.0	5.5	5.8	5.6	5.3	5.6	5.2	5.4
Koloniale Bank	July	K	80	83	85	61	54	45	38	46	47	45	35	29	34	72
		D	0	5	3.5	0	0	0	0	0	0	2	0	0	0	3
		W	2.5	2.5	2.5	1.8	1.6	1.4	1.2	1.5	1.6	1.5	1.1	0.9	1.1	2.3
Nederlandsche Bank	July	K	216	203	211	203	201	199	198	198	189	182	168	181	191	194
		D	8.6	7.5	8.9	6.9	7.6	9.0	9.5	8.7	10.8	10.4	9.4	9.7	10.9	7.8
		W	6.9	6.2	6.3	6.0	6.0	6.0	6.1	6.3	6.3	5.8	5.2	5.7	6.0	5.9
Ned.-Ind. Handelsbank	July	K	91	96	94	77	67	80	83	78	83	83	68	61	87	140
		D	4	6.3	5	0	2.3	4.5	3.3	4.7	5	5	2.9	0	5	9.1
		W	2.9	2.9	2.8	2.3	2.0	2.4	2.4	2.6	2.8	2.6	2.1	1.9	2.7	4.5
3 per cent Dutch State Bonds	May	K	94	98	99	101	100	98	98	96	91	93	95	96	94	94
	June	K	94	98	101	101	100	99	98	95	91	94	96	96	95	94
	July	K	95	98	101	101	101	99	97	94	90	94	97	96	96	94

TABLE IV, *continued*

Enterprise	Month		1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919
Amsterdamsche Bank..........	June	K	202	191	184	197	201	199	193	189	179	168	173	192	181	185
		D	10	11	8.5	9	10	10	9.5	11	10.5	9	11	13	12	12
		W	6.4	6.4	6.1	6.4	6.6	7.1	7.2	7.4	7.0	7.0	7.0	7.8	7.9	9.1
Cultuurmij. der Vorstenlanden....	June	K	96	101	116	164	171	154	175	163	165	180	219	229	111	242
		D	5.8	6.75	7.5	8	7.25	8.5	10	10	10.5	10.5	15	20	0	15
		W	3.1	3.4	3.9	5.3	5.6	5.5	6.6	6.3	6.4	7.5	8.9	9.3	4.7	11.9
Handelsvereeniging "Amsterdam"	July	K	159	159	161	225	219	227	196	210	216	292	363	422	265	551
		D	10	10	10	10	10	10	10	10	15	25	25	30	25	25
		W	5.1	5.3	5.4	7.2	7.3	8.2	7.3	8.2	8.4	12.0	14.7	17.4	11.7	27.5
Intern. Crediet- en H.V. "Rotterdam"......................	May	K	135	144	148	175	208	199	206	208	198	172	208	222	207	257
		D	7.2	8	8.8	10.4	10.4	10.4	12	12.5	11.5	10	14	17	17	17
		W	4.3	4.8	4.9	5.7	6.9	7.0	7.6	8.0	7.6	7.2	8.7	9.1	9.1	12.2
Javasche Bank.................	July	K	185	185	190	209	225	231	243	240	249	245	251	271	259	305
		D	9.5	11	14	11.4	10.7	13.4	13.2	14	15.2	16	16	18	18	25
		W	5.9	6.2	6.3	6.7	7.5	8.4	9.1	9.4	9.7	10.0	10.2	11.2	11.4	15.2
Koloniale Bank................	July	K	72	83	101	134	131	127	132	123	104	120	138	149	91	210
		D	3	5	6	6	7	7	7	8	6.5	6	8	12	5	7
		W	2.3	2.8	3.4	4.3	4.4	4.9	4.9	4.8	4.0	4.9	5.6	6.1	4.0	10.5
Nederlandsche Bank............	July	K	192	195	208	206	201	210	212	225	223	227	225	216	175	189
		D	8.0	11.6	13.6	8.8	8.3	11.7	10.2	12.2	13.4	13.1	13.4	11.2	13.7	20.7
		W	6.1	6.5	6.9	6.6	6.7	7.6	8.0	8.8	8.7	9.3	9.1	8.9	7.7	9.4
Ned.-Ind. Handelsbank.........	July	K	129	130	129	173	280	265	236	215	207	181	215	213	155	285
		D	10.2	8.7	8	10	12	23	18.5	15	12	10	14	23	12	17
		W	4.1	4.3	4.3	5.5	9.3	9.6	8.9	8.4	8.1	7.4	8.7	8.8	6.8	14.2
3 per cent Dutch State Bonds.....	May	K	94	89	90	92	91	85	81	78	78	72	72	73	69	63
	June	K	94	89	90	93	91	84	80	77	77	72	74	74	69	61
	July	K	94	90	90	94	90	83	80	77	77	73	74	73	68	60

TABLE V
STOCK PRICES AND DIVIDENDS PAID, 1921–1932, FOR THREE JAVA RUBBER PLANTATIONS

Enterprise	Year	Stock prices												Dividends
		Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
1. Amsterdam Rubbercultuur Maatschappij	1921	141	134	116	95	105	86	96	97	91	94	104	106	0
	1922	101	93	85	87	78	61	52	66	75	98	110	116	0
	1923	138	149	149	165	155	149	145	152	155	144	147	145	8
	1924	153	163	148	143	132	117	133	147	151	159	158	162	12
	1925	165	167	189	211	225	229	284	285	318	368	397	386	15
	1926	356	356	344	331	332	313	323	318	334	333	324	316	25
	1927	331	332	351	333	342	307	288	304	298	293	311	323	25
	1928	319	295	264	233	239	230	230	234	228	231	236	232	18
	1929	262	282	275	260	264	256	261	266	266	254	200	167	15
	1930	160	175	148	152	141	121	123	105	89	99	110	104	15
	1931	103	109	111	88	83	73	86	68	50	54	54	44	0
	1932	47	46	41	30.6	30	29.9	42	62	68	62			0
2. Serbadjadi-Sumatra-Rubber-cultuurmij	1921	230	229	197	158	175	139	150	176	169	177	197	227	0
	1922	221	213	208	211	202	193	170	184	197	232	240	267	17
	1923	280	285	293	323	288	282	284	297	299	286	290	262	20
	1924	227	234	211	202	188	177	175	194	193	194	193	203	18
	1925	214	214	220	223	240	238	278	267	300	363	426	410	17
	1926	382	377	365	348	343	313	325	322	339	337	328	321	30
	1927	337	335	352	344	339	306	291	310	299	288	306	329	25
	1928	328	303	256	205	204	201	178	185	172	175	188	181	20
	1929	214	238	235	203	200	187	203	205	206	197	143	120	8
	1930	118	127	113	120	105	85	84	70	58	59	64	62	0
	1931	62	68	71	48	36	37	48	34	20.4	25.5	23.8	19.1	0
	1932	19.3	19.5	15.0	7.1	7.8	7.0	12.5	24.9	30	22.5			0
3. Deli-Batavia Rubbermij	1921	111	106	90	73	85	67	71	77	66	65	71	74	0
	1922	71	64	58	56	47	37	29	37	40	59	65	72	0
	1923	82	81	82	90	84	75	76	79	78	73	76	78	0
	1924	82	82	83	79	72	68	75	83	87	88	87	91	0
	1925	108	110	118	122	140	147	180	179	211	241	281	273	0
	1926	257	255	241	235	241	228	248	244	267	269	259	250	15
	1927	265	269	278	271	281	254	234	248	242	243	252	254	20
	1928	252	235	199	165	168	161	154	164	152	155	163	160	10
	1929	179	196	191	173	173	164	172	175	174	168	127	103	10
	1930	95	110	107	107	93	77	78	62	46	50	60	54	0
	1931	54	60	63	44	41	29	42	31	19	21.2	21.5	18.4	0
	1932	19.7	19.3	14.8	7.6	8.8	8.5	15.5	27.5	33	27.3			0

TABLE VI
RUBBER PRICE AND YIELD ON DUTCH STATE BONDS, 1921–1932

	Year	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Rubber price in (Dutch) cents per ½ kg	1921	68	71			48	40	50	47	45	50	56	60
	1922	52	45	43	45	41	42	40	39	39	53	67	74
	1923	89	96	95	89	77	76	76	82	82	76	65	65
	1924	74	73	69	68	58	56	59	68	76	87	97	101
	1925	102	99	112	118	150	197	253	236	224	243	276	294
	1926	224	175	157	145	126	116	114	108	113	116	110	102
	1927	108	106	111	113	112	102	94	97	92	93	102	109
	1928	106	89	70	58	50	51	52	52	48	48	48	49
	1929	54	67	66	58	59	59	61	58	55	52	46	43
	1930	41	43	42	40	38	35	30	26	23	22	24	24
	1931	22	21	21	17	17	17	17	14	13	13	13	12
	1932	12	11	12	11	10	9	9	11	12	11		
Yield on 3 per cent Dutch State Bonds.	1921	5.55	5.36	5.15	5.13	4.98	4.83	4.84	4.76	4.86	4.85	4.95	5.42
	1922	5.28	5.16	5.04	4.88	4.80	4.79	5.22	4.88	4.69	4.83	4.83	4.83
	1923	4.83	4.79	4.68	4.57	4.49	4.47	4.52	4.52	4.66	4.71	4.69	4.92
	1924	4.70	4.79	4.81	4.90	4.89	4.74	4.55	4.50	4.47	4.53	4.53	4.49
	1925	4.39	4.38	4.27	4.32	4.25	4.08	4.09	4.04	4.07	4.03	4.07	4.12
	1926	4.09	4.10	4.08	4.07	4.06	4.03	3.98	3.97	3.97	3.97	3.96	4.00
	1927	3.97	4.04	4.01	4.05	4.01	4.05	3.97	3.89	3.99	3.97	4.08	4.04
	1928	3.99	3.94	3.87	3.88	3.91	3.87	3.89	3.85	3.84	3.82	3.83	3.87
	1929	3.86	3.83	3.84	3.84	3.96	3.92	3.96	3.94	3.96	3.97	3.99	3.99
	1930	3.92	3.86	3.85	3.87	3.85	3.78	3.79	3.80	3.69	3.73	3.69	3.67
	1931	3.64	3.70	3.69	3.81	3.82	3.70	3.75	3.73	3.81	4.24	4.15	4.59
	1932	4.30	4.14	4.05	3.99	4.13	3.88	3.80	3.72	3.67			

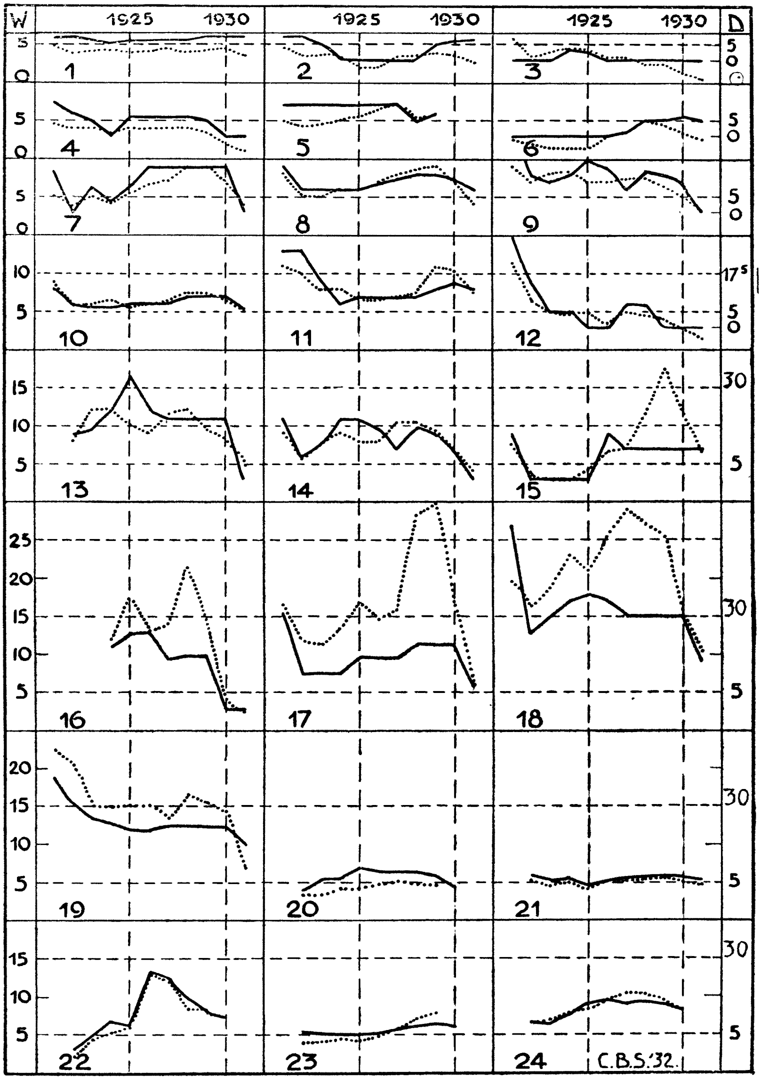

FIGURE 2. .... Dividend (D) paid, and —— Worth (W) in the quarter of dividend payment, for 19 Dutch enterprises and 5 groups of enterprises, 1921–1932.

The scale of this chart has been chosen in such a way that the lines cover each other when the relation

$$W = 3 + 0.4D.$$

is satisfied. This relation represents the relation found for the totality of the material, by rough estimate.

The explanation of the numbers and the figures for D and W are given in Table I.

Figs. 2 and 3 and Table III relate to a number of Dutch stocks, selected out of several branches of industry, for the period 1921–1931. For each stock considered, D and W have been calculated; figures relate to the month in the middle of the quarter in which dividend was paid.[4] The calculations were made for 19 leading companies separately and, in addition, for 5 groups of enterprises, as indicated in Table III. The results are represented graphically in two ways. Fig. 2 compares, for each case, D and W. The scales for D and W are taken different, such that the curves for D and W are identical when the relation

$$W = 3 + 0.4D \tag{1}$$

is satisfied. This was, roughly estimated, the relation found for the majority of cases to hold fairly well. So Fig. 2 shows the degree of ac-

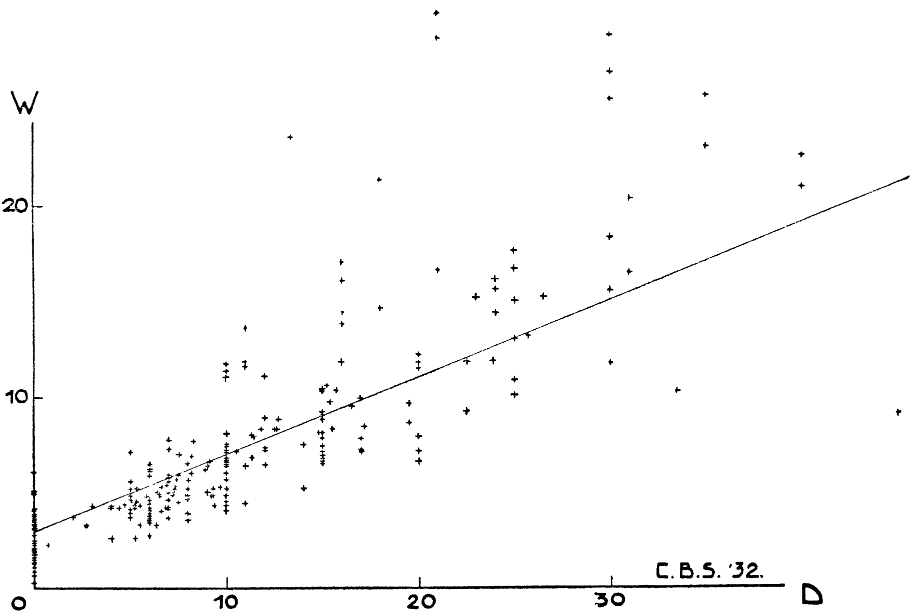

FIGURE 3.—D and W for the enterprises and groups considered (1921–1932). Straight line:

$$W = 3 + 0.4D$$

cordance for the individual stocks. It is interesting that the deviations from relation (1) are largest for the really speculative stocks Nos. 15–19.

In Fig. 3, corresponding values of D and W, as given in Table III

[4] This method of calculation was chosen for reasons of simplification. A number of tests indicated that no great differences occur when other possible methods are followed.

and Fig. 2, have been plotted against each other. The same has been done for 8 stocks (banking and colonial agriculture only) for which data were easily to be found, in the period 1892–1919. The result is not very different. Owing to rough graphical calculation the relation between D and W for these stocks is about (cf. Fig. 4):

$$W = 1.5 + 0.47D \tag{2}$$

The significance of the result, in connection with the fairly good correlation between the two members of the equations given, may be formulated as follows: The chief determinant factor to W, i.e., to dividend expectancies, is the last dividend paid.[5] The movements of D, however, are reflected only about half as intensively. This shows that reactions are always expected in about such a way that the total picture of the future corresponds to a dividend of about "half as abnormal" as the last dividend paid. As "normal" dividend D_0 occurs, then, the dividend for which $W = D$, i.e., 5 per cent for the decade after the war, and about 3 per cent for pre-war years.

The most interesting feature in our result is illustrated by Fig. 7. To fix the ideas, τ is indicated by the distance shown at the bottom. D may indicate the real course of dividend through a business cycle. As we just have seen that for the period τ there exists an average dividend expectance equivalent to a "normal" dividend D_0 plus about half the excess of D over D_0, we can, also, to fix the ideas, suppose that the expected course of D at each moment is indicated by the dotted lines. The essential feature of those lines is that something like the surface between each such line and the D_0-axis should be proportional to the height of D over D_0. Although a conclusion might be premature, this diagram suggests the absence of any "forecasting quality" of stock prices.

III

SHORTER MOVEMENTS OF STOCK PRICES

The above-considered relation between D and W only determines the annual movement of W, and therefore of stock prices. For shorter movements, other determining factors exist, which is illustrated by Figs. 5 and 6 for rubber plantation stocks. Fig. 5 again shows the agreement between D and (twelve month averages of) W; Fig. 6 illustrates the correlation between the "shorter movements" of W (viz. deviations from 12 months' averages) and those of rubber prices P. (Numbers 1, 2 and 3 relate to three different enterprises.)

[5] Cf. also *Wochenbericht des Instituts für Konjunkturforschung*, 15 Nov. 1932, p. 133, giving similar results of an investigation by Dr. O. Donner.

As to the correlation shown in Fig. 6, the following remarks may precede our further considerations: The best agreement exists between W_i and percentage values of P (i.e., P in per cent of 12 months' moving

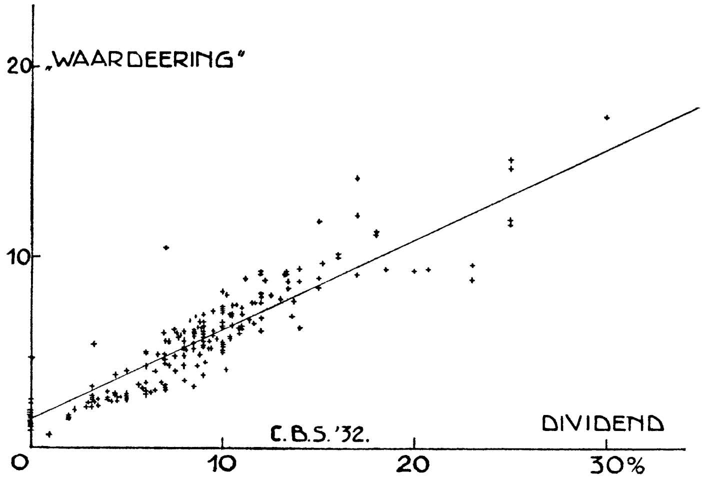

FIGURE 4.—D and W, for the enterprises considered, (1892–1919). Straight line:

$$W = 1.5 + 0.47D.$$

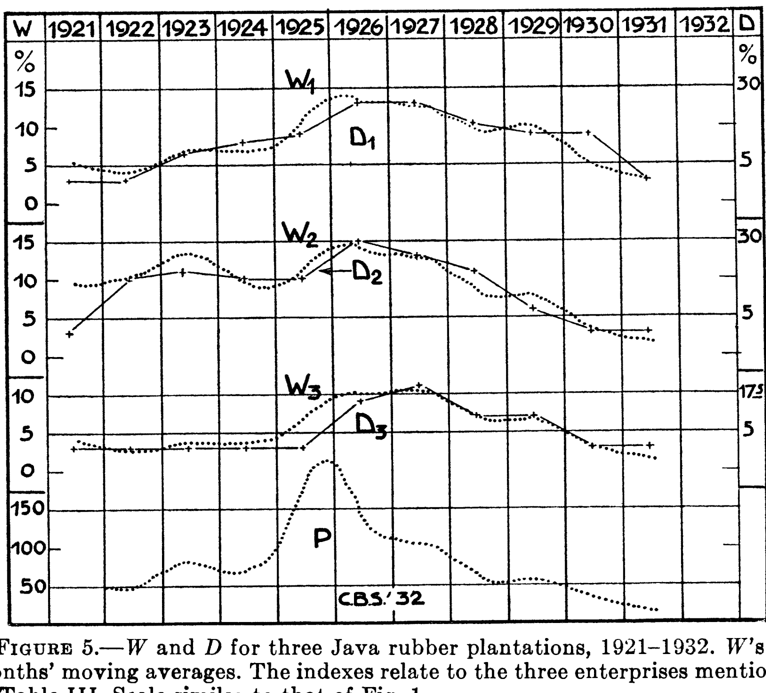

FIGURE 5.—W and D for three Java rubber plantations, 1921–1932. W's: 12 months' moving averages. The indexes relate to the three enterprises mentioned in Table III. Scale similar to that of Fig. 1.

averages, heavy line); logically one should expect W to correlate with the absolute price movements (as equal absolute price increments cause equal dividend increments), indicated by the dotted line. This correlation is, however, far poorer; and it remains still a little poorer when a multiple correlation between W on one side and P and K on

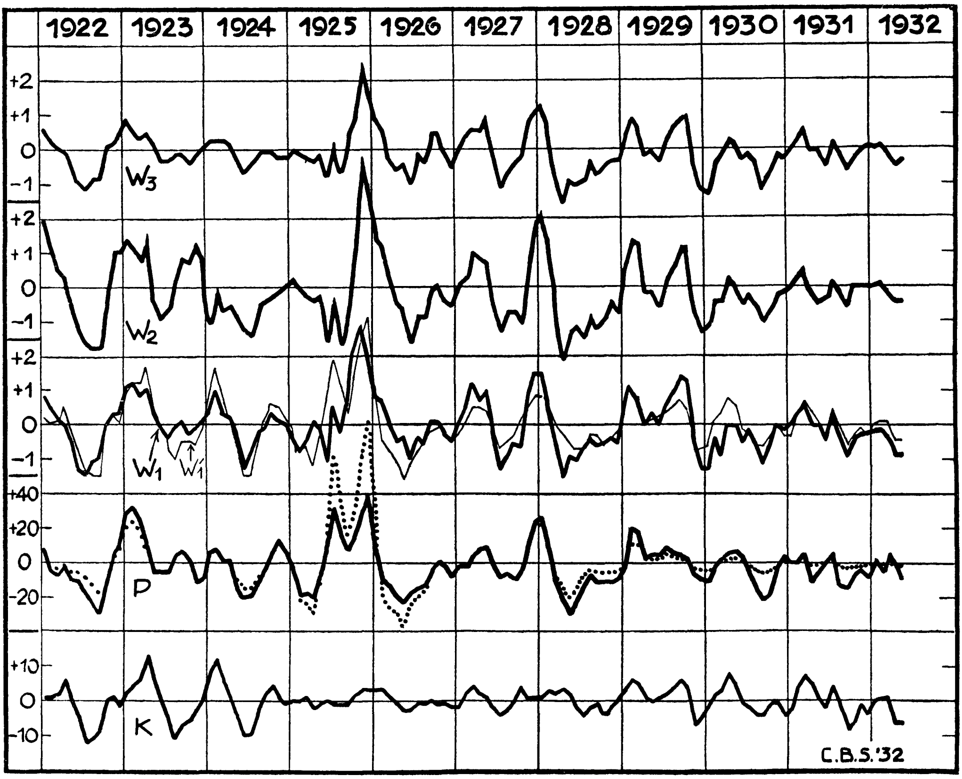

FIGURE 6.—Short fluctuations of worth of rubber stocks, W, as compared with short fluctuations in rubber price, P, and in general index of stock prices, K (1921-'25 = 100). The indexes relate to the enterprises mentioned in Table III. All series: deviation from 12 months' moving averages. Heavy line P: percentage deviations; dotted line P: absolute deviations, in cts per $\frac{1}{2}$ kg. W_1', calculated from formula:

$$W_1' = 0.035P + 0.097K,$$

in which P represents absolute price deviations, giving maximum correlation with W_1.

the other side is considered $-K$ indicating general stock price index (deviations from 12 months' averages). This is shown by the line W_1', giving the "best combination" of K and (dotted) P. As far as I can see a simple explanation of this fact is not easy.

We may consider the matter also from another angle. Supposing the correlation between the absolute price deviations and W is satisfactory, what is then to be deduced, with the help of our notions "horizon" and "expectancy," from the regression coefficient?

From that coefficient we deduce that, for the short movements, 1 cent of price difference (per $\frac{1}{2}$ kg) corresponds to a difference in 0.035 per cent of W_1, i.e., of dividend expectance during the period of τ. Now from other sources that are known to every investor, viz. the profit and loss account,[6] I deduce that a price movement of 1 cent causes a dividend movement (during the period 1921–1931, with large increases and large decreases) of 0.3 per cent. If the investor expected the deviation of price from normal to apply for his whole τ, then he had to expect, for this τ, a dividend of 0.3 per cent multiplied by the

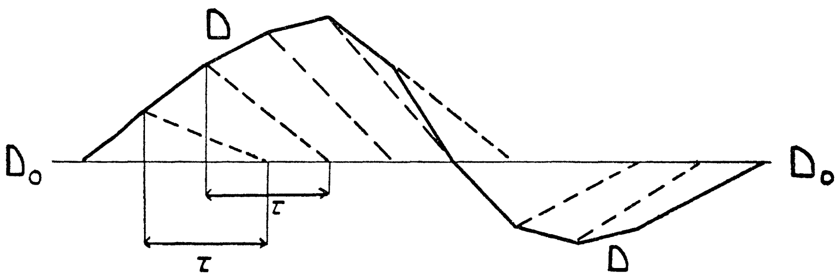

FIGURE 7.—Character of Dividend expectances. D: actual course of dividends. Dotted lines: expectances at each moment; τ: length of "horizon," chosen arbitrarily. The essence of the scheme is that at each moment expectances gravitate to D_0, a sort of "normal" dividend.

price deviation in cents. As he only seems to expect 0.035 per cent, our conclusion is that he expects price to move back again within the period τ, such that "on the average" only a deviation of about 0.1 of the deviation observed will exist.

So, although it was not possible in the second and third problem presented to evaluate the horizon, it seems, nevertheless, possible to learn something about the expectancy.

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[6] See e.g. Van Oss' *Effectenboek* 1932 I, 1084–1088.