NATIONAL BANK FOR ECONOMIC DEVELOPMENT

ECONOMIC DEPARTMENT

MONETARY CORRECTIONS IN FINANCING CONTRACTS

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The purpose of this study is to establish corrections intended to reduce the effects of currency devaluation upon and/or make it possible to obtain the resources required for meeting long term commitments in the operations carried out by the National Bank for Economic Development.

2. Many criteria have been suggested for that purpose among which the following stand out:

i) profit sharing, and

ii) increased charge rates so as to render the loan profitability equivalent to 19% per annum, that is at present the rate capable of providing financial stability to the Bank. Lately there has been a systemmatic resort to participation accounts in financing applications, with the adoption of the following inflation rates:

i) 40% in 1964;

ii) 30% in 1965;

iii) 20% from 1966 onwards.

Furthermore, a real interest rate of 4% p.a. has been admitted, raising the nominal loan profitability to:

i) 45.6% in 1964;

ii) 35.2% in 1965;

iii) 24.8% from 1966 onwards.

By means of these corrections, estimation is made of the Bank's participation in the probable profits of companies, to be received after maturation of the investment. The use of this procedure envolves a participation which has been as high as 30% of the profits. This participation system has the following disadvantages:

i) it is based on inflation rates which do not correspond to reality;

ii) the inflation hypotheses adopted for 1964 and 1965 lead to actual rates higher than those of the capital market. Indeed, according to the Stock Exchange Bulletins the annual average profitability of bills of exchange are the following:

1963	FIDES	FINCO
May	27.37%	28.72%
June	32.88	42.09
July	31.74	34.95
August	33.80	35.37
September	33.00	40.13
October	34.58	41.92
Average	32.26	37.20

iii) In addition, the adoption of the same hypotheses on inflation for all sectors of the economy, leads to the absurdity of the Bank's participation being greater in undertakings presenting a lower marginal efficiency of capital. 1/

3. As respects the second criterion, designed to render the Bank's operations financially balanced, the Bank's Legal Department is of the opinion that it is not feasible from a legal standpoint.

4. In view of the foregoing, we tried to establish another criterion entirely different from those in its basis, founded on the fact that it is possible to obtain money in the capital market by paying an interest rate lower than that of money devaluation. Indeed, statistical data show that, under present conditions, when inflation is as high as 55% a year, the interest rate in the capital market is 32.3% per annum and when

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1/ The marginal efficiency of capital is the discount rate to be applied in calculating the actual value of the expected return on the investment to make it equal to its replacement cost.

inflation is 72% per annum, the interest rate in the capital market is 35.9% . This results in a proposition to be adopted in any monetary correction system: it should be such that the profitability from the loan will not exceed the interest rate in the capital market. Following this line of thought, we tried to establish " coeteris paribus", a model through which we correlate the inflation rate and the monetary correction to be made in the debt. Furthermore, the total profitability from the loan is required to coincide with the interest rate in the capital market.

The relation we get is the following:

$$(1) \quad i_\rho = \frac{K\rho}{\rho + H}$$

where K and H are two constants to be estimated according to the conditions prevailing in the capital market and ρ is the inflation rate. Using the fact that when the inflation rate is 55% and 72%, interest rates are 32.3% and 35.9 per annum respectivaly, we may give the following estimates 1/ to parameters K and H:

$$\hat{K} = 0{,}538$$
$$\hat{H} = 0{,}788$$

Thus, we have:

$$i_\rho = \frac{0{,}538\,\rho}{\rho + 0{,}788}$$

The formula is applied for annual correction. However, as we will require corrections for fractions of the year, we should modify the formula accordingly. Calling ρ_n the inflation rate related to the fraction $\frac{1}{n}$ of the year, we have:

$$(2) \quad i_{\rho_n} = \frac{0{,}538\,\rho_n}{n\rho_n + 0{,}788}$$

5. If we observe the estimates made for parameters K and H in formula (1), we will see that the adoption of the corrections obtained would not bring any advantage to the entrepreneur (ceteris paribus), considering that everything occurs as if he had obtained money directly in the capital market through bills of exchange. As some undertakings require an

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1/ These estimates shorld be adopted on a provisional basis pending availability of a larger volume of statistical data.

indirect endowment in order to be set up in the country, it would be desirable to find such a criterion as would render it possible to relate the said correction to the sector covered by the loan. A condition to be met is that the aggregate remuneration of the loan must not be lower than 19% per annum, as we have already shown in a previous paper. Therefore, minimum corrections of the debt value should be obtained by means of the formula:

$$(3) \qquad i_{\rho_m} = \frac{0{,}436\,\rho_m}{n\rho_m + 1{,}850}$$

Formulas (2) and (3) make it possible to calculate inflation corrections for the two limit cases of marginal efficiency of capital:

i) maximum efficiency, and

ii) minimum efficiency.

As these two tipes of investment are extreme cases, we tried to obtain inflation correction formulas to be applied to investments the marginal efficiency of which falls within these extreme cases.

Thus, we obtained the following expressions:

$$(4) \qquad i_{\rho_m} = \frac{0{,}512\,\rho_m}{n\rho_m + 1{,}054}$$

for investments with marginal efficiency lower than maximum but higher than average;

$$(5) \qquad i_{\rho_m} = \frac{0{,}488\,\rho_m}{n\rho_m + 1{,}330}$$

for investments with average marginal efficiency;

$$(6) \qquad i_{\rho_m} = \frac{0{,}462\,\rho_m}{n\rho_m + 1{,}584}$$

for investments with marginal effiency below average but higher than minimum.

The above mentioned formulas should be applied jointly with an interest rate varying from 10% to 12% per annum. For some ρ values inflation corrections are calculated in the attached table.

6. We will now demonstrate how to apply the corrections mentioned above. First, the Projects Department should rank the project in one of the following groups according to its marginal capital efficiency:

i) maximum efficiency;
ii) high efficiency;
iii) average efficiency;
iv) low efficiency;
v) minimum efficiency.

This classification, once made, will mark the formula to be used in correcting inflation which we suggest be measured by the price indices of column 2 of Conjuntura Econômica. The manner of applying the correction is the following:

1) loan installments are reajusted at the times of payment, by estimating:

i) the relative increase in price indices (inflation rate) between each two consecutives payment dates;

ii) by means of that increase, we determine the inflation correction value, using the formula selected;

iii) next, we determine the cumulative correction obtained by capitalizing the inflation correction values calculated according to item ii).

2) the loan installments calculated at a rate between 10% and 12% per annum are readjusted by multiplying them successively by the accumulated corrections.

3) the same accumulated correction rates are applied to the debt balance.

Let us consider, for instance, the application of the correction criterion to the case of a Cr$1.000.000 loan made in July 1957, with the following characteristics:

i) period of grace: 2 semesters;

ii) amortization period: 8 semesters;

iii) interest: 5% semi-annually.

The amortization plans for this loan are:

a) AMORTIZATION PLAN WITHOUT CORRECTION

Month	Debt Balance	Amortization	Interest	Installment	Inflation rate	Correction *	Accumulated Correction
July/57	1.000.000	-	-	-	-	-	-
Jan./58	1.000.000	-	50.000	50.000	8,4	2,76	1,027600
July/58	1.000.000	-	50.000	50.000	7,2	2,40	1,052262
Jan./59	895.278,2	104.721,8	50.000	154.721,8	19,4	5,54	1,110557
July/59	785.320,3	109.957,9	44.763,9	154.721,8	16,0	4,76	1,163420
Jan./60	669.864,5	115.455,8	39.266,0	154.721,8	17,2	5,05	1,222173
July/60	548.635,9	121.228,6	33.493,2	154.721,8	8,7	2,84	1,256883
Jan./61	421.345,9	127.290,0	27.431,8	154.721,8	20,4	5,76	1,329279
July/61	287.691,4	133.654,5	21.067,3	154.721,8	12,5	3,89	1,380988
Jan./62	147.354,2	140.337,2	14.384,6	154.721,8	9,6	3,10	1,423799
July/62	-	147.354,2	7.367,6	154.721,8	29,8	7,59	1,531865

(*) (maximum efficiency)

b) IF MONETARY CORRECTION IS ADOPTED

Month	Debt Balance		Amortization	Interest	Installment
	Before payment of the installment	After payment of the Installment			
July/57	1.000.000	1.000.000	-	-	-
Jan/58	1.027.600	1.027.600	-	51.380	51.380
July/58	1.052.262	1.052.262	-	52.613	52.613
Jan/59	1.110.557	994.258	116.299	55.528	171.557
July/59	1.041.585	913.660	127.925	52.081	180.006
Jan/60	959.800	818.690	141.110	47.986	189.096
July/60	841.941	689.571	152.370	42.096	194.466
Jan/61	729.290	560.086	169.204	36.463	205.667
July/61	581.873	397.298	184.575	29.093	212.668
Jan/62	409.614	209.803	199.811	20.481	220.292
July/62	225.727	-	225.727	11.286	237.013

Finally, it should be observed that the Legal Department agrees with the criterion presented for inflation correction, since it issued a favorable opinion on the criterion of considering as monetary correction the entire inflation rate which has occurred. In the criterion now proposed only part of the inflation is taken into account.

November 1963

Jessé Montello
JESSE MONTELLO

MONETARY CORRECTION

Annex

INFLATION RATE			MAXIMUM EFFICIENCY			HIGH EFFICIENCY			AVERAGE EFFICIENCY			LOW EFFICIENCY			MINIMUM EFFICIENCY		
Annual	Semi-annual	Monthly	Annual	Semi-annual	Monthly	Annual	Semi-annual	Monthly	Annual	Semi-annual	Monthly	Annual	Semi-annual	Monthly	Annual	Semi-annual	Monthly
0.000	0.000	0.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.050	0.025	0.004	0.0320	0.0160	0.0026	0.0218	0.0109	0.0018	0.0176	0.0088	0.0015	0.0146	0.0073	0.0012	0.0106	0.0053	0.0009
0.100	0.050	0.008	0.0586	0.0293	0.0049	0.0450	0.0225	0.0035	0.0338	0.0169	0.0028	0.0262	0.0131	0.0022	0.0226	0.0113	0.0019
0.150	0.075	0.012	0.0862	0.0431	0.0072	0.0632	0.0316	0.0053	0.0490	0.0245	0.0041	0.0392	0.0196	0.0033	0.0320	0.0160	0.0027
0.200	0.100	0.016	0.1092	0.0546	0.0091	0.0830	0.0415	0.0069	0.0632	0.0316	0.0053	0.0516	0.0258	0.0043	0.0430	0.0215	0.0036
0.250	0.125	0.021	0.1224	0.0647	0.0108	0.0982	0.0491	0.0082	0.0764	0.0382	0.0064	0.0632	0.0316	0.0053	0.0514	0.0257	0.0043
0.300	0.150	0.025	0.1470	0.0735	0.0122	0.1122	0.0561	0.0093	0.0914	0.0457	0.0076	0.0742	0.0371	0.0062	0.0614	0.0307	0.0050
0.350	0.175	0.029	0.1656	0.0828	0.0138	0.1282	0.0641	0.0107	0.1030	0.0515	0.0086	0.0828	0.0414	0.0069	0.0690	0.0345	0.0057
0.400	0.200	0.033	0.1818	0.0909	0.0151	0.1402	0.0701	0.0117	0.1140	0.0570	0.0095	0.0928	0.0464	0.0077	0.0782	0.0391	0.0065
0.450	0.225	0.037	0.1954	0.0977	0.0163	0.1542	0.0771	0.0128	0.1242	0.0621	0.0103	0.1022	0.0511	0.0085	0.0852	0.0426	0.0071
0.500	0.250	0.042	0.2080	0.1040	0.0173	0.1648	0.0824	0.0137	0.1340	0.0670	0.0112	0.1114	0.0557	0.0093	0.0918	0.0459	0.0076
0.550	0.275	0.046	0.2210	0.1106	0.0184	0.1746	0.0873	0.0145	0.1432	0.0716	0.0119	0.1180	0.0590	0.0098	0.1000	0.0500	0.0083
0.600	0.300	0.050	0.2334	0.1167	0.0194	0.1862	0.0931	0.0155	0.1520	0.0760	0.0127	0.1264	0.0632	0.0105	0.1062	0.0531	0.0088
0.650	0.325	0.054	0.2430	0.1215	0.0202	0.1948	0.0974	0.0162	0.1604	0.0802	0.0134	0.1342	0.0671	0.0112	0.1136	0.0568	0.0095
0.700	0.350	0.058	0.2526	0.1263	0.0210	0.2032	0.1026	0.017[illegible]	0.1682	0.0841	0.0140	0.1418	0.070[illegible]	0.0118	0.1192	0.0596	0.0099
0.750	0.375	0.062	0.2624	0.1312	0.0219	0.2128	0.1064	0.0177	0.1758	0.0879	0.0146	0.1490	0.0745	0.0124	0.1262	0.0631	0.0105
0.800	0.400	0.066	0.2696	0.1348	0.0225	0.2200	0.1100	0.0183	0.18[illegible]	0.0924	0.0154	0.1544	0.0772	0.0129	0.1314	0.0657	0.0109
0.850	0.425	0.071	0.2792	0.1396	0.0232	0.2290	0.1145	0.0191	0.1916	0.0958	0.0160	0.1610	0.0805	0.0134	0.1378	0.0689	0.0115
0.900	0.450	0.075	0.2868	0.1434	0.0239	0.2354	0.1177	0.0196	0.1982	0.0991	0.0165	0.1674	0.0837	0.0139	0.1426	0.0713	0.0119
0.950	0.475	0.079	0.2942	0.1471	0.0245	0.2434	0.1217	0.0203	0.2044	0.1022	0.0170	0.1736	0.0868	0.0145	0.1472	0.0736	0.0123
1.000	0.500	0.083	0.2998	0.1499	0.0250	0.2492	0.1246	0.0208	0.2104	0.1052	0.0175	0.1780	0.0890	0.0148	0.1530	0.0765	0.0127
1.050	0.525	0.087	0.3072	0.1536	0.0256	0.2548	0.1274	0.0212	0.2160	0.1080	0.0180	0.1838	0.0919	0.0153	0.1572	0.0786	0.0131
1.100	0.550	0.092	0.3114	0.1557	0.0259	0.2618	0.1309	0.0218	0.2214	0.1107	0.0184	0.1892	0.0946	0.0158	0.1620	0.0813	0.0135
1.150	0.575	0.096	0.3192	0.1596	0.0266	0.2668	0.1334	0.0222	0.2268	0.1134	0.0189	0.1946	0.0973	0.0162	0.1666	0.0839	0.0139
1.200	0.600	0.100	0.3240	0.1620	0.0270	0.2732	0.1366	0.0228	0.2318	0.1159	0.0193	0.1996	0.0998	0.0166	0.1718	0.0859	0.0143

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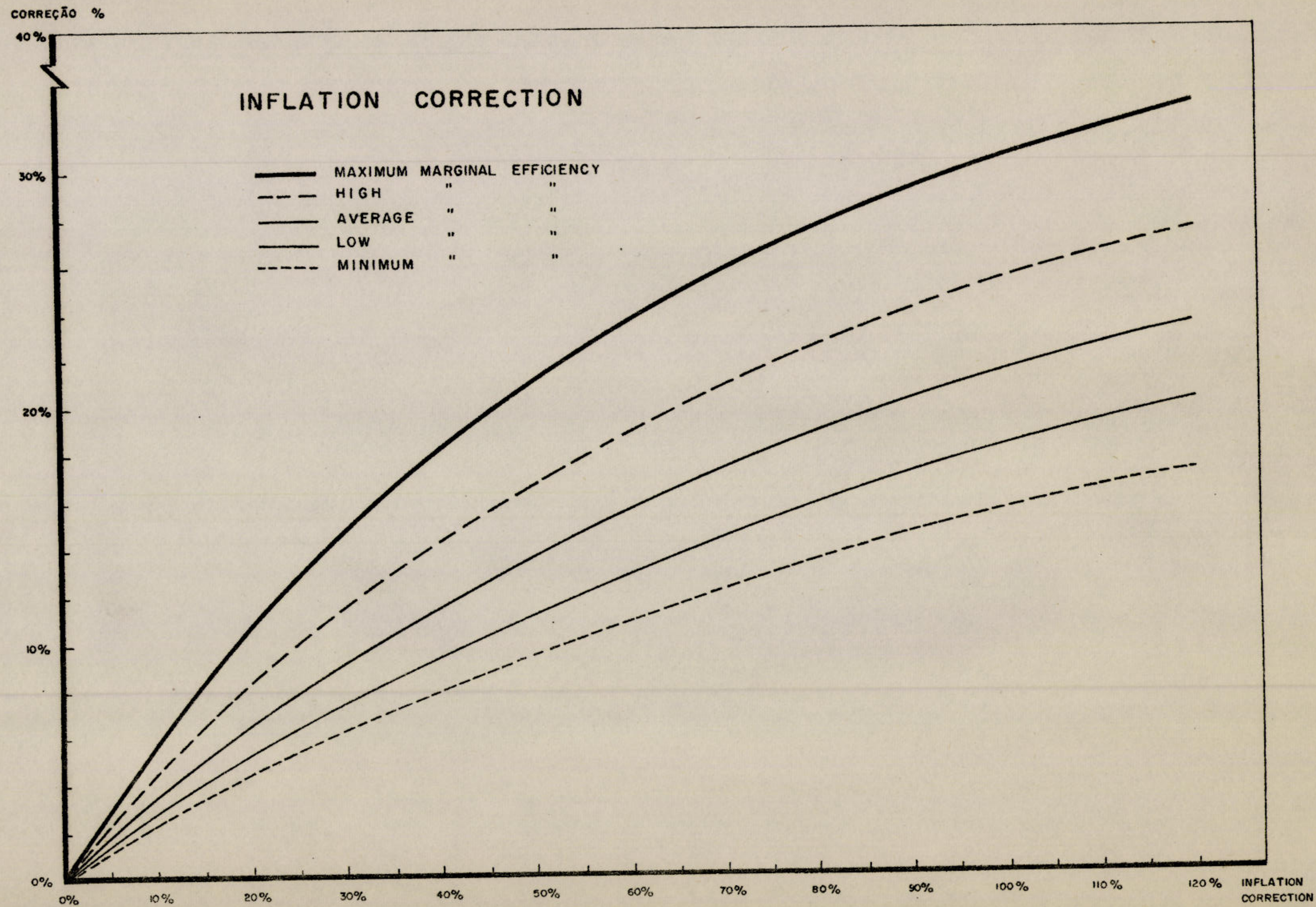

CORREÇÃO %
40%
30%
20%
10%
0%
INFLATION CORRECTION
MAXIMUM MARGINAL EFFICIENCY
HIGH " "
AVERAGE " "
LOW " "
MINIMUM " "
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
110%
120%
INFLATION CORRECTION

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TECHNICAL NOTE ON INFLATION CORRECTION

Let ρ stand the inflation rate. We adopted in establishing the cumulative correction of inflation that should fall on the debt principal, a f (ρ) function of that rate with the following properties:

i) $f(\rho) = 0$ if $\rho = 0$

ii) $f(\rho) < \rho$ if $\rho > 0$

iii) $f(\rho)$ is an increasing function to $\rho > 0$

iv) Function $\varphi(\rho) = \frac{f(\rho)}{\rho}$, to $\rho > 0$, is a decreasing function of ρ

v) Function $f(\rho)$, to $\rho > 0$, should be concave downwards;

vi) Function $f(\rho)$, to $\rho \geq 0$, is continuous and has derivatives of first and second continuous orders.

From condition iv) it results that $\varphi'(\rho) = \frac{\rho f'(\rho) - f(\rho)}{\rho^2}$ or $\rho f'(\rho) < f(\rho)$, to $\rho > 0$.

In order to find a family of functions with the above properties we will further set the following condition:

vii) $f'(\rho) = a\,\varphi^2(\rho)$, a being a positive constant.

It is immediately seen that this function, $f(\rho)$, meets conditions iii) and v). Indeed, $f'(\rho) > 0$, to $\rho > 0$, and $f''(\rho) = 2a\,\varphi(\rho)\,\varphi'(\rho)$.

As through condition iv) we have $\varphi'(\rho) < 0$, it follows that $f''(\rho) < 0$, to $\rho > 0$, since $\varphi(\rho) = \frac{f(\rho)}{\rho}$ is decreasing to $\rho > 0$.

From functional equation vii) we take:

$$(1) \qquad f'(\rho) = a\,\frac{f^2(\rho)}{\rho^2}$$

Whence:

$$\frac{d\,f(\rho)}{f^2(\rho)} = a\,\frac{d\rho}{\rho^2}$$

and, by integration:

$$\int \frac{df(\rho)}{f^2(\rho)} = a \int \frac{d\rho}{\rho^2} - \frac{1}{k}$$

$-\frac{1}{k}$ being the integration constant.

Whence:

$$-\frac{1}{f(\rho)} = -\frac{a}{\rho} - \frac{1}{k}$$

or

$$\frac{1}{f(\rho)} = \frac{a}{\rho} + \frac{1}{k} = \frac{ak+\rho}{\rho k};\ \rho \neq 0$$

Whence:

$$(2)\ f(\rho) = \frac{k\rho}{\rho + ak};\ \rho \neq -ak$$

As $f'(\rho) = \dfrac{ak^2}{(\rho + ak)^2}$, condition $\rho f'(\rho) < f(\rho)$

brings $\dfrac{\rho f'(\rho)}{f(\rho)} < 1$

Therefore, $k > 0$, to $\rho > 0$

It is seen that fucntion (2) meets condition i).

In fact, for $\rho = 0$ we have $f(\rho) = 0$

Function (2) defines a family of functions dependent on two parameters a and k that should be determined by the conditions prevailing in the market.

2. Variation of the following function: $f(\rho) = \dfrac{k\rho}{\rho + ak}$

Although we are only concerned with the behavior of this function to $\rho \geq 0$, it is desirable to study it throughout the real field. In this field, it is continuous in all points but in point $\rho = -ak$, where it is descontinuous, and we have:

$$\lim_{\rho \to -ak+0} f(\rho) = -\infty; \quad \lim_{\rho \to -ak-0} f(\rho) = +\infty$$

Therefore, the equation straight line, $\rho = -ak$ is a vertical asymptote of a curve defined by

$$f(\rho) = \frac{k\rho}{\rho + ak}$$

This curve also has a horizontal asymptote. Indeed,

$$\lim_{\rho \to \pm\infty} f(\rho) = k$$

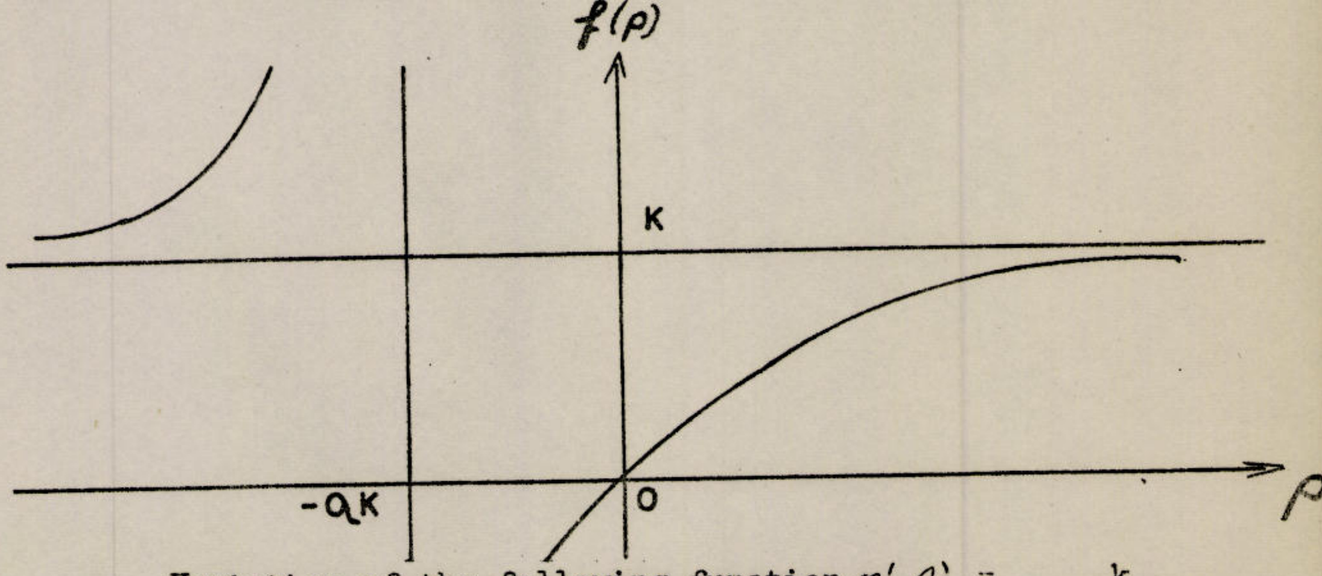
Let us now consider the derivative of $f(\rho)$. We have:

$$f'(\rho) = \frac{ak^2}{(\rho + ak)^2}$$

Thus, $f(\rho)$, is an increasing function in the entire real field. We can then organize the following variation table for $f(\rho)$.

ρ	$-\infty$	↗	$-aK$	↗	0	↗	$+\infty$
$f(\rho)$	K	↗	$\pm\infty$	↗	0	↗	K
$f'(\rho)$	0	+	+	+	+	+	0

This table makes it possible to draw the following diagram for the above mentioned function.



3. <u>Variation of the following function</u> $\varphi(\rho) = \frac{k}{\rho + ak}$

We shall study this function when ρ varies in the entire real field. In this field it is continuous in all points but in point $\rho = -ak$, where we have:

$$\lim_{\rho \to -ak+0} \varphi(\rho) = +\infty \quad ; \quad \lim_{\rho \to -ak+0} \varphi(\rho) = -\infty$$

Consequently, the equation straight line $\rho = -ak$ is a vertical asymptote of a curve defined by

$$\varphi(\rho) = \frac{k}{\rho + a k}$$

This curve also has a horizontal asymptote which is the axis of the abscissas. In fact,

$$\lim_{\rho \to \pm\infty} \varphi(\rho) = 0$$

The derivative of $\varphi(\rho)$ is:

$$\varphi'(\rho) = \frac{-k}{(\rho + ak)^2}$$

It follows that $\varphi(\rho)$ is decreasing in the entire real field.

The variation table for the said function is the following:

<u>Variation of $\varphi(\rho)$</u>

ρ	$-\infty$	↗	$-aK$	↗	0	↗	$+\infty$
$\varphi(\rho)$	0	↘	$+\infty$	↘	$\frac{1}{a}$	↘	0
$\varphi'(\rho)$	0	$-$	∞	$-$	$-$	$-$	0

The function diagram may be arranged as follows: