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The future of the world economy: An appraisal of Leontief's study

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The Future of the World Economy

— An Appraisal of Leontief's Study —

by Jamuna P. Agarwal, Dean Spinanger, Bernd Stecher

CONTENTS:

The UN study concludes that by the end of this century a substantial reduction in the present income gap between developed and developing countries is feasible. The resource base for realizing the envisaged growth rates is not seen as a limiting factor; limits might rather be imposed by the inflexibility of the international economic order as well as by economic, social and political institutions in developing countries. Industrialization in developing countries based on heavy industries is expected to serve as the engine of growth, the capital requirements for which are met primarily by domestic sources.

Different conclusions, however, are arrived at in this appraisal of major aspects of the UN study:

- A high concentration of productive resources in heavy industries tends to aggravate the developing countries' problems of unemployment and balance-of-payments deficits, since technologies involved are labor-saving, capital requirements are too high and export chances are low.
- There is not enough empirical evidence to support the UN study's optimism that investment in heavy industries of the order of magnitude involved can be financed by increasing domestic savings and by the inflow of foreign capital into developing countries.
- An industrialization strategy which aims at exploiting existing resources of developing countries more efficiently should concentrate on labor- and/or raw material-intensive activities. An industry-mix based on present and potential comparative advantages will increase their international competitiveness and encourage direct investment from abroad.
- The proposition to increase the relative prices of developing countries' primary commodity exports would neither help reduce their balance-of-payments deficits nor improve their income position over the long run. On the contrary, it would result in a world-wide misallocation of resources and induce resource saving in the developed countries.

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Contents

I. Introduction

1. The work of Wassily Leontief and his associates [1977] represents the most recent attempt to depict and forecast the world economy by applying mathematical methods, integrated into a global model. While the authors of the "The Future of the World Economy" (hereafter referred to as FOWE) have constructed a very complex model, the fundamental question must still be raised about the actual ability of such procedures to correctly portray the present situation and accurately capture future developments. An answer to this question is of considerable relevance, as ever since the publication of The Limits to Growth [Meadows et al. 1972] there has been an increasing tendency to employ such global approaches and place a certain degree of confidence in their results particularly for policy purposes.

2. It is the purpose of this paper to attempt to answer this question by critically analyzing the findings and conclusions presented in FOWE[1]. Although it might be assumed the logical starting point for such an appraisal would be an extensive discussion of the methods involved and the assumptions made, this paper purposely concentrates on the model's results as well as on its policy conclusions. This, however, does not mean that every comment on specific peculiarities of the model is precluded. It means rather that criticism of methods and assumptions is of secondary nature and serves only to explain differences in results between FOWE and alternative projections. This implies that no attempt has been made to offer still another global model but instead to proceed in a partial analytical manner. Such an approach has the advantage of not only keeping the presentation from being burdened with the technicalities of mathematical forecasting models but it also avoids the pitfalls of passing judgement on the model by criticizing its premises. It might be added that in this paper it is not pretended that all issues raised in FOWE have been covered, but rather those deemed to be most relevant and where empirical evidence to the contrary was unambiguous.

3. In appraising FOWE this study concentrates on four major aspects - interrelated but dealt with separately - pertaining in general to the preconditions and determinants of economic growth and in particular to the factors influencing changes in the international division of labor. The first of these four aspects covers the resource parameters, i.e., growth of population, the endowment with mineral resources, and the supply of foodstuffs. The study then focusses on factors influencing the momentum with which the world economy will grow. Foremost in this respect is the industrialization process together with the investments necessary to induce and sustain it; it is followed by a brief discussion of the impact of pollution and abatement expenditure on economic development. The role that international trade can play in accelerating economic growth is the fourth aspect. In this connection the consequences of the realization of a New International Economic Order (NIEO) are also discussed.

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[1] It should be pointed out that a certain amount of difficulty is encountered in trying to determine exactly what the authors of FOWE were aiming at. While in the preface it is noted that the study deals with the impact of prospective economic issues on the economic outcome of the Second United Nations Development Decade, the authors state in the introduction that the basis is a study on the environmental aspects of the future world economy. In light of the title it is assumed that the former more aptly represents the thrust of FOWE.

II. A Critical Appraisal of the Results

1. The Resource Base - Human, Mineral and Nutritional

4. The overriding tenor of the global forecasts in the UN study is optimistic and as such differs noticeably from the many doomsday predictions in the past years[1]. This is particularly the case with respect to the resource base where the authors claim that no insurmountable physical barriers to economic growth in this century exist. To those who were convinced by the controversy caused by The Limits to Growth [Meadows et al. 1972], etc., this might come as a surprise; to others, that is to those who realize that in market economies forces are embodied which - if allowed to prevail - ensure that the necessary adjustments will be forthcoming, such a result is inherent.

5. Whether or not FOWE has definitely clarified the "Limits to Growth - Issue" is of particular relevance and needs some further examination. This is all the more necessary due to the attention given to such forecasts as well as due to the reactions they cause, and particularly in light of the key role of the resource base in setting the input parameter framework upon which development strategies can be based. Two specific questions need to be answered: Are the resource forecasts of the FOWE model[2] tracking? If not, what are the possible underlying reasons for their errant behavior?

a. Human Resources (Population)

6. The population parameters used in FOWE are based on detailed United Nations estimates of fertility, mortality, age structure, urbanization and other basic factors underlying and determining population dynamics and are not merely the result of an exponential growth process[3]. Until recently such UN population projections have suffered from a tendency to underestimate and thus were subjected to constant upward revisions[4]. Although it cannot be doubted that the methods used to forecast population developments have become more sophisticated over the years and the data base more accurate, they still suffer from their inability to predict shifts in demographic developments[5]. It is therefore not surprising that the recent, unexpected slow-

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[1] For a review and analysis of world models see S. Cole [1977]; Clark, S. Cole [1975]. - For a to-the-point but cynical view of the "doomsdayists" see Beckermann [1974].

[2] The global input-output model used in FOWE was disaggregated geographically into 15 regions and sectorally into 45 sectors. It might be noted that a number of crucial questions concerning the geographical classification used in FOWE remain unanswered, for instance, what determined the cut-off income levels between low, medium and high-income regions? Why is Israel included in low-income arid Africa? What is the reason for including budding developed countries like Hong Kong and Singapore in low-income Asia? Why is Greenland included in both North America and Europe (high income) but Taiwan, Cameroon and Guinea left out entirely?

[3] Although the UN method differs from Meadows' [in Meadows et al. 1972], the estimated world population in 2000 is roughly the same.

[4] For example, the 1951 estimate for total world population in 1980 (3.28 billion) had been increased to 4.46 billion by 1968 - an error amounting to over 36 %.

[5] An excellent case in point is the experience made in the United States during the last ten years: By 1975 the predicted population (highest estimate) for 2000 had been reduced (with respect to the 1966 estimate) by 74 million to 287 million - a downward revision of about 20 % in less than 10 years. The reason for this downward shift was a large drop in the birth rate (-38 % from 1960-1975) [U.S. Department of Commerce 1976, Tables 3 and 8]. - It is interesting, for instance, to note what Woytinsky wrote in 1953 that the future growth of population will be stabilized at about 4 billion by the end of the century, with "a new cycle of growth or decline, or [the process of depopulation] might continue until the human race is extinct" [Woytinsky, Woytinsky 1953, p. 262].

down in birth rates has caused the latest UN population estimates to show a noticeable downward revision in population forecasts; i.e., the estimates for 1980 have been reduced by 83 million (about 1.5 %). An important factor in this development has been the introduction of effective family planning programs in developing countries - those countries with such programs showed a sizeable decrease in the population growth rate [George Washington University 1976]. A comparison of the population estimates used in FOWE and the most recent UN figures reveals that FOWE's estimates are above current forecasts (albeit only marginally). Although it is still too early to determine to what extent the population data used in FOWE are really running errant, current trends in birth rates (together with other factors) would seem to be indicating that FOWE's estimates are probably upper limits [see, e.g., Tabah 1977]. The influence of such a downward shift in the rate of population growth[1] on demand for resources, particularly in the developing countries, is an aspect which unfortunately was not given due emphasis in FOWE.

b. Mineral Resources

7. Beginning with exogenous estimates of income levels and after having determined the production[2] as well as the consumption structure, the regional resource production and consumption of minerals were calculated for the respective years [pp. 44-46][3]. These figures were then compared with conservative estimates of potential resource supply (from the U.S. Bureau of Mines) to determine whether supply is adequate. Since the initial estimates proved to be "too pessimistic", new estimates of potential reserves for certain minerals were produced by multiplying the original reserve figure with a "reserve expander"factor, besides allowing for relative price rises (so as to decrease demand)[4]. These "new" reserves were then distributed to areas assumed most likely to have such potential supplies. Despite such supply and demand adjustments it was established that the demand for lead and zinc would have exceeded the supply by the 1990s. In order to take this into account it was merely assumed that all interregional trade in these two commodities would have stopped after 1990, and that all those countries without any indigenous supplies would have found substitutes for these commodities by then. As far as the other commodities specifically included in FOWE are concerned no shortages were encountered - at least not on a global level.

8. Although there can be no question about the applicability of using input-output techniques[5]

[1] A reduction to the UN low variant would mean about 600 mill. persons less by the year 2000.

[2] The production structure and the input-output coefficients were calculated as a function of per capita gross national product on the basis of cross-country regressions. While it might be assumed that a representative sample of countries covering the full development spectrum would be used for such calculations, this was not the case and the actual regressions included only eight countries, not representative of the full spectrum. To begin with this reference to eight countries is somewhat confusing since the source from which it is drawn includes ten countries [see Kravis et al. 1975]. More important, however, the countries in the sample are clustered at the top of the income ladder (6 high-income countries) and at the bottom (3 very low-income countries). Granted, the extent to which this clustering distorted the results could not be determined, it can nevertheless not be ruled out as a possible underlying explanation for forecasts which seem to be "out of the ballpark".

[3] Hereafter references to specific pages in FOWE are generally made with page number(s) in [ ].

[4] Leontief et al. [1977, p. 44]. - The following factors were used and applied to the known reserves in the base year: copper 2.5; lead 1.5; nickel 2.0; zinc 1.2.

[5] It would seem appropriate to recall at this point three important assumptions underlying the input-output analysis. First of all the shares of all primary factor and intermediate inputs are fixed and are unaffected by relative price changes, implicitly assuming that no substitution takes place. Secondly it is assumed that production capacities are optimally utilized in order to fulfill the condition that a given change in income is always met by the same amount and structure of inputs. Thirdly each sector produces a single good or a number of closely related goods, whereby the share of each of these goods as well as the structure of the inputs must remain constant. For a discussion of input-output analysis see Friedman [1955]; Taylor [1975].

to determine the amount of commodity input needed for a given change in output, an extension over a thirty year period - even after adjusting the technical coefficients for changing income levels - is bound to produce estimates heavily biased by today's technology. The authors of FOWE (knowing this to be the case) attempted to make the necessary adjustments in their model by "correcting" the technical I-O coefficients for possible changes in resource use due to future technologies. Likewise the raw inputs of each commodity per unit output were scaled down each decade to take account of increased recycling, which was assumed to reach a maximum potential by 2000 [p. 45][1].

9. It must, however, be questioned whether such attempts will adequately represent the real potential, since (aside from other factors) relative prices are not given free reign to

- increase supply by inducing more exploration and/or improved mining and production methods[2] and
- shift demand to substitutes and/or cause commodities to be consumed (produced) with a greater degree of efficiency.

10. On the supply side of the issue it must be pointed out that the term "reserves" used in FOWE refers to "that portion of the identified resource from which a usable mineral or energy commodity can be economically and legally extracted at the time of determination" [U.S. Bureau of Mines 1976, p. 16]. A glance at the Diagram in the Appendix shows that the word "reserve" in this context is the most limited definition possible, and represents only a small fraction of what really exists and could be mined if prices and/or technology changed accordingly. The extent to which the market has been capable of adjusting in the past is underlined in Table 1 - despite an exponential increase in consumption, the ratio of reserves to consumption (= production) has increased in most cases[3].

Table 1 - Multiples by Which Commodity Reserves and Production Changed, 1948-1976

	Change in	
	reserves	production
Bauxite	15.6	9.5
Copper	4.6	3.4
Lead	3.6	2.4
Nickel	3.9	5.4
Zinc	2.7	3.2

Source: Own calculations based on the following: UN [1973, p. 4, Add. 2]. - Tilton [1977, p. 10]. - U.S. Bureau of Mines [Commodity Data Summaries 1977]. - Metallgesellschaft AG [1977, pp. 56-59].

Looking at the situation in another way, if the known reserves existing in 1948 had been consumed at the rate which actually prevailed after 1948 (for comparison's sake 1948 rate also applied) then all commodity reserves would have been depleted by now or 1979 (see Table 2). This, of course, is not the case and by the "year of depletion" (in col. 3) the time horizon had (or would have) been pushed ahead and now another "year of depletion" exists (col. 5); in three cases the estimated life span was either longer than or just as long as before[4].

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[1] The maximum potential was assumed to be less than 55 %.

[2] For a well-documented and interesting description of future potential supplies of certain commodities see Radetzki [1977].

[3] For additional evidence see Liebrucks [1976].

[4] It would almost seem appropriate to contend that Say's Law (in reverse) holds.

Table 2 - Life Span of Reserves

	Known reserves late 1940s[a]	Year in which reserves depleted - based on[b]:		Known reserves in depletion	Year in which (4) depleted[c]
	mill. tons	1948 production	cumulative production	year from (3) mill. tons	
	(1)	(2)	(3)	(4)	(5)
Bauxite	1 400	2113 (165)	1979	21 800	2247[d] (271)
Copper	100	1991 (43)	1972	308	2016 (44)
Lead	40	1976 (28)	1966	82	1994 (28)
Nickel	14	2045 (96)	1979	61	2054[d] (78)
Zinc	70	1985 (37)	1969	106	1989 (20)

[a]Reserves assumed to refer to 1948. - [b]1948 reserves divided by 1948 production and 1948 reserves depleted by prevailing production rates. The number in ( ) is the life span. - [c]Based on production in year in (3). - [d]Reserves in 1976.

Source: Own calculations based on sources in Table 1.

11. It is of particular importance to stress the fact that the market forces must be allowed to prevail (as the authors of FOWE did not) if an adequate supply of mineral resources is to be forthcoming in the future. An excellent example of a future area, in which it must be assumed that the market can work, is the "mining" of undersea nodules[1]. However, at the moment a potential threat to the market forces can be seen in the proposals currently discussed at the United Nations Law of the Sea Conference to place such ocean mining activities (outside territorial boundaries) under the control of an international organization, which is to restrict the access to the seabed. While the intent of such proposals - both to distribute the rewards of the oceans equitably among all nations and to prevent the terms of trade of primary producing developing countries from deteriorating - has been agreed upon in principle, an agreement on the modus vivendi (for instance auctioning off the extraction rights vs. permanent control on access) has yet to be reached and - as a matter of fact - is not even in sight [see Ishimine 1977; Cooper 1975]. It must be stressed that an unimpeded exploitation of the minerals from the seabed (taking into account ecological constraints) would serve the needs of the world economy in terms of resource availability best, for it would lead to more competition (within mineral industries) and would generate less scarcity than in the case of restricted access.

12. In turning to the demand side of the issue it can be shown that in the past changes in relative prices have exerted a significant influence on demand patterns of natural resources. Of particular interest in this respect is the case of the structure of demand for energy in the United States. As can be seen from Table 3, the demand for the three major competitors for

[1] In the case of copper, for instance, it is estimated that reserves would be increased by almost 100 % when such an undertaking becomes feasible [U.S. Bureau of Mines 1977, p. 47]. The authors of FOWE acknowledge the fact that they did not include such known but "unrecoverable" deposits in their calculations.

Table 3 - Changes in Prices of and Demand for Certain Types of Energy in the United States, 1950-1975 (Percent)

	Change[a]	
	prices	demand
Coal	331.1	-27.1
Heating oil	175.0	20.1
Gas	116.4	44.7

[a] Percentage change for the period 1950 to $(\frac{1974-1975}{2})$.

Source: Own calculations based on data in U.S. Department of Commerce [1976, various tables].

directly heating private homes - or buildings in general - (natural gas, heating oil and coal)[1] increased the most where prices rose the least[2].

13. Another relevant case where changes in demand have a noticeable impact on the consumption of commodities is offered by FOWE's own estimates on lead - one of the metals expected to be exhausted by the end of the century. A glance at the following Diagram, in which FOWE's estimates are compared with three time-trends, prompts a certain amount of skepticism with regard to the validity of the future trends estimated in FOWE. Although the diagram is not meant to create the impression that past trends will continue far into the future, the break in the trend, i.e., the difference between the new consumption (production) path and the old one, is too large not to be subjected to further scrutiny. Upon investigating the possible reasons for this development it can be determined that particularly the increased use of low-leaded gasoline - in accordance with stronger antipollution legislation - (as well as the substitution of plastic materials for lead in sanitary piping) lies behind the shift. Aside from underlining the impossibility of predicting such unexpected changes, as well as invalidating the forecast that lead demand will exceed supply by the 1990's, this sizeable downward shift in the demand for lead produces positive feedbacks with respect to the environment. Such a positive feedback would seem to substantiate the contention that attempting to depict future problems based on today's technology is virtually impossible and is surely something that cannot be achieved by adjusting the I-O coefficients to account for technical progress.

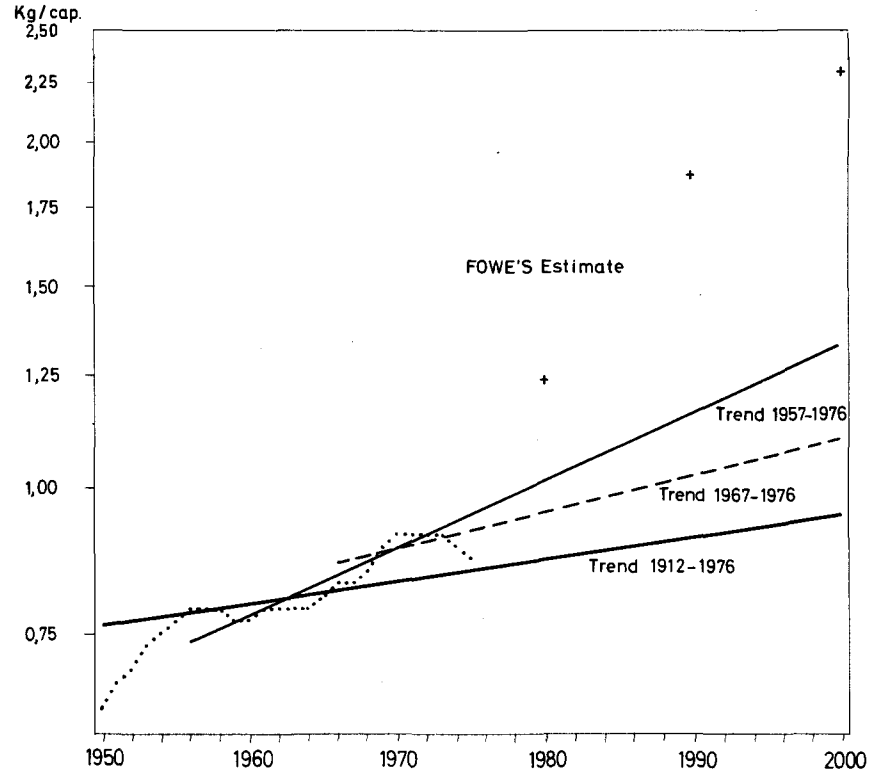
14. In light of the forecast for lead consumption (production) running errant, a check of some of the other commodities - to find out if the estimates are tracking (using the latest data) - and a comparison with estimates made elsewhere as well as with "naive" estimates (merely based on the extrapolation of three different past trends - see appendix for summary of the regressions) was made. These calculations (shown in Table 4) reveal that

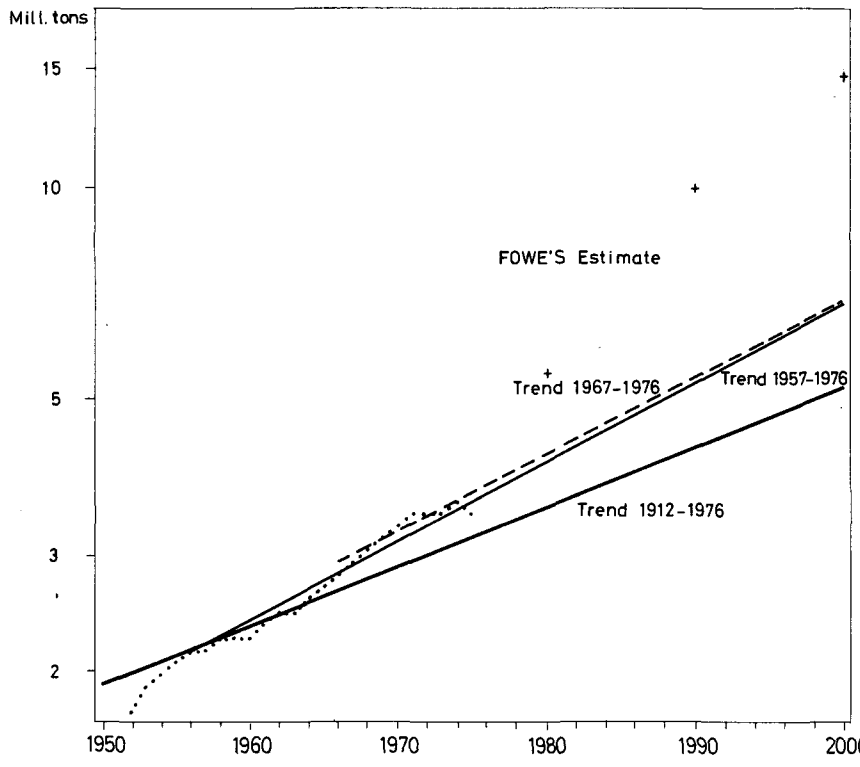
- the actual rate of production in 1975 lies below the forecasted rate for all minerals, due essentially to the sluggish economic growth rates in past years;

[1] It is realized that coal has certain disadvantages (it is dirty and requires removal of ashes) and is thus not a perfect substitute for oil and gas. This merely means, however, that the price of coal relative to the other energy sources would have to have decreased all the more.

[2] The U.S. Government during this period regulated both the oil price and the natural gas price. Both were controlled to such an extent that demand expanded to the point where the supply was no longer able to keep pace (as evidenced in the past winters by regional shortages). As a matter of fact the price was kept so low that in the last years domestic exploration virtually ceased and domestic production fell.

Diagram - Trend of Lead Production Per Capita and Absolute Values





See Table A 1 for trend functions and source

Table 4 - Estimated World Output of Selected Commodities, 1975 and 2000

Source of estimate	Production (mill. tons) 1975	Production (mill. tons) 2000	Average annual rate of growth 1975-2000 (%)	Cumulative production 1975-2000 (mill. tons)	Ratio of known reserves to cumulative production[a]	Ratio of potential reserves to cumulative production[b]
			Bauxite			
FOWE[c]	13.8	38.5	4.2	589.5	8.48	3.4×10^9
FOWE (rev.)[d]	13.42	37.43	4.2	573.3	8.72	3.5×10^9
MFP 1970[e]	13.42	70.25	6.9	830.2	6.02	2.4×10^9
Malenbaum 1973[f]	13.42	46.76	5.1	651.2	7.68	3.1×10^9
MFP 1975[g]	13.42	59.9	6.2	753.8	6.63	2.7×10^9
Naive A[h]	13.42	109.30	8.8	1095.6	4.56	1.8×10^9
Naive B[i]	13.42	93.40	8.1	991.1	5.05	2.0×10^9
Naive C[j]	13.42	90.14	7.9	969.2	5.16	2.1×10^9
			Copper			
FOWE[c]	7.7	23.6	4.6	347.6	1.32	4.3×10^6
FOWE (rev.)[d]	7.65	23.39	4.6	344.4	1.33	4.4×10^6
MFP 1970[e]	7.65	29.3	5.5	392.3	1.17	3.8×10^6
Malenbaum 1973[f]	7.65	19.69	3.9	312.4	1.47	4.8×10^6
MFP 1975[g]	7.65	20.1	3.9	316.0	1.45	4.8×10^6
Naive A[h]	7.65	17.08	3.3	288.8	1.59	5.2×10^6
Naive B[i]	7.65	22.59	4.4	337.5	1.36	4.4×10^6
Naive C[j]	7.65	25.90	5.0	365.1	1.26	4.1×10^6
			Lead			
FOWE[c]	4.35	14.7	5.0	207.4	0.70	1.4×10^6
FOWE (rev.)[d]	3.56	12.03	5.0	169.7	0.85	1.7×10^6
MFP 1970[e]	3.56	6.2	2.2	117.7	1.23	2.5×10^6
Malenbaum 1973[f]	.	.	.	.	.	.
MFP 1975[g]	3.56	6.87	2.7	124.2	1.17	2.3×10^6
Naive A[h]	3.56	5.68	1.9	112.4	1.29	2.6×10^6
Naive B[i]	3.56	7.19	2.9	127.3	1.14	2.3×10^6
Naive C[j]	3.56	6.85	2.7	124.0	1.17	2.3×10^6
			Nickel[k]			
FOWE[c]	798	2135	4.0	32295	1.71	0.7×10^5
FOWE (rev.)[d]	753.33	2014.75	4.0	31451	1.76	0.7×10^5
MFP 1970[e]	753.33	1258.5	2.1	24359	2.27	0.9×10^5
Malenbaum 1973[f]	.	.	.	.	.	.
MFP 1975[g]	753.33	1442	2.6	26173	2.11	0.8×10^5
Naive A[h]	753.33	2936.44	5.6	39036	1.42	0.5×10^5
Naive B[i]	753.33	3154.33	5.9	40727	1.36	0.5×10^5
Naive C[j]	753.33	3055.75	5.8	39966	1.38	0.5×10^5
			Zinc			
FOWE[c]	6.4	17.8	4.2	273.0	0.58	8.1×10^6
FOWE (rev.)[d]	5.95	16.64	4.2	254.6	0.62	8.6×10^6
MFP 1970[e]	5.95	11.85	2.8	211.2	0.75	10.4×10^6
Malenbaum 1973[f]	5.95	13.45	3.3	226.2	0.70	9.7×10^6
MFP 1975[g]	5.95	11.2	2.6	204.9	0.77	10.7×10^6
Naive A[h]	5.95	12.50	3.0	217.3	0.73	10.1×10^6
Naive B[i]	5.95	16.15	4.1	250.3	0.63	8.8×10^6
Naive C[j]	5.95	12.55	3.0	217.8	0.73	10.1×10^6

[a]Reserves taken from U.S. Bureau of Mines [Commodity Data Summaries 1977]. - [b]Potential Reserves taken from Tilton [1977, pp. 12 sq.]. - Potential reserves reflect the quantity of commodity in earth's crust. It is based on calculations in which the elemental abundance in grams/tons is multiplied by the weight of the earth's crust [see Lee, Yao 1970]. - [c]The values for FOWE were taken from Leontief et al. [1977, Scenario A, p. 107]; the figure for 1975 was calculated by interpolating between 1970 and 1980. - [d]The FOWE (rev.) was calculated on the basis of actual 1975 figures (average of 1974-1976). - [e]MFP 1970 taken from U.S. Bureau of Mines [Mineral Facts and Problems 1971, pp. 433-434]. - [f]Estimates taken from Malenbaum et al. [1973]. - [g]MFP 1975 taken from U.S. Bureau of Mines [Mineral Facts and Problems 1975, p. 21]. - [h]Extrapolation of semi-log trend estimated for period 1912-1976. - [i]Extrapolation of semi-log trend estimated for period 1957-1976. - [j]Extrapolation of semi-log trend estimated for period 1967-1976. - [k]1 000 tons.

- in all cases except bauxite FOWE's estimates exceed those made elsewhere, in the case of lead, for instance, by over 100 % and about 50 % for zinc;
- the naive projections produce values which in three cases (copper, lead and zinc) coincided roughly with other estimates and generally decreased over the last two time periods. Only in the case of copper did the growth rate increase significantly for the three time periods estimated;
- using a broad definition of potential resources the cumulative demand over the 25 year period 1975-2000 is shown to be but a minute part of the potential resource base.

15. In addition to these global commodity comparisons the regional demand for certain commodities was examined in order to determine whether the projected regional intensity of commodity use roughly coincides with well-known intensity of use patterns[1]. After calculating the intensity of use for three commodities (aluminium, copper and iron) for 1970 and 2000 (from the data available in FOWE) and comparing them with per capita income levels, a certain amount of difficulty arises in attempting to establish the "expected" intensity-of-use patterns (Table 5):

Table 5 - Per Capita Income and Intensity of Resource Use[a] - Selected Resources, 1970 and 2000

	Per capita income[b]		Copper[c]		Iron[c]		Bauxite[c]	
	1970	2000	1970	2000	1970	2000	1970	2000
High income								
North America	4 624	9 070	1 699	1 544	70 127	70 987	3 681	3 345
Europe	2 584	6 682	2 470	3 001	131 843	135 417	4 253	4 940
Asia (Japan)	1 915	6 327	4 004	5 232	288 288	312 998	5 506	6 660
Oceania	2 798	6 591	2 320	1 238	269 142	258 204	6 961	7 430
Medium income								
Latin America	594	2 149	3 518	4 826	69 481	116 049	1 759	3 030
Europe	698	3 476	3 974	5 041	21 192	135 581	5 298	6 431
Africa	786	2 964	0	1 350	165 681	283 401	5 917	4 723
Low income								
Latin America	443	1 577	0	2 761	190 476	93 252	0	2 147
Asia	119	353	0	394	45 677	83 301	4 078	5 387
Africa (tropical)	167	245	0	0	177 215	22 086	21 097	1 227
Africa (arid)	205	292	0	0	37 175	44 395	0	1 110
Centrally planned								
Europe	1 564	5 419	1 217	1 757	160 584	191 390	1 825	2 636
Soviet Union	1 791	6 207	1 840	2 056	206 714	217 001	2 529	2 909
Asia	166	680	742	1 438	192 878	309 535	742	1 318
Oil producing								
Middle East, Africa	286	3 111	0	6 873	0	79 745	0	1 516

[a]See footnote in text for explanation of intensity of use. - [b]In $. - [c]Metric tons per billion dollars GDP.

Source: Own calculations based on Leontief et al. [1977, Annex VI, Scenario X].

[1] Intensity of use is a ratio of the consumption of a given commodity to GNP. Generally speaking as an economy develops the intensity to which a commodity is used first increases and then - at a certain income level - begins to decrease as technology permits a more efficient utilization and substitutes are introduced. This is the case for both copper and iron; they exhibit the tendency to decline somewhere around a per capita income level of U.S.$ 2 000. Aluminium (bauxite), however, because of its wide range of properties, tends to show a continual, although slower, increase above a given income level.
In the following "dollar ($)" is used for U.S.$.

- there would seem to be little justification for the large decrease in the intensity of copper use in Oceania, while Japan on the other hand shows a considerable increase;
- the high-income regions' intensity of iron ore use would seem to remain at an overly high level, while for several low-income regions the usage shows a surprising drop;
- the intensity-of-use pattern for aluminium, although more consistent with a priori expectations, exhibits an incomprehensible figure (1970) for Africa (tropical) and an unexpected drop for North America and Africa.

16. In closing this discussion on mineral resources it seems that little can be added to the conclusion drawn at the Tokyo Tripartite Conference in 1974 which stated that the possibility of actual global shortages (due to depletion of the resource base) in this century is out of the question. This, of course, does not mean - as the authors of FOWE also point out - that structural adjustment problems and regional shortages will not occur - as a matter of fact the difficulties that must be overcome by those developing countries which have few natural resources and a rapidly expanding population present a grave challenge to the world economic system [Weltrohstoffversorgung, 1974].

c. Nutritional Resources

17. The authors of FOWE were well aware of the crucial role that nutritional resources assume in the world economy and accordingly incorporated a considerable amount of detail into this sector of their model[1]. They included four sectors of specific agricultural outputs (animal products, high protein crops, grains and roots) as well as one residual sector, and also focussed their attention on the land and yield requirements necessary to fulfill the hypothesized demand patterns evolving from changing income levels and increased population. Likewise per capita consumption levels of proteins and calories, essential for drawing conclusions on minimum nutritional levels, are also estimated[2].

18. As mentioned earlier the structure of demand, i.e., consumption patterns (in this case) of nutritional resources, was estimated by cross-sectional analysis (based on the ten countries in the Kravis et al. [1975] study), in which per capita income was the independent variable. While the projections of these patterns for each of the three years were estimated basically by adjusting for changes in income levels, they were also made to conform to constraints based on the results of regressions relating caloric intake to per capita income levels[3].

19. On the supply side agricultural output was assumed to rise by an amount necessary to roughly maintain the 1970 level of regional self-sufficiency[4]. This implies, of course, that in those regions where population and/or income levels increase the most, the increase in output is the greatest. Once this domestic output was calculated, the increase (over the prior period) was then attributed to changes in the amount of arable land (based on FAO data on potential arable land) and changes in the land productivity (the "green revolution" in the widest sense of the word). As can be seen in Table 6 the change in output necessary to fulfill the conditions in the

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[1] It should be mentioned that some of the growth rates shown in the summary [p. 4] are incorrect. For instance: a 5 % annual growth rate is equivalent to a 3.3-fold increase in 30 years and not 4.3-fold.

[2] Pollutants (pesticides but not fertilizer solid wastes) are also included in FOWE, but not dealt with in this section.

[3] Since projected per capita income levels (for the years 1980, 1990 and 2000) in many cases exceeded the highest level in the base year a modification of the consumption patterns for these regions had to be introduced. This was done by incorporating estimates of high-income consumption patterns from the 1960 Consumer Expenditure Survey in the United States.

[4] It was assumed that a 4 % rate of annual growth of agricultural production was consistent with a GDP growth rate of 6 %. Assuming a higher growth rate for LDCs (7 %) the necessary average annual increase in agricultural production would have to be about 5 %.

Table 6 - Agricultural Demand and Supply Indicators: 2000 Compared with 1970 (Scenario X) (Index: 1970 = 100 percent)

Region	Population	Income/capita	Agricultural output	Arable land	Land productivity	Land/yield[a] index	Agricultural consumption
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
High income							
North America	131	196	196	111	194	215	171
Western Europe	115	259	130	100	162	162	160
Japan	127	330	176	100	269	269	332
Oceania	159	236	192	183	162	296	253
Medium income							
Latin America	217	362	495	166	311	517	452
Europe (medium)	153	498				286	298
Low income							
Latin America	230	356	532	140	328	460	371
Asia	211	297	506	113	331	376	349
Africa (arid)	234	142	409	131	282	371	302
Africa (tropical)	235	147	438	152	324	492	292
Centrally planned							
Soviet Union	132	347	164	100	215	215	202
Eastern Europe	120	346	143	100	186	186	182
Asia	152	410	488	120	278	333	296
Oil producing							
Middle East, Africa	251	1088	950	126	487	612	696

[a] See text for explanation.

Source: Leontief et al. [1977, p. 40 (for columns 3-6) and Annex VI, Scenario X (for columns 1, 2 and 7)]. - Own calculations.

basic scenario (particularly in the lower-income countries) is quite massive and to achieve such a forecast a very sizeable increase in land productivity has to be realized[1]. Should such increases in productivity not be forthcoming, the land/yield index reveals the area that would have to be turned into arable land if (assuming equal yields) the same output were to be reached.

20. An interesting point (in FOWE) was made in attempting to estimate the impact of attaining self-sufficiency for low-income Asia: In this case the redirection of investments into agriculture would seem to produce economically profitable results, as the investment costs are nominal and the increased expenditure for imported fertilizers and pesticides do not outweigh the large drop in imported foodstuffs [p. 41]. The results of this calculation cause the authors of FOWE to suggest "that self-sufficiency in food is a promising kind of 'import substitution' for reducing balance-of-payments deficits in developing countries"[2].

[1] Figures on the investment cost of increasing the amount of arable land and/or increasing productivity are not given in the FOWE study.

[2] Leontief et al. [1977, p. 41]. - In closing their chapter on nutritional resources two specific foodstuffs (grains and animal products) are briefly examined for developed and developing regions. It is pointed out that in the case of grains the gap between the various levels of grain consumption in the different regions decreases, but - due to increased meat products

21. Despite the attempt of the FOWE authors to include many relevant details in examining the future supply of and demand for nutritional resources, their approach in general creates a somewhat mechanical impression, and does not meet the expectations raised in their introductory remarks on the critical role and importance of agriculture. As unfortunate as this shortcoming is, it should be realized that this mechanical impression should not actually be surprising, since it can be considered to be the inherent result of the model itself. For instance, the applying of fixed 1970 shares of exports in all world exports or imports in domestic consumption (of a given commodity) allows no room for the impact of a possible, more efficient integration of countries producing agricultural products into the world economy within the framework of a reordering of the world economy.

22. As a matter of fact nutritional resources in particular lend themselves to a market-oriented approach evolving out of a more efficient division of labor in the world, since such products are a prime example of Ricardo type goods, i.e., goods whose production is determined primarily by the endowment with particular natural resources. While specialization in the production of such goods can be construed as meaning that the production structure of many developing countries should be limited to products with a low-income elasticity of demand, it would be incorrect to conclude (aside from being only one aspect of the issue) that such a specialization would not help in achieving the goal of reducing income disparities between developing and developed countries. First of all, to the extent that developing countries can increase their share of world trade and output (as production is shifted from DCs to LDCs) the lower income elasticity of demand is outweighed[1]. Secondly, even when a further increase in these shares is not possible, the extension of mere food production to food processing and diversification - complemented by the necessary rural development programs - helps to achieve an adequate rate of growth and at the same time reduces the terms of trade between urban and rural areas by expanding employment and increasing income in rural areas. Thus an additional problem - the urban overcrowding, the severe diseconomies resulting therefrom and the concomitant misallocation of public infrastructure investments - is also mitigated to a large degree. That there is adequate potential to allow such an integrated and wide sweeping strategy to be achieved can be seen in Table 7 coupled with the knowledge that

- hybrid strains and the accompanying technology are far from being used extensively in all LDCs [cf., e.g., Banerji 1971];
- land reform, as (among other things) a means of ensuring a more intensive use of arable land, has been applied only to an insignificant degree, although its positive impact - under certain conditions and within the framework of an integrated development strategy - is well substantiated [cf., e.g., Fiqueroa 1977];
- the potentials of double cropping have hardly been tapped [OECD 1976, p. 211].

23. Knowing that the above-mentioned integration and development potential with respect to nutritional resources is available, it would seem to be a somewhat useless computational exercise to show the success of concentrating on increasing domestic agricultural production with the mere goal of reducing trade deficits. To draw such general conclusions (labeled "a kind of import substitution" by FOWE [p. 41]) neglects the specific comparative advantages a region might have in the production of nutritional resources and reinforces the omni-present tendency to become self-sufficient at any cost. The result of such a policy is a misallocation of scarce resources and a lower growth path. To avoid such mistakes FOWE should have pointed out that only in those cases where regions possess the necessary potential should such policies be followed. In any case the inward-oriented slant, which might be necessary

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consumption in the higher-income countries - the characteristic differentials still remain in 2000. For a regional breakdown of commodity production, consumption and net exports see Appendix.

[1] The extent to which the various regions of the world have been able to increase production (and yields) in the past - as compared with their population changes - can be seen in the Appendix.

Table 7 - Land Utilization in the World by Regions, 1961-1965, 1975 (percent)

Region	Land area[a]		Arable land irrigated[b]	
	1961-1965	1975	1961-1965	1975
World				
Arable land and permanent crops	10.7	11.5	13.6	15.1
Permanent pasture	23.3	23.3		
Developed Countries				
Arable land and permanent crops	12.1	13.2	7.2	7.6
Permanent pasture	28.6	27.4		
North America				
Arable land and permanent crops	12.1	13.8	6.7	6.7
Permanent pasture	15.4	13.1		
Western Europe				
Arable land and permanent crops	28.1	25.8	6.8	9.5
Permanent pasture	19.8	19.3		
Oceania				
Arable land and permanent crops	4.4	5.9	0.4	0.3
Permanent pasture	58.2	59.4		
Developing Countries				
Arable land and permanent crops	9.4	10.4	11.8	13.5
Permanent pasture	21.8			
Africa				
Arable land and permanent crops	7.2	7.9	0.8	1.2
Permanent pasture	29.6	29.4		
Latin America				
Arable land and permanent crops	5.7	6.9	8.6	8.7
Permanent pasture	24.3	26.0		
Near East				
Arable land and permanent crops	6.3	6.9	18.9	20.3
Permanent pasture	15.9	16.1		
Far East				
Arable land and permanent crops	30.6	32.5	18.6	22.7
Permanent pasture	4.5	4.1		
Centrally planned				
Arable land and permanent crops	11.7	12.1	22.2	24.9
Permanent pasture	21.2	21.5		
Asian				
Arable land and permanent crops	11.2	12.2	60.9	61.4
Permanent pasture	30.4	31.2		
Europe, USSR				
Arable land and permanent crops	11.9	12.0	4.2	6.5
Permanent pasture	16.6	16.6		

[a]Percent of total land. - [b]Percent of arable land.

Source: FAO [various issues]. - Own calculations.

for a given period of time, should not prevail in the long run over an outward-looking approach, if an efficient international division of labor is to be achieved. Needless to say, the best-conceived strategy is worthless if the manifold barriers of political, social and institutional nature are not eliminated. Although the authors of FOWE also underline in their summary the necessity of overcoming these barriers [pp. 10-11], in the chapter on nutritional resources - one appropriate place to be more specific in this respect - no mention is made at all.

2. Investment and Industrialization

24. In order to achieve the rates of growth of GDP specified in the central scenario (X) the ratio of investment to GDP would have to be nearly doubled in Africa and Asia, trebled in Latin America and quadrupled in Middle East between 1970 and 2000. The investment ratios in developing countries in the year 2000 would thus generally exceed those prevailing in developed countries - a complete reverse of the base year (1970). The main burden of this rise in investment levels in UN projection would be borne in most of the developing countries by the ratio of private consumption to GDP since the authors of FOWE assume that the ratios of government consumption to GDP and of net long-term capital inflow to fixed investment in these regions would remain constant and that of net aid inflow to fixed investment would even decrease (Table 8).

The first question which arises is why the study assumes the share of government expenditure in GDP in developing and developed countries to be equal in the benchmark year 1970, and throughout the time frame of the forecasts, whereas on the one hand the share of government expenditure in GNP in 1970 (18 %) may come near to 1970 figures for developed countries, it is grossly overstated for most of the developing countries, especially for those at the lower level of per capita GDP [see UNCTAD 1976, pp. 346-359]. On the other hand the empirical evidence, which shows that the demand for government services is elastic with respect to income, does not seem to justify a constant government share in rising GDP.

25. Concerning the inflow of net long-term foreign capital it is shown in FOWE that substantial changes in the direction and volume of long-term capital would have to take place in the thirty years following 1970, if the projected rates of growth of GDP in different regions are to be realized[1]. Among the developing countries those which are richly endowed with resources would be able to import as well as export long-term capital at an above average rate[2]. Developed countries would continue to remain the net suppliers of long-term capital to developing countries[3] (Table 9).

26. Although the world pool of economic aid (as defined in FOWE) will increase from $ 27 billion in 1970 to $ 114 billion in 2000, its net volume is only expected to rise from $ 8 billion to $ 22 billion. The resource-rich developing countries are seen as contributing about two thirds of the total net economic aid, thus exhibiting a swing from a position of net receivers of aid in 1970 to a position of net suppliers of aid in 2000. The importance of the inflow of economic aid, i.e., the ratio of net aid to fixed domestic investment, will drop considerably also in the case of the resource-poor developing countries (Table 9).

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[1] FOWE presumes that the annual volume of long-term capital movement will increase from $ 27 billion in 1970 to $ 211 billion in 2000. Developed countries accounted for 81 % of the long-term capital inflow and 91 % of its outflow in 1970. By the year 2000 these shares will drop to 43 and 77 %, respectively.

[2] About a 100 % increase is envisaged in the share of resource-poor developing countries in the total inflow of long-term capital by 2000.

[3] The annual net flow of long-term capital from developed to developing countries will have to increase from $ 2.5 billion in 1970 to $ 72.2 billion in 2000 in order to meet their investment requirements estimated in FOWE.

Table 8 - GDP Growth and Shares of Consumption (C) and Investment (I) in GDP, Ratios of Net Long-Term Capital and Net Aid to Domestic Fixed Investment in 15 Regions, 1970 and 2000 (Scenario X, percentages)

Region	Year	Annual growth of GDP between 1970 and 2000[a]	Share in GDP		Ratio of net long-term capital inflow to fixed investment	Ratio of net aid to fixed investment
			C	I		
Developed regions						
North America	1970		64.3	16.5	- 2.0	- 2.2
	2000	3.2	61.1	18.4	- 7.4	- 2.4
Western Europe (high-income countries)	1970		65.7	14.9	- 1.0	- 4.6
	2000	3.7	58.2	15.9	-11.0	- 0.4
Soviet Union	1970		61.3	18.2	0.0	- 0.8
	2000	5.2	59.4	20.5	0.0	- 0.7
Eastern Europe	1970		64.1	16.5	0.0	0.0
	2000	4.9	55.8	16.5	0.0	0.0
Western Europe (medium-income countries)	1970		68.9	15.0	8.0	20.4
	2000	7.0	65.2	24.0	5.1	5.9
Japan	1970		55.8	22.4	- 1.8	- 1.6
	2000	4.9	57.2	16.4	-13.7	- 2.0
Oceania	1970		64.3	15.8	20.6	- 1.5
	2000	4.5	65.6	21.9	19.3	- 0.6
Southern Africa	1970		69.8	14.8	24.0	8.0
	2000	7.5	67.5	26.4	19.9	12.8
Resource-rich developing regions						
Latin America (low-income countries)	1970		69.4	10.3	17.1	19.5
	2000	7.3	65.0	27.6	19.3	1.4
Middle East	1970		55.2	9.1	9.1	9.1
	2000	11.7	55.9	34.6	10.4	- 5.4
Tropical Africa	1970		70.0	8.0	5.3	15.8
	2000	4.2	61.1	13.3	2.8	15.7
Resource-poor developing regions						
Arid Africa	1970		73.6	8.9	4.2	29.2
	2000	4.1	75.1	15.1	0.7	25.7
Asia (low-income countries)	1970		74.7	8.8	5.6	45.4
	2000	6.3	72.0	16.2	4.1	14.8
Asia (centrally planned)	1970		72.0	8.4	0.0	- 0.9
	2000	6.3	60.3	19.7	0.0	- 0.5
Latin America (medium-income countries)	1970		69.0	11.6	6.8	6.8
	2000	7.1	61.4	24.8	6.2	0.4

[a] In many cases the growth rates calculated here from the annex tables of the UN study differ from those quoted in the scenario analysis of this study. The reasons for these differences could, however, not be identified.

Source: Calculated from: Leontief et al [1977, Annex VI, pp. 86-105].

Table 9 - GDP Growth and Shares of Personal Consumption and Fixed Investment in GDP, Flow of Long-Term Capital and Aid in Three Groups of Developed and Developing Regions, 1970 and 2000 (Scenario X)

Region	Year	Annual growth of GDP between 1970 and 2000	Share of personal consumption in GDP	Share of fixed investment in GDP	Inflow of long-term capital	Outflow of long-term capital	Net capital inflow (+) or outflow (-)	Net capital flow as percent of fixed domestic investment
		percent			bill. U.S.$			
Developed regions	1970		63.7	16.7	21.5	24.0	- 2.5	- 0.6
	2000	4.2	59.7	18.5	90.7	162.9	-72.2	- 4.2
Resource-rich developing regions	1970		64.4	9.3	1.9	0.8	1.1	11.8
	2000	9.1	58.3	31.7	74.3	21.0	53.3	12.0
Resource-poor developing regions	1970		72.1	9.5	3.3	1.7	1.6	4.2
	2000	6.4	64.6	20.3	45.4	26.7	18.7	3.6

Region	Year	Aid inflow	Aid outflow	Net aid inflow (+) or outflow (-)	Net aid flow as percent of fixed domestic investment	Net foreign investment income	Net foreign income as percent of total exports
		bill. U.S.$				bill. U.S.$	
Developed regions	1970	15.0	22.8	- 7.8	- 1.7	7.9	2.8
	2000	63.7	69.8	- 6.1	- 0.4	- 30.4	- 1.8
Resource-rich developing regions	1970	3.2	1.8	1.4	15.1	- 5.6	- 19.9
	2000	13.4	29.0	-15.6	- 3.5	357.3	182.9
Resource-poor developing regions	1970	8.8	2.4	6.4	17.0	- 2.3	- 7.9
	2000	36.9	15.2	21.7	4.2	-326.5	-210.9

Source: Calculated from: Leontief et al. [1977, Annex VI, pp. 86-105].

27. From the projections for both net long-term foreign capital and net foreign aid[1] it can be concluded that for financing the investment of the order of magnitudes involved in the FOWE developing countries would have to depend largely and more than in the past on domestic resources. The domestic resources can be made available for this purpose only when a rising

[1] Taken together they will amount to 8 % of domestic fixed investment in the year 2000 in resource-poor developing countries and to 9 % in resource-rich developing countries compared with 21 and 27 %, respectively, in 1970.

proportion of increasing income levels is devoted to investment at the expense of personal consumption. As pointed out in FOWE this would "necessitate relevant measures of taxation, credit and fiscal stimulation of savings, as well as certain institutional changes, facilitating the accumulation of resources for investment and directing them into those areas essential for development" [p. 34]. What FOWE does not include, however, is a specification of these required institutional, monetary and fiscal measures.

28. Most of the total investment in developing regions is directed into the industrial sector which has to serve as an engine of the economic growth projected in the FOWE model. Growth of output in the manufacturing sector is expected to be higher than in the primary sector (agriculture and mineral resources) in all developing regions. The services sector including transportation and communication shows, however, a differentiated rate of growth: whereas is grows faster than all other sectors in Asia and Africa it lags behind the manufacturing sector in Latin America and the Middle East (Table 10).

Table 10 - Sectoral Annual Growth Rates, 1970-2000 (Scenario X, percentages)

Region	Agriculture and mineral resources	Manufacturing				Services
		total	consumer goods[a]	capital goods[b]	intermediate products[c]	
Latin America (medium income)	5.8	8.5	7.6	10.6	8.5	8.0
Latin America (low income)	5.6	8.8	7.8	10.5	9.3	8.7
Middle East	7.7	14.0	10.5	16.0	17.5	12.2
Asia (low income)	5.4	7.8	7.1	8.7	8.0	8.7
Arid Africa	5.1	6.2	5.4	6.4	7.0	7.4
Tropical Africa	5.5	6.6	5.3	8.7	8.3	7.8

[a]Food products, textile and apparel, furniture and fixtures, paper, printing and 'other manufactures'. - [b]Motor vehicles, aircraft, other transportation equipment, metal products, machinery, electrical machinery and instruments. - [c]Petroleum refinery, primary metals, wood and cork, rubber, industrial chemicals, fertilizers, other chemicals, cement and glass.

Source: Leontief et al. [1977, pp. 35 sq.].

29. Within the industrial sector the leading role is assigned to capital goods industries. They are to grow faster than consumer goods industries in all the six developing regions and faster than industries producing intermediate goods in Latin America, Asia and tropical Africa. It is stated in FOWE that: "on the regional, though not necessarily on the country level, an accent on heavy industry is essential for industrialization and economic development. There is special need for priority investment in the growth of machinery- and equipment-producing branches of industry, where faster development is expected" [p. 36].

30. The industrialization process underlying the FOWE model will obviously lead to considerable structural changes in developing regions. By the year 2000 the primary sector will lose its dominating position either to manufacturing or to the services sector in all the developing regions except tropical Africa (Table 11). Within the manufacturing sector the shares of capital and intermediate goods industries will rise at the expense of consumer goods industries,

Table 11 - Structural Distribution of Total Output, 1970 and 2000 (Scenario X, percentages)

Region	Year	Agriculture and mineral resources	Manufacturing				Utilities and construction	Services
			total	consumer goods industries[a]	capital goods industries[b]	intermediate goods industries[c]		
Latin America (medium income)	1970	21.0	31.5	16.8	7.0	7.7	10.2	37.3
	2000	11.4	36.8	15.1	11.4	10.2	14.5	37.3
Latin America (low income)	1970	33.5	23.8	13.5	3.4	6.9	9.3	33.4
	2000	16.1	28.5	12.3	6.6	9.5	16.2	39.2
Middle East	1970	63.3	11.3	7.4	2.0	1.8	6.5	18.9
	2000	15.0	31.0	7.1	10.1	13.8	17.5	35.6
Asia (low income)	1970	33.2	29.9	17.2	5.5	7.2	8.3	28.6
	2000	19.4	32.3	16.4	7.8	8.1	11.0	37.3
Arid Africa	1970	28.1	33.6	16.2	8.5	8.9	7.1	31.2
	2000	23.8	35.9	14.1	9.8	11.9	9.4	35.0
Tropical Africa	1970	46.9	17.8	12.2	1.3	4.3	7.9	27.4
	2000	39.0	18.6	8.8	2.5	7.3	10.0	32.4

[a]Food products, textile and apparel, furniture and fixtures, paper, printing and 'other manufactures'. - [b]Motor vehicles, aircraft, other transportation equipment, metal products, machinery, electrical machinery and instruments. - [c]Petroleum refinery, primary metals, wood and cork, rubber, industrial chemicals, fertilizers, other chemicals, cement and glass.

Source: Leontief et al. [1977, p. 35 sq.].

and by the end of this century far exceed the share of consumer goods sector in total industrial output in all the developing regions except arid Africa. In the view of the FOWE authors the developing countries would be following nearly the same development pattern as the developed countries [p. 35] in their initial stages of development.

31. As a result of the projected rapid industrial growth developing countries are likely to raise their share in world manufacturing output from 6 % (1970) to 17.5 % (2000) as compared with an increase to 25 % stipulated in the UNIDO's Lima Declaration; for the centrally planned countries an increase from 22 % (1970) to 29 % (2000) is envisaged[1]. Among the developing countries the biggest gain in this respect would be recorded by Asia and the Middle East and, sectorally speaking, by capital and intermediate goods industries [p. 37].

32. Keeping these developments in mind the question arises as to what extent the FOWE strategy for LDC industrialization, with emphasis on heavy industries, will

- help equalize income distribution within LDCs,
- mitigate the problems of persistent unemployment and underemployment,
- induce a fuller use of comparative advantages, both static and dynamic, and
- solve the problem of balance-of-payments constraints in resource-poor developing countries.

As to the income distribution issue, the authors merely state that special measures will have to be taken "to facilitate a more equal distribution of income ... so that the benefits of faster

[1] The corresponding world share of developed market-economy countries decreases from 70 % to 49 %.

growth of per capita income are shared fully, as a matter of priority by the poorest groups in these countries" [p. 35]. It must be doubted, however, whether the heavy-industry oriented development policy proposed in FOWE will serve the authors' purpose in this respect. As a matter of fact past experience shows that such a policy may even counteract attempts to achieve a more equal distribution of income. First of all, heavy industries have tended to be located in urban areas in the LDCs (in order to profit from agglomeration economies) thereby further shifting the terms of trade between urban and rural areas in favor of the former. Not only do the poorer population cohorts (in the rural areas) suffer, but the urban areas also become burdened with migrants hoping to find a job in such industries - an almost hopeless task since the industries are capital intensive and only relatively few jobs are available. A development strategy which promotes light industries on the basis of a balanced regional dispersion, would be more effective in facilitating an equal distribution of income. Secondly, the promotion of light industries will contribute to the supply of consumer goods to satisfy the additional demand for wage goods resulting from rising incomes. Compared with this, the strategy proposed in FOWE is likely to lead to inflation given the balance-of-payments constraint which may prevent the LDCs from satisfying additional demand for wage goods via imports. If an income distribution variable had been incorporated in the FOWE model, it is quite likely that the tendency of its underlying development strategy to aggravate the inequality of income distribution in LDCs would have become evident.

33. An attack on the problem of income inequality in developing countries presupposes a solution to their problem of unemployment. Rough estimates of total unemployment (including underemployment and disguised unemployment) approach 20-25 % of the labor force. Measures to increase the income of the labor force without integrating it into the active economy through employment are very difficult to be implemented, especially in the absence of a well functioning social security system in these countries.

Although FOWE does show that the development strategy involved in its model leads to an increase in employment in absolute number as well as in terms of the ratio of employed labor force to total population, it does not include any estimates of the labor force so that no conclusions can be drawn with regard to the rate of unemployment in any of the developed or developing regions.

34. A solution to the unemployment problems in LDCs can be expected to arise from a development strategy based on comparative advantages. A suitable industry mix in the sense of an optimal allocation of resources can be achieved if the country concerned chooses to specialize in those industries in which it is likely to have comparative advantages in its trade with other countries [see Fels 1972]. An analysis of comparative advantages as revealed by the foreign trade figures of developing countries for the years 1970, 1971 and 1972 shows that they had these advantages primarily in consumer goods[1] (Table 12). It should be emphasized, however, that it is also necessary to distinguish between resource-rich and resource-poor developing countries in prescribing a development strategy based on comparative advantages. Whereas a heavy-industry oriented industrialization may be successful in the former with regard to both growth of income as well as achievement of fuller employment, it is not likely to bear enough fruits in these respects in the resource-poor countries owing to the balance-of-payments bottleneck faced by them.

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[1] These are: essential oils and perfume materials (SITC 55), leather and leather goods (SITC 61), wood and cork manufactures (SITC 63), textiles (SITC 65), nonmetallic mineral manufactures (SITC 66), furniture (SITC 81), travel goods (SITC 82), clothing (SITC 84), footwear (SITC 85) and miscellaneous articles like musical instruments (SITC 89). Their comparative advantage in mineral tar and crude chemicals from coal, petroleum and natural gas (SITC 52) is accounted for mainly by those of developing countries which are rich in these resources. Studies at a more disaggregated level reveal a few exceptions, e.g., India in metal manufactures (SITC 69). See Donges, Riedel [1977] ; Agarwal, Rodemer [1977, Annex Tables].

Table 12 - Revealed Comparative Advantages (+) and Disadvantages (-) of Developing Countries in their World Trade, 1970-1972[a]

Commodity group according to SITC		1970	1971	1972
51	Chemical elements and compounds	-22,7	-29,6	-38,8
52	Mineral tar and crude chemicals from coal, petroleum and natural gas	48,6	70,9	69,6
53	Dyeing, tanning and colouring materials	-28,6	-29,5	-32,4
54	Medicinal and pharmaceutical products	-27,8	- 0,8	-27,1
55	Essential oils and perfume materials	10,2	10,1	9,8
56	Fertilizers, manufactured	-34,1	-18,4	-17,8
57	Explosives and pyrotechnic products	- 3,4	- 9,0	-20,1
58	Plastic materials, generated cellulose and artificial resins	-76,9	-77,4	-74,3
59	Chemical materials and products, n.e.s.	-63,7	-58,8	-59,8
61	Leather, leather manufactures, n.e.s. and dressed fur skins	74,6	73,1	78,2
62	Rubber manufactures, n.e.s.	-41,4	-45,8	-44,7
63	Wood and cork manufactures (excluding furniture)	57,7	60,1	63,6
64	Paper, paper board and manufactures thereof	-65,2	-62,9	-61,1
65	Textile yarn, fabrics, made-up articles and related products	28,5	22,9	23,3
66	Non-metallic mineral manufactures, n.e.s.	23,2	21,4	22,9
67	Iron and steel	-38,5	-54,4	-44,7
69	Manufactures of metal, n.e.s.	-34,4	-36,6	-33,6
71	Machinery, other than electric	-72,6	-74,4	-69,6
72	Electrical machinery, apparatus and appliances	-33,1	-25,5	-23,8
73	Transport equipment	-67,2	-59,2	-59,5
81	Sanitary, plumbing, heating and lighting fixtures and fittings	10,0	0,9	0,8
82	Furniture	11,0	9,3	10,0
83	Travel goods, handbags and similar articles	40,5	45,2	50,2
84	Clothing	60,9	64,6	66,7
85	Footwear	43,3	49,8	51,2
86	Professional, scientific and controlling instruments, photographic and optical goods, watches and clocks	-43,3	-38,3	-38,0
89	Miscellaneous manufactured articles, n.e.s.	30,0	26,3	24,9

[a]Calculated according to the following formula:

$$RCA_{ij} = \left[\frac{x_{ij} - m_{ij}}{x_{ij} + m_{ij}} - \frac{\sum_j (x_{ij} - m_{ij})}{\sum_j (x_{ij} + m_{ij})} \right] \cdot \left[\begin{array}{l} \dfrac{100}{1 - \dfrac{\sum_j (x_{ij} - m_{ij})}{\sum_j (x_{ij} + m_{ij})}} \quad \text{if} \quad \dfrac{x_{ij} - m_{ij}}{x_{ij} + m_{ij}} > \dfrac{\sum_j (x_{ij} - m_{ij})}{\sum_j (x_{ij} + m_{ij})} \\ \dfrac{100}{1 + \dfrac{\sum_j (x_{ij} - m_{ij})}{\sum_j (x_{ij} + m_{ij})}} \quad \text{if} \quad \dfrac{x_{ij} - m_{ij}}{x_{ij} + m_{ij}} < \dfrac{\sum_j (x_{ij} - m_{ij})}{\sum_j (x_{ij} + m_{ij})} \end{array} \right]$$

where x = exports, m = imports, i = developing countries, j = SITC commodity group

Source: UN [1974].

35. Comparative advantages are, as the empirical evidence also shows, subject to changes as time passes [see Banerji, Donges 1972; Balassa 1977]. As developing countries move to higher stages of industrialization, as their demand for capital and intermediate goods increases and the balance-of-payments situation improves as a result of increasing export of products of industries established in earlier stages of industrial development, they can introduce heavy industries also. Introduction of these industries at a very early stage of industrialization, however, involves underutilized capacities and lack of competitiveness resulting in a relative waste of scarce resources especially foreign exchange required for imports of capital goods. Thus, attempts to establish heavy industries irrespective of comparative advantages reduce welfare. Industrialization based on comparative advantages in developing countries need not lead to the preservation of their existing industrial and foreign trade structures as sometimes wrongly believed in these countries. Studies done at the Institut für Weltwirtschaft (IfW) show that such an industrial strategy could enable developing countries to raise their share in world industrial production approximately to the same level as projected in FOWE [see Donges 1975; Stecher 1977].

36. The success of an industrial strategy oriented towards consumer goods and other light goods industries in developing countries would, of course, also depend on the degree of freedom granted to the imports of these goods into developed countries. Resurgence of protectionist forces in these countries in the last few years, especially in those industries in which developing countries definitely have comparative advantages, does not augur well at present in this respect. If the developed countries are interested in promoting a better international division of labor on the basis of mutual advantages and international cooperation they will have to open their markets for the products of the Third World more than what has been the case so far. The resulting problems of structural changes and unemployment in the related industries in the developed countries will have to be solved by them with the help of a suitable mix of subsidies and reemployment policies [see Fels 1976; Dicke et al. 1976, pp. 120-143; Wolter 1977].

37. The implementation of the developmental strategy underlying the central scenario (X) of the FOWE model would lead to a balance-of-payments deficit for the resource-poor LDCs (in 2000) amounting to $ 413.2 billion[1], which is about two and a half times their export earnings and ten times the net inflow of capital and aid into these countries[2]. This deficit presumes a corresponding outflow of short-term capital from the developed and resource-rich developing countries. The FOWE-authors have made some alternative projections in this respect by changing their assumptions about relative prices, capital and aid flows, import coefficients and export shares (scenarios D, R and M) as a result of which the estimated deficit of the resource-poor countries decreases [pp. 64-69].

38. All this leads us to presume that the FOWE heavy-industry biased industrialization strategy for LDCs is likely to entail serious negative side-effects. Selection of an industry mix according to the principle of potential comparative advantages would, on the other hand, enable the developing countries to achieve a given rate of income growth with a lower rate of investment than that estimated in FOWE as a precondition for reducing the income gap between the developed and developing countries. Physical and human capital required per unit of output as well as per employee in light industries is generally lower than in heavy industries. Therefore even if the developing countries are not able to raise as much domestic capital as envis-

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[1] The structure of this deficit is as follows: debt servicing burden: $ 326.5 billion; trade deficit: $ 127.1 billion; long-term capital and aid surplus: $ 40.4 billion.

[2] See Leontief et al. [1977, Annex VI, Scenario X]. - According to these figures, the balance-of-payments deficit of the resource-poor developing countries amounts to $ 466.4 billion but the total of net trade, net aid and long-term capital flows, and foreign income in the year 2000 comes to $ 413.2 billion. The difference of $ 53.2 billion between these two figures is, however, not explained in FOWE.

aged in the FOWE model, they need not fail to attain the growth objective provided they shift the emphasis from heavy to light industries.

39. Moreover, while the strategy suggested in FOWE, if implemented, would leave a large number of people unemployed in Asian and African developing countries, recent estimates (made at the Institut für Weltwirtschaft) of capital requirements for full employment and growth in developing market economies in the year 2000 show that full employment in these countries can be achieved at an investment level of 15.6 to 18.3 %, with growth rates of labor force between 2.1 and 2.35 % and of GDP between 5.2 and 6.3 % (depending on assumptions made about their income level and rate of unemployment), provided they choose a suitable mix of labor-intensive technologies and goods to be produced [Hiemenz 1977].

40. Light industries, for instance, can be profitably operated in the small-scale sector, thereby providing a relatively large scope for the use of labor-intensive techniques and decentralized industrial production. Large-scale industries tend to be capital intensive and to concentrate in cities thus aggravating the problems associated with overpopulated urban areas in the developing countries. In order to avoid these problems more attention will have to be paid to rural industrialization which creates opportunities for additional employment of seasonal agricultural labor. Naturally there are industries which can be economically operated only on a large scale owing to indivisibilities of available production technologies. Further, a particular developing country can have locational advantages in some heavy industries because of the domestic availability of related raw materials, skills, markets, etc. In such cases local production is quite advisable. The emphasis on light industries here is therefore to be viewed in terms of relative priorities to be assigned to these industries over heavy industries. The evidence gathered from an analysis of industrialization policies and efforts in 15 country studies carried out recently at the IfW [see Donges 1976] lends support to the view that a combination of light industries, labor-intensive technologies and small-scale production is more suitable for employment creation, income growth and equal distribution of income than a combination of heavy industries, capital-intensive technologies and large-scale production. It also involves a lower burden on the balance of payments at early stages of industrialization when the foreign exchange position is usually tight and permits an easier transition from production for only local markets to that for exports enabling the country concerned to go over to the next higher stage of industrialization.

41. However, the need for foreign direct investments cannot be eliminated even in the case of the alternative industrialization strategy suggested above. In order to encourage such investments in developing countries, efforts will have to be made to minimize political risks for such investments in these countries. An analysis of the nationalization of foreign property amounting to about $ 10 billion in some forty developing countries between 1952 and 1972 showed that nationalization based on political grounds affects further flow of foreign direct investments into the respective countries negatively [see Agarwal 1976]. Repeated statements of developing countries to exercise their right of sovereignty over their resources and an explicit recognition of this right in the UN Charter of Economic Rights and Duties of the Nations together with their right to nationalize foreign property according to their national laws have further increased the concern of investors for political risks in the future. Therefore it appears to be advisable that investing and host countries should evolve a system of multilateral guarantees against political nationalization of foreign investments in order to secure a smoothly functioning flow of long-term foreign capital across the national boundaries, especially from the developed into developing countries. So far these guarantees are given on the basis of bilateral agreements between the nations and involve higher costs than a multilateral agreement is likely to have [see Juhl 1976].

42. The need for multilateral guarantees against political oriented nationalizations in developing countries has to be viewed especially in light of their investment requirements for exploration and development of ocean mineral resources which are highly capital and technology intensive. The financial and technological capacity of these countries is very limited. If the seabed mineral resources in their territorial waters are to be efficiently exploited, they will have to grant mineral rights to foreign investors on attractive terms which might require the establishment of a system of multilateral guarantee.

3. Pollution and Abatement

43. The basic question raised in FOWE about the pollution emerging from the growth of industry, transportation, urban agglomeration as well as agricultural output and about the economic costs of abating this pollution is concerned with limits to growth which they may set. The FOWE authors have come to the conclusion that pollution and abatement expenditure are not expected to "pose an insurmountable barrier for accelerated development" [p. 7]. This conclusion is based on two empirical findings. First, the estimates of emissions of eight major pollutants[1] after their abatement treatment[2] show that pollution can be reduced to manageable limits with the help of available abatement technology. Secondly, the estimated costs of all abatement activities are not likely to exceed 2 % of GDP even in the case of most developed regions where abatement standards are strictly and fully applied [p. 7][3].

44. Developing regions with per capita income of less than $ 700 p.a. are assumed to have no abatement activities and expenditure (scenario 1). As their income levels rise they too would divert resources from consumption and investment to pollution abatement activities. The authors of FOWE expect, however, that by the turn of the century only Latin America and the Middle East will reach a stage where they would be devoting some proportion of their GDP (0.2 to 0.4 %) and capital stock (1.0 to 2.3 %) to abatement activities. From the estimated net emission of pollutants like solid waste, particulates and suspended solids it can, therefore, be concluded that in absolute terms the developing regions will be more polluted towards the end of this century than the developed countries [p. 50 sqq.]. Estimates of absolute amounts of the net emission of pollutants in different regions, are, however, not compared in FOWE with the natural capacities of these regions to absorb pollution without endangering the environment so that nothing can be inferred about the quality of environment available by that time in the developed countries with relatively more abatement expenditure compared with that in the developing countries with less or no abatement expenditure.

45. The FOWE authors had to make their projections of pollution and abatement under the constraint of only sparsely available relevant data for developing as well as developed countries except the United States of America. So they have generally relied on the United States data, assuming that the gross emissions of pollutants per unit of output in different industrial sectors would be the same across the regions and that input requirements per unit of each abatement process are uniform throughout the world. Four abatement scenarios are used in the FOWE model assuming further that the United States 1970 abatement standards are applied, the degree of which is determined by the level of per capita GDP of the regions[4]. These scenarios are, as the authors themselves candidly point out, "highly speculative" [p. 50].

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[1] The eight pollutants are: particulates, biological oxygen, nitrogen (water), phosphates, suspended solids, dissolved solids, solid wastes and pesticides.

[2] Except in the case of pesticides, which are not covered under 1970 standards of abatements in the United States and where no information on the costs of their abatement was available to the FOWE authors [Leontief et al. 1977, p. 49].

[3] Cost estimates of the abatement of major particulate air pollution, primary, secondary and tertiary treatment of water pollution, and land filling or incineration of urban solid wastes in FOWE vary between 0.2 and 0.9 % of GDP and the share of capital stock of the abatement sector in total capital stock between 0.9 and 3.9 % depending on the region, its per capita income and abatement standards applied. However, these estimates do not cover all forms of pollution and abatement and the FOWE authors maintain that the abatement activities covered by them account for about 35 to 45 % of the total costs of all abatement expenditure [p. 7 and 52 sqq.].

[4] Regions with per capita income of more than $ 700 but less than $ 2 000 are supposed to apply half the abatement standards practised in the United States in 1970 (scenario 2). In regions with current per capita income over $ 2 000 but less than that in the previous period the same proportion of abatement standards is applied as in the United States in 1970 (scenario 3) and finally the fourth scenario includes regions with per capita income of more than $ 2 000 in the current as well as previous period. In this scenario the net emission is held constant at the level of the first year when full abatement standards of the United States were applied.

46. Although it would hardly seem worthwhile to explicitly deal with forecasts labeled by the authors themselves as being "highly speculative," it does seem necessary to direct the readers' attention to some possible weaknesses of their approach. First of all, while the authors of FOWE went to great lengths to calculate regional pollution patterns, even taking into account industrial structure differences, they failed to take scale differentials into account. For example, a country in which a major part of industrial production originates in the small-scale sector is likely to have a lower pollution level than a country whose industrial production is concentrated in the large-scale sector. Moreover, production technologies in two regions at the same income level but in different periods of time, especially when the difference between these periods stretches over decades as in FOWE, are not likely to be the same; i.e., production technologies to be transferred to a developing country, for example, in the year 2000 are not going to be as pollutive as those applied in the transferring developed country in 1971 when its income level might have been the same as that of the technology-importing developing country in 2000 [see Schatz 1976; Giersch (Ed.) 1974]. The fact that elsewhere in FOWE it is assumed that substantial transfers of technology from developed to developing countries would have to take place if the industrialization of the order of magnitudes involved in the study is to be realized [p. 63], would also coincide with this contention.

4. International Trade

47. In view of the important role international trade plays in the process of economic growth not only in developed countries but also (and especially) in countries at an early development stage, the study's projections of international trade flows merit particular attention. The authors of FOWE are well aware of this importance and incorporate - as mentioned earlier - both trade flows and capital movements as the basic mechanism, by which the 15 regional input-output-systems are linked.

48. Beginning with the structure of world trade in 1970, projected trade flows are not determined by changes in the relative competitiveness of a region, but rather by assuming that - given the level of income and the structure of the economy - exports of a particular commodity from one region to the world represent a constant share of total world exports of this commodity, while the imported quantities of this commodity are fixed shares of the region's consumption. Thus the regions' output and the regional components of global input determine the internal input-output balances of each of the trading regions. These "trade-coefficients" then are applied to any change in regional inputs and outputs (of internationally traded goods); the result is a change in the respective region's foreign trade pattern, which simply means that each region's exported and imported quantities are not only related but also determined by its sectoral input-output structure.

49. At least as important as traded quantities is the question of projected future values of imports and exports, which requires the determination of prices and income. Since in the model framework applied, the technical input-output coefficients (and their change over time) govern relative prices between various goods on the one hand and wages and profits (value added) of various industries on the other, it is principally possible either to determine the value added (at a given price) of a particular industry or the price of its product (at given value added). Starting from the appropriate price/value-added relations, product prices can be computed; this has been done for developed regions, at first incorporating expected changes in technical input coefficients. Prices of internationally traded goods which have been estimated and projected in this way, reflecting economic conditions prevailing in industrialized countries, have then been inserted in the respective price/value-added relations of developing countries; technology and resource endowment of the different regions - via differences in technical coefficients - affect the respective price/value-added relations.

50. As to the expected changes in technical input coefficients which will be reflected by changes in relative prices, the FOWE study has assumed the following prospective lines in development: (1) In the industrialized countries the prices of various raw material inputs are assumed to rise

sharply, since the depletion of known and accessible resources will induce higher capital requirements of primary extractive industries [p. 65]; (2) in developing countries, which are richly endowed with natural resources, raw material extracting industries will realize higher profits than comparable activities in developed countries; (3) as regards the manufacturing sector of developing countries the authors assume a low - in many activities even negative - value added.

51. The projections of the regions' balances of trade, based on estimated quantities for exports, imports and prices, have been computed in current prices. Within the model's framework these regional trade balances are treated either as a given variable with the respective GNP being unknown, or vice versa. Having, for example, numerically fixed a GNP target value for developing countries (areas) it is then possible to determine the import surplus needed under certain prevailing economic conditions to achieve this target. Any deficit, however, which would accrue in the balance of payments if goods were priced at the market level may be offset by an increase in export prices of developing countries, and/or financial transactions.

52. These characteristics of the methods used pose several major limitations to the model's ability (a) to realistically forecast trade figures and (b) to serve as an appropriate tool to analyse long-run trade patterns reflecting changes in the international (interregional) division of labor. Before proceeding to scrutinize these two issues first of all a few numerical results of the projections will be presented.

53. In its most favorable set of conditions (scenario X) the volume of world trade is expected to increase with an annual rate of 5.2 %, which is slightly above the growth rate of world gross product (4.8 %). It is projected that in the year 2000 about 14.5 % of world gross product would cross national (regional) borders as compared to 10.6 % in 1970. A particularly rapid expansion of trade is estimated for manufactured exports (7 % annually), while trade in agricultural products and in mineral resources is projected to be less than average (2.9 % and 5 % respectively p.a.).

54. Parallel to the developing market regions' increased share of world gross product (1970: 11 %; 2000: 22 %), these regions - according to the model's projections - will manage to increase their export share of mineral resources, light industry, machinery and industrial materials considerably (see Table 13). The share of developing countries' total manufactured ex-

Table 13 - Regional Structure of Exports and Imports[a] (Scenario X), 1970, 2000 (Percent)

Region	Year	Agriculture	Mineral resources	Light industry	Machinery and equipment	Materials	Agriculture	Mineral resources	Light industry	Machinery and equipment	Materials
		exports					imports				
Developed market economies[b]	1970	46.0	43.5	75.2	83.9	85.0	63.5	70.6	70.5	63.2	63.8
	2000	47.5	16.4	69.6	73.2	77.4	43.1	56.0	59.4	45.8	44.5
Developing market economies	1970	32.7	39.3	12.8	1.5	5.1	15.3	10.7	16.2	18.8	20.4
	2000	31.6	75.0	13.8	2.7	7.1	39.4	19.3	22.2	34.0	39.6
Latin America	1970	12.7	10.8	1.2	0.4	1.7	3.5	3.5	3.7	6.4	7.0
	2000	12.9	15.6	1.9	0.9	2.7	7.5	8.2	4.4	12.0	8.9
Asia and the Middle East	1970	12.9	23.8	9.9	1.0	2.6	9.3	5.7	9.4	9.3	10.0
	2000	12.1	51.9	11.2	1.7	3.9	28.6	10.3	15.1	22.0	28.4
Africa (non-oil)	1970	7.1	4.8	1.7	0.1	0.8	2.4	1.5	3.1	3.0	3.4
	2000	6.6	7.5	0.7	0.1	0.5	3.2	0.9	2.7	1.7	2.3

[a] In 1970 prices. - [b] Not including medium-income regions.

Source: Leontief et al. [1977, Tables 49, 51, pp. 56, 57].

ports in world manufactured exports will rise from 8.9 % (1970) to 12.5 % in the year 2000, the respective annual growth rate for this period being 5.6 %.

An acceleration of growth (industrialization) in the developing regions is clearly reflected in their rapidly growing import requirements, leading to an increasing share of developing countries in world imports from 16.4 % (1970) to 31.4 % (2000), above average increases are realized in the categories agricultural commodities, industrial materials, machinery and equipment. Depending on the region, the share of manufactured imports varies from 60 to 85 %, of which (in all regions) machinery and equipment is the largest. With the exception of light industry products (in the case of only one region, low-income Africa), all developing regions in all sub-categories of manufactured products remain net-importers.

55. As to the balance-of-payments position of various regions the study offers different alternatives. While all quantities in the model have been measured in constant prices of 1970, traded goods in the balance of payments are valued in current prices, assuming changes in relative product prices for 1980, 1990 and 2000. In order not to overload the presentation of projected results with too many (confusing) details the discussion will be confined to sketching the main lines of changes in the regional balance-of-payments' positions rather than providing numerical evidence[1].

56. As to the impact of changes in relative prices on balance of trade results, attention should be given to the technique applied in order to get some idea about the proximity of the projections to reality. Within the given methodological framework, a determination of relative prices for goods involves the solution of the "dual of the input-output-system, given the technologies and the value-added proportions" of the respective reference years [p. 65]. Changes in relative prices - defined in this system - are nothing else but expected shifts in labor productivity, technique of production and resource costs. While, as a first approximation, such a procedure seems to be acceptable, it is too much of a simplification to apply this technique to the most developed region (North America) - as the authors of FOWE have done - and to assume that these regional projected price changes would be representative of price changes prevailing in world trade. From an economist's point of view, for whom patterns of the international division of labor and hence trade flows are a reflection of internationally different developments of relative prices over time, this is an altogether unsatisfactory approach. Another major weakness of the study (admitted by the authors), having strong implications for the allocation issue, has to be seen in the fact - as mentioned earlier - that though the model assumes autonomous substitution of inputs with changing technology and supply conditions, there has been no effort to measure effects of price changes on the choice of competing technologies and substitutes.

57. There have been three alternative assumptions with regard to these exogenously determined price changes: (1) prices in world trade would change in accordance with relative price movements computed within the model; (2) prices of 1970 would generally prevail, but there would be a 3.5-fold increase in the price of petroleum; (3) the implementation of commodity schemes - being presently a matter of international negotiations - results in substantial relative price increases for some of the agricultural and mineral primary commodities; (4) alternatives (1) to (3) are assumed to prevail at the same time.

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[1] To start with, it should be borne in mind that FOWE's computations - as "regards balance-of-payments results" - only present what one might call "first round effects." Supposing the balance of trade in any given year is more (less) favorable to a particular region, this will have implications on future foreign debt and interest payments; these will be lower (higher) than originally calculated [pp. 66-67].

The broad lines of these results can be stated as follows:

(1) Changes in prices are gradual; net differences for the trade balances are not large (1980); by 1990 substantial deficits emerge in high-income regions. Likewise unfavorable is the development in some developing regions (medium-income Latin America, low-income Asia) while additional net export revenues are achieved by the mineral exporting regions.

(2) The trade position of the developing countries as a whole would be improved considerably. Petroleum-importing regions' trade balance deteriorates, resulting in large deficits.

(3) Significant reduction in developed regions' total deficit; the largest beneficiaries would be the two Latin American regions, tropical Africa and low-income Asia. The cumulated effect of commodity price increases is smaller than in (2).

(4) The main beneficiaries are still the oil-exporting region and tropical Africa, the other developing regions' position being somewhat improved as compared to (1).

58. The description of the model as regards the trade flow issue, has led to a sceptical a priori assessment of its ability to reasonably estimate future trends and realistically predict changes in the international division of labor. In substantiating this contention, first of all, the economic implications accruing from model-specific factors will be discussed. Furthermore, the projected results are then - wherever possible - contrasted with alternative projections or at least with some economic plausibility considerations which might serve as a kind of reference system.

The technical complexity of the FOWE model as well as the authors' meticulous simulation of alternative sets of assumptions in many respects exceeds previous global models without, however, at the same time improving the extent to which these approaches are able to produce plausible results. Some examples of model-inherent attributes and assumptions have already been elaborated on before. These essentially concern the study's failure to include foreign trade as a major determinant of the future division of labor within the world economy. Consequently it is not only impossible to use the model as a tool for explaining the present pattern of regional specialization but also for predicting future trends. These methodological constraints can briefly be summarized as follows:

- Regional import and export projections in the model are based on the hypothetical assumption of constant prices (1970); changes in relative prices, due, for instance, to interregional differences in inflation rates (including exchange rate changes), are incorporated only for the purpose of setting up regional trade balances and do not have an impact on allocation decisions[1]. Allocation is determined by the structure of demand and supply - a function of the income level. Thus the world depicted does not account for a continuation of the manifold integration developments which have already occurred over the last years, let alone any attempts to accelerate this process in the future[2].
- Another constraint of the model has to be seen in the way the authors of FOWE have linked the domestic sector with the respective trade flows. Although the extent to which any economy as a whole and the producing sectors in particular imports (exports) goods is essentially a function of the competitive position of this economy (and its sectors), the model is equipped with so-called "trade-coefficients." Their application is equivalent to assuming that the development of the future import content of inputs does not differ from the past trend. What in the real world is actually imported, however, is determined by the development of domestic demand and foreign and domestic prices.

Keeping these constraints in mind the question of whether the projections of exports, imports and trade balances are at least (incidentally) plausible in their order of magnitude needs to be examined, i.e., compared with plausibility considerations as well as other projections carried

[1] This seems to be a weakness of other global models as well: see Schatz [1977, p. 5].
[2] Strange as it might seem the FOWE authors consider the noninclusion of the impact of relative prices as a factor determining allocation to be an advantage [p. 16].

out, for example, by the Institut für Weltwirtschaft and the World Bank. Needless to say, an evaluation of the relevance of these projections requires an examination of theoretical assumptions and an implicit assessment of the probability of changes in prevailing economic-political conditions as well[1]. As to the overall results of the FOWE model, projected annual growth rates of 9.1 % for developing regions' manufactured exports and of 5.6 % for total exports, are significantly lower than the respective figures of the IBRD and IfW projections; this holds especially for manufactures[2], for which alternative growth rates ranging from 12.7 to 15.3 % have been estimated.

These differences rest on diverging assessments with respect to how successful developing countries (regions) will be in accelerating their process of economic growth. In the FOWE model the industrialization process would seem to be biased by the 1970 parameters (adjusted for income levels), which could well reflect the inward-looking policy of import-substitution. It also seems, however, as if the authors favor heavy-industry biased import substitutions as a promising avenue for industrialization being able not only to secure enduring growth impulses but also to mitigate balance-of-payments problems in developing countries [p. 68]. Empirical evidence so far, however, does not lend much support to this contention; on the contrary, the pursuing of import-substituting activities, without regard to the comparative advantages of a country, has proved to create substantial limitations for long-term growth prospects, the most important of them being the establishment of inefficient plants and of an inefficient industrial structure, thereby postponing the time of a reorientation of policies once the limits of an inward-looking strategy have been reached [Little, Scitovsky, Scott 1970, pp. 80 sqq.; Donges 1976, pp. 629 sqq.].

Table 14 - Composition of Developing Countries' Exports, 1967-2000

Projections	1967[a]	1970	1977	1980	1985	1990	2000
IBRD:							
Agricultural products	61.0	-	45.0	-	32.0	-	-
Non-fuel minerals	17.0	-	14.0	-	13.0	-	-
Manufactures	21.0	-	41.0	-	55.0	-	-
FOWE:							
Agricultural products	-	62.7	-	41.8	-	31.2	24.8
Non-fuel minerals	-	12.0	-	31.7	-	37.6	35.2
Manufactures	-	25.3	-	26.5	-	31.2	40.0

[a] Actual figures.

Source: Leontief et al. [1977, Annex VI]; IBRD [1977, Table VI, 1].

[1] A comparison of the FOWE results with alternative projections (Tables 14 and 15) meets several difficulties. First of all, annual growth rates of projected exports for primary commodities and fuels could not be calculated, since the published FOWE material provides only production and net exports. Second, since FOWE does not allow for any bilateral (biregional) trade flows, the impact of bilateral liberalization of exports cannot be determined. Third, time horizons of the projections differ.

[2] It has to be borne in mind that the IfW projection has been based on a limited sample representing about 80 % of all developing countries' manufactured exports.

Table 15 - Real Growth of Developing Countries' Exports

Country group	Primary commodities[a]	Fuels[a]	Manufactures				Total		
			IBRD[b]						
	IBRD[b]	IBRD[b]	status quo	alternative	FOWE[c]	IfW[d]	IBRD[b]	FOWE[c]	IfW[e]
Low income (< 265 U.S.$)	4.9	-	8.4	14.9	-	-	6.1	-	-
Lower middle income (265-520 U.S.$)	5.8	10.5	14.7		-	-	8.4	-	-
Intermediate middle income (521-1075 U.S.$)	4.8	6.0	13.7	15.3	-	-	9.6	-	-
Upper middle income (1076-2000 U.S.$)	4.6	4.3	11.8		-	-	8.4	-	-
Total	5.0	5.6	12.7	15.3	9.1	12.8	8.7	5.6	6.4

[a] No FOWE projection available. - [b] 1976-1985. - [c] 1970-2000. - [d] 1972-1985. - [e] 1970-1985.

Source: IBRD [1977, p. 45 and p. 151]; Leontief et al. [1977, Annex VI]; Donges, Riedel [1977, Table 4, pp. 58 sqq.]

Compared with alternative calculations which have been based on past successes, FOWE's projection of export growth seems quite pessimistic. Two such alternative estimates are presented here (Table 15). These reveal that the international pattern of comparative advantage has rapidly changed during the past two decades: Developing countries are supplying a wide and ever expanding range of manufactured products, while in many developed countries output and thus employment are declining in formerly traditional industrial sectors. This process of restructuring of the world economy can be expected to continue in the future securing a probable export growth rate for manufactures from LDCs of nearly 13 % in real terms (Table 15). Such an acceleration of manufactured exports will, on the one hand, be required, since the need of creating productive employment for the increased population of LDCs implies significant importation of intermediate products and capital goods, to be paid for mainly by exports. On the other hand, the export acceleration is feasible because more and more LDCs are making headway in their industrialization process up to the stage at which their manufacturing sector becomes internationally competitive. The IBRD and the IfW estimations have been based on the status quo assumption that there will be no improvements in international trade policy framework, e.g., tariff cuts, relaxation of non-tariff barriers in developed countries, reduction of discrimination against exports, diminishing of import protection and exchange rate adjustments in developing countries [IBRD 1977, p. 45]. In spite of these somewhat "restrictive" assumptions the projected growth rates show that overall growth of exports exceeds the 1968-1973 growth by about 2 %, probably as a result of a continued diversification of exports as well as expansion of intra-developing country trade. These status quo results as well as the projections of the IfW (also based on trend extrapolation) no doubt have to be considered as "minimum figures." This "minimum" is considered to hold even in light of the developments after 1973, i.e., as a consequence of the quadrupling of the oil price; it is assumed namely that future improvements in trade policy will at least offset such possible growth-dampening effects.

59. Judging from past experiences, prospects for improving overall trade policy conditions do not seem to be promising. It is true that the trading system both in developed and developing countries has been liberalized during the last 15 to 20 years: Trade regimes in some developing countries have been partly liberalized and sizeable tariff cuts took place in the OECD countries. But it is also true that the industrial countries are now facing mounting protectionist pressures from within[1]. To the extent that the pressure groups succeed, the prospects for a harmonious development of the world economy becomes open to question. Not only will the spread of import restrictions for the benefit of noncompetitive industries reduce the scope of expansion of the internationally competitive and dynamic branches by absorbing too many scarce resources. The violation of the hitherto agreed and observed rules of international trade may increase economic uncertainty to a point where long-term investment grows at a substantially slower rate than it otherwise would. Whether governments of these countries will be able to effectively resist such pressures, thus making a breakthrough in the current GATT trade negotiations still remains to be seen. Much will depend on their ability to explain *organized groups that further reductions in trade barriers will generate important net benefits* in terms of additional economic growth, higher real incomes, less monopoly power in product markets and better inflation control.

60. Although it would not be realistic to assume that remaining protection will be completely dismantled by 2000, there is surely a definite range for further liberalization of trade between developed and developing as well as in trade between developing countries. This would encompass both tariff reductions and a dismantling of non-tariff barries. In the past GATT negotiations have been mainly centered around the reduction or elimination of import barriers for those products of interest to industrialized countries - be they imports or exports. This is the consequence of the principle of reciprocity, i.e., a balanced exchange of concessions among the negotiating countries, which governed the various GATT rounds. As LDCs were not prepared or able to provide concessions, they could not gain much, at least until the Kennedy Round in which for the first time these countries were allowed to participate on a less than full reciprocal basis. Liberalization consequently took place in fields of activity where developing countries' competitiveness and thus interest was still relatively limited. It is, therefore, not surprising to find that manufactures from developing countries with substantial export potential are either hit by high effective tariffs and quotas or by several so-called "voluntary" export restraints (the so-called "orderly marketing agreements").

61. The General Systems of Preferences for manufactures from LDCs was expected to improve the access to industrial countries' markets. However, the regulations agreed upon so far are incomplete, since they are - generally speaking - more generous the less competitive the developing countries' export goods are and the more inelastic the export supply is. It cannot be overlooked that a number of manufactures of special export interest to developing countries (in particular textiles, leather goods, footwear, petroleum products) are still restricted on the import market of one or more liberalizing countries. The schemes of the EEC, Japan and the United States embody restrictive ceilings for preferential imports. The recent enlargement of the EEC, the concomitant free trade area agreement between the European Community and the rest of the EFTA members, and the association arrangement with Mediterranean countries (de facto) have resulted in intra-west European trade creation and, hence, substantially eroded the value of the EEC system of generalized tariff preferences. Imports from developing countries which proved to be competitive in developed countries' markets, however, substantially exceeded the ceilings and the expansion of these imports was always ahead of increases in the respective ceilings. This means that developing countries have to surmount tariff barriers, if they want to increase the export of manufactures along the lines of present comparative advantages. It also means that LDCs would be better off in the last resort if they ask for substantial tariff cuts on a most-favoured-nation basis than opposing them on grounds of an erosion of the margins of preferences they are enjoying[2].

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[1] For a detailed discussion of the sources of these pressures see Blackhurst, Marian, Tumlir [1977].

[2] For detailed calculations see Baldwin, Murray [1977].

62. In view of these aspects it would seem fairly realistic to expect further liberalization efforts to induce a more dynamic rate of export growth. The World Bank has tried to quantify potential gains in exports of manufactures accruing from (a) an expected partial relaxation of nontariff barriers and tariff-cuts (Tokyo-Round) and from (b) an assumed improvement of trade policies in developing countries. The Bank's estimates [IBRD 1977, p. 49] reveal an acceleration of export growth of about 3 % annually for both sources taken together (see Table 15), of which the larger effects are attributed to potential improvements of trade policies in developing countries (approx. 2 %). International trade policy changes are not only expected to lead to increases in trade between developing and developed but also to intensified relations among developing countries[1].

63. As to the potential welfare and export gains of the multilateral trade negotiations mentioned above (Tokyo-Round), there are some quantitative estimates available which recently have been conducted by the Brookings Institution [Cline et al. 1976] and which perhaps might serve as a guideline for "optimizing" negotiations. According to these calculations, which have been carried out assuming alternative outcome of negotiations (twelve different tariff cutting formulas, including one which completely eliminates tariffs to give a benchmark-estimate for the effects of free trade) it can be expected that welfare gains to consumers in industrial countries as well as export gains to developing countries could be doubled, if, instead of adopting the somewhat restrictive tariff cutting formulas now under consideration, deep cuts in tariffs and nontariff barriers (such as the full U. S. proposals - 60 % cut with elimination of protection below 5 %) could be realized. The Brookings Study considers the impact of liberalization on labor displacement to be of "inconsequential magnitudes" for the areas United States, Japan, Canada and the EEC and concludes that any prospective trade balance losses for individual countries from even the most liberal tariff cuttings would be rather modest and would not constitute a basis for limiting the extent of liberalization [Cline et al. 1976, pp. 65 sqq.].

There is, however, growing interest about the potential benefits of increased trade between developing countries [Balassa, Stoutjesdijk 1975] because trade between developing countries seems to have much to offer in the medium and long run; particularly so, as income levels, tastes and wants, let alone production patterns, are more similar among these countries than between this group and the highly industrialized nations. The opportunities for gains lie mainly in greater specialization which involves increasing both the export-to-output ratios in the manufacturing sector and the share of manufactured imports in total domestic supply. By intensifying the division of labor between themselves, the developing countries would also be induced to reduce the (in some cases extreme) product variability in individual firms which involves a high cost to the national economy. Apart from improvements in resource allocation, benefits from intra LDC-trade could be derived from further economies of scale, for actual or would-be exporters would have access to wider markets which are better known to them and less risky and uncertain than the markets in industrial countries. By penetrating the neighboring markets, firms would be prepared to face competition in world markets at a later stage. Finally, increased trade between developing countries would expose domestic producers to more competition, thus providing inducements for productivity improvements and modernization of the industrial apparatus.

64. The explanation for the FOWE study not having taken into account the potential of division of labor between developing countries could be two-fold. On the one hand, the aggregation of developing countries into regions does not allow to explicitly analyze trade flows within such regions. On the other hand, the low degree of intra-LDC-trade and the fact that this trade has shrunk over the years, may have suggested to the team that this is a 'quantité négligeable.' And experience made with various attempts of institutionalized economic integration between developing countries (e. g., free trade areas, common markets in Latin America, customs and economic unions in Africa) seems not to be very encouraging.

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[1] Unfortunately FOWE's trade projections - due to the methodological shortcomings, mentioned above - do not provide biregional trade figures thus making any comparison of changes in the structure of origin and destination of traded goods impossible.

65. Whatever the case, the intra-LDC-trade patterns of the past are not necessarily the adequate guide to what may happen in the future. As developing countries are determined to further accelerate industrialization of their economies, they will have to seek closer economic integration among themselves. Import substitution alone would not provide for sustained growth; and export expansion into industrial countries' markets alone would be difficult to achieve for many less advanced developing countries due to both the lack of marketing capabilities and the inability of meeting specific quality standards. The case for increased intra-LDC-trade will be stronger the slower trade liberalization in industrial countries proceeds. As a matter of fact, manufactured exports from several developing countries went largely to other developing countries in recent years. In order to intensify this process, certain trade policies may be necessary including a gradual reduction of their own import protection - allowing developing countries at lower levels of development to reduce at a slower rate in order to avoid various dislocations in their existing industries caused by increased competition from the more advanced LDCs - and an exchange rate policy that avoids currency overvaluations.

The above presentation of alternative estimates for future export developments has lent support to the scepticism with which FOWE's assumptions were viewed. Although there is admittedly uncertainty surrounding the IBRD and IfW estimates, the overall probability of assumptions underlying the IBRD and IfW estimates would seem to be higher; this, of course, does not necessarily mean that these guesstimates will actually take place but rather that they are at least in the right direction. The extent to which they can be realized will be severely influenced by the future general growth conditions resulting from the current negotiations about the "New International Economic Order." FOWE mentions this issue but does not tackle this highly crucial problem; it simply confines its approach to a scenario in which relative prices for natural resources are increased, thereby calculating the possibilities of reducing the balance-of-payments deficit for developing regions by increased export earnings of primary commodities.

66. This commodity issue, however, is economically far more complex. A realization of the developing countries' demand for a reorganization of the international commodity trade along UNCTAD's lines which aims at stabilizing and raising prices to "just and remunerative" levels by concluding international commodity agreements or producer cartels would most probably result in a fundamental change of growth conditions for the world economy as a whole. On the one hand, there will be an artificial stimulation of commodity production in LDCs and hence a slower diversification of their economies would then be desirable under overall development aspects. On the other hand, industrial countries might direct more resources than they otherwise would into the production of own primary commodities (even at higher costs) or the development of new substitutes, let alone the danger that a worldwide regulation of commodity markets may play in the hands of protectionist pressure groups in the industrial countries and that commodity overpricing creates additional adjustment pressures in developed countries, thereby reducing economic growth and narrowing the potential capital investment flowing to the developing countries' manufacturing sector [Baron, Glismann, Stecher 1977; Glismann, Stecher 1977]. It is difficult to revise the FOWE forecasts to account for such happenings without revising the whole model. It nonetheless seems probable that the prospects of LDCs accelerating industrialization and expanding manufactured exports would be shifted in an upward direction, as would also be the case for the predicted growth rates for industrial countries.

III. Summary and Concluding Remarks

67. As stated at the outset of this appraisal the authors of FOWE conclude that there are no physical limits in the world which would prevent the per capita income gap between developed and developing countries from being reduced from 12 : 1 in 1970 to 7 : 1 by the year 2000. The limits instead are imposed by inflexibilities in the existing world economic order as well as by economic, social and political institutions in developing countries. In light of the fact that most economists never really believed in the global doomsday predictions anyhow, the usefulness of a study which - despite its complexity - ends with common knowledge must be questioned. An attempt to delineate the changes in world economic order as well as in institutions in developing countries, which are considered by the FOWE authors as preconditions for accelerated economic growth envisaged in their model, could probably have made the entire exercise more useful. By failing to specify what changes in institutional order in developing countries and in world economic order the FOWE authors had in mind, they have led the reader into the realm of speculation about the plausibility of their quantitative as well as qualitative conclusions.

68. Insofar as the model underlying FOWE is concerned, the preceding appraisal has shown that it suffers from some important weaknesses. Some of them are inherently related with the limitations of input-output analysis used in the model as an instrument of long-run forecasting for the world economy consisting of very heterogeneous countries. Others are to be sought in the application of this analytical tool by the FOWE authors as well as in availability and selection of data. The attention in FOWE is focussed on developing countries and it is true that statistical data for these countries are only sparsely available, but the FOWE authors do not appear to have made enough efforts to make use of even those data which are relatively easily available. Instead they have relied on the surrogation of data for these countries from the statistics of developed countries which could have negatively effected the results[1].

69. As far as the empirical results in FOWE are concerned, it is important to note that although the FOWE authors find reserves of most of the mineral resources to be adequate for the stipulated economic growth in developed and developing countries, they proceed in a similar manner as in other global models in assuming that known reserves in essence represent potential reserves. It is, therefore, not surprising to discover that in FOWE those minerals with relatively small supplies of known reserves are predicted to run out before the turn of the century. Such results could have been avoided if adequate allowance had been made for market forces to react and cause supply and/or demand parameters to change. It is also shown that an increasing demand for nutritional resources due to higher incomes, increased population and nutritional improvement can be easily met, provided the developing regions are able to carry out land reforms as well as social and institutional changes for overcoming nontechnological barriers to increased use of land and productivity. FOWE refrains, however, from specifying the changes required in the developing regions for increased agricultural production.

70. An acceleration of industrialization of developing regions is expected in FOWE to serve as an engine of their proposed high rates of economic growth, whereby particular stress is placed on the growth of heavy industries. Rapid industrialization is seen as leading to a considerable rise in the share of industrial production in total output and of capital and intermediate goods in total industrial output. The developing regions are thus supposed to tread the development path followed by the developed countries. It would enable them according to the numerical solutions of the FOWE model to raise their share in world manufacturing output from 6 % (1970) to 17.5 % (2000), whereas the share of the developed market economy countries is estimated to fall from 70 % (1970) to 49 % (2000).

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[1] Further, editing in FOWE leaves much to be desired. Some of the tables in scenario analyses are not consistent with the annex tables and explanations for these inconsistencies are missing.

71. The emphasis on heavy industries proposed in FOWE is, however, not the appropriate development strategy. The experience of developing countries in the past 20 to 30 years shows that an industrialization oriented towards heavy industries has aggravated the problems of unemployment, income inequality and balance-of-payments deficits rather than solving them. Introduction of heavy industries at an early stage of industrialization involves underutilized capacities, low levels of productivity and a relatively high import intensity. A suitable economic development strategy for developing countries means that the balance between light and heavy industries, small and large-scale industries, domestic and foreign investments, capital and labor-intensive technologies, rural and urban development must be chosen.

72. Such a balance can be better realized if the industry mix is oriented towards potential comparative advantages of the country concerned. At an early stage of industrialization these advantages are likely to be found in light industries which are labor intensive and/or raw material intensive. As a country moves towards higher stages of industrialization it can also introduce heavy industries, because by that time its demand for their products would have increased and its balance-of-payments situation improved as a result of increasing exports of products of industries established at earlier stages of industrialization. Industrialization of developing countries based on their comparative advantages need not lead to the preservation of their existing industrial and foreign trade structures or their present share in world industrial production. On the contrary, estimates from various sources show that such a policy for developing countries could lead to a considerable improvement in these respects.

73. Since light industries are usually less capital intensive than heavy industries, they could enable the developing countries to achieve the high rates of growth of industrial production proposed in FOWE with lower capital requirements. As a matter of fact it is disputed that the capital requirements forecasted in FOWE can be raised in the LDCs by depending on domestic sources (i.e., at the expense of consumption) in light of limitations imposed by the low levels of income. Thus shifting the emphasis of development strategies from heavy to light industries could enable them to attain the given growth objectives even if they fail to raise as much domestic financial resources as projected in FOWE. Establishment of light industries is also more suitable with respect to improving the income distribution and reducing unemployment in developing countries.

74. The success of an industrial strategy oriented towards light industries in developing countries also depends on the degree of market accessibility granted to the exports of their products to developed countries. If the developed countries are sincerely interested in improving an international division of labor between themselves and the developing countries on the basis of mutual advantages and international cooperation, they will have to open their markets for the products of the Third World more than in the past.

75. The burden on domestic resources in developing countries resulting from financing the accelerated rate of investment can be reduced by encouraging the inflow of foreign private investment for which an essential precondition is the minimization of political risks for these investments. This can be achieved by introducing a system of multilateral guarantees against political nationalization of foreign property. So far these guarantees are given on the basis of bilateral agreements between nations and involve higher costs than a multilateral system is likely to cause. Developing countries should also avail themselves of the opportunity to grant foreign investors access to their environmental resources as long as such activities do not result in an endangering of the environment. Presently these countries either have few pollution problems, and those they have are related more to poverty or to agglomeration diseconomies than to industrialization.

76. It has been pointed out that the resource-poor developing regions are going to have a foreign exchange deficit of more than $ 400 billion by the end of this century if they follow the development strategy evolved in FOWE. The optimism of the authors of FOWE that a deficit of this order of magnitude can be financed by augmenting the flow of aid and/or short-term capital from the developed and resource-rich regions cannot be shared. A better solution, i.e.,

one which also mitigates balance-of-payments problems of such proportions, can be achieved by following a two-pronged development strategy. On the one hand efforts should be made to encourage those productive activities which require comparatively lesser amounts of imported inputs of capital and intermediate goods as well as raw materials so that the demand for foreign exchange is minimized without endangering economic growth. On the other hand, measures to encourage exports of domestic products have to be carefully selected and implemented to increase foreign exchange earnings. The experience of natural resource-poor countries like Hong Kong, Singapore, South Korea and Taiwan has shown that such a development strategy can be successful in solving balance-of-payments problems as well as in achieving a relatively high rate of economic growth in a reasonable time period.

77. In concluding this appraisal it must be underlined that although the authors of FOWE admit to many of the weaknesses of their model and analysis, - they even concede (in the preface) that their model is not a finished piece of work -, they still felt that their model would "provide the basis for continuing contributions to the quantitative analysis of the world economy" [p. 2]. To lend credence to this contention it would have at least been necessary to run the model backwards to 1960 or 1950[1]. However, in lieu of empirical substantiation of the model's capabilities and in light of the above criticism, it does not appear that a world model of this kind can prove to be the useful tool for economic analysis as envisaged by the authors. As a matter of fact it would be "grossly irresponsible if ... global strategies for development were accepted simply because they appear to have been authenticated by a method of calculation" [S. Cole 1977, p. 116]. Policy makers both in developing and developed countries would seem to stand to gain more from a piecemeal approach, i.e., from studies carried out in great depth and detail taking into account as many characteristics of the countries as possible.

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[1] For a dramatic example of what can happen see, for instance, H.S.D. Cole, Curnow [1973, pp. 112-113]: "One obvious thing to investigate ... is what the [World Dynamics] model has to say about the period before [the model, i.e., before 1900]. ... the credibility of the futures portrayed by the models rests on their ability to reproduce to a plausible degree historical trends ... As it stands [the model] World 2 will not run backwards from 1900 for more than a little over 20 years ... [After] running the model back to 1880 and then forwards from that date ... [curious curves are produced] - they seem to indicate the 20th century lies in the aftermath of a catastrophic population collapse [from a previously infinite population] ..." !!

Appendix

To cut printing costs the tables have been reproduced directly from the original manuscript.

Table A 1 - Regression Estimates of Production Trends[1] for Selected Commodities, 1912-1976

Commodity	Production/Capita			Absolute production		
	a	b	R^2	a	b	R^2
			1912-1976			
Bauxite	-2.4836	0.0748	0.973	4.7696	0.0875	0.980
Copper	-0.9401	0.0199	0.858	6.3131	0.0327	0.931
Lead	-0.6244	0.0061	0.414	6.6288	0.188	0.836
Zinc	-0.9457	0.0174	0.842	6.3075	0.0302	0.927
Nickel	-4.9005	0.0431	0.912	2.3527	0.0559	0.944
			1957-1976			
Bauxite	-1.6291	0.0618	0.990	5.2384	0.0807	0.994
Copper	-1.2699	0.0254	0.972	5.5976	0.0443	0.991
Lead	-0.8163	0.0096	0.801	6.0512	0.0285	0.973
Zinc	-1.2095	0.0219	0.910	5.6581	0.0408	0.972
Nickel	-4.6845	0.0400	0.969	2.1830	0.0589	0.986
			1967-1976			
Bauxite	-1.5200	0.0603	0.954	5.3556	0.0791	0.973
Copper	-1.6923	0.0312	0.950	5.1833	0.0500	0.981
Lead	-0.6681	0.0077	0.426	6.2075	0.0265	0.901
Zinc	-0.4560	0.0115	0.693	6.4196	0.0303	0.941
Nickel	-4.5954	0.0388	0.896	2.2802	0.0576	0.951

[1] All trends were estimated with a semilog (exponential function using moving 3 year averages.

$\ell n\ y = a + bt$ which is equivalent to

$y = a + e^{bt}$

y = commodity production in mill. tons (except nickel - 1000 tons)

t = time period

The coefficients of all variables were significant at least at the 95% level.

Source: Own calculations, based on data from Metallgesellschaft AG {1977, pp. 56-59}.

Table A 2 - Intensity of Use of Selected Minerals, 1951-2000

Region[a]	1951-1955	1966-1969	2000
Refined copper (metric tons per billion dollars GDP)			
Western Europe	2,810	2,590	2,075
Japan	2,020	3,500	2,800
O.D.L.	2,240	2,490	2,200
U.S.S.R.	1,860	1,960	1,750
Eastern Europe	1,450	1,710	1,600
Africa	210	200	600
Asia	310	290	700
Latin America	900	800	950
China	150	1,340	1,750
United States	2,240	1,920	1,400
Primary aluminium (metric tons per billion dollars GDP)			
Western Europe	1,480	2,470	4,000
Japan	830	3,120	6,000
O.D.L.	1,250	2,240	4,100
U.S.S.R.	1,450	2,650	3,900
Western Europe	870	2,770	4,100
Africa	30	300	900
Asia	120	830	1,600
Latin America	280	850	1,800
China	50	1,190	2,200
United States	2,090	3,480	5,000
Iron ore (thousand tons per billion dollars GDP)			
Western Europe	95	107	90
Japan	54	217	150
O.D.L.	73	121	109
U.S.S.R.	143	165	140
Eastern Europe	70	111	100
Africa	3	27	50
Asia	20	33	60
Latin America	17	53	80
China	37	202	230
United States	102	76	45

[a]Western Europe (includes OECD countries, Spain, Portugal, Greece, Turkey); Japan; Other Developed Lands (Canada, Australia, New Zealand, Israel, South Africa); Union of Soviet Socialist Republics; Eastern Europe (also includes Albania and Yugoslavia); Africa (excludes South Africa); Asia (excludes Israel, Japan, mainland China and related areas); Latin America; China (includes Mongolia, North Vietnam, North Korea); United States.

Source: Committee on Banking, Currency and Housing {1974, pp. 517-518}.

Table A 3 - Change in Production, Consumption and Net Exports by Agricultural Sector and Regions[a], 1970-2000

	Animal products			High protein crops			Grains			Roots		
	output	consumption	net exports	output	consumption	net exports	output	consumption	net exports	output	consumption	net exports
High income												
North America	150	148	0.4	220	158	27.0	211	185	95.8	119	101	2.0
Western Europe	164	159	1.7	160	163	- 6.8	184	180	- 7.2	122	115	2.9
Japan	600	603	-1.1	433	422	-13.1	284	291	-17.7	315	313	-1.1
Oceania	218	197	2.6	300	350	- 0.3	299	297	13.2	127	120	0.1
Medium income												
Latin America	396	405	0.9	433	405	0.6	541	571	- 1.2	259	260	-0.7
Europe	283	285	-0.4	289	301	-2.2	290	292	- 6.0	317	329	-0.1
Low income												
Latin America	465	480	-0.7	450	472	-0.9	423	431	-11.0	227	228	-0.5
Asia	531	531	-1.7	334	345	-0.8	326	329	-30.2	404	408	-1.8
Africa (arid)	333	329	-0.1	242	247	0	310	315	- 4.2	207	207	0.2
Africa (tropical)	334	336	-0.3	384	422	0.6	366	369	- 6.1	230	231	0
Centrally planned												
Soviet Union	214	213	0.1	240	242	0.6	215	216	2.6	161	161	0.2
Eastern Europe	179	176	0.6	210	211	-1.8	203	203	-15.9	149	147	0.5
Asia	429	429	0	313	313	0	320	320	- 0.1	200	200	0
Oil producing												
Middle East, Africa	1600	1545	-1.8	633	923	-2.1	558	561	-12.1	761	780	-1.4

[a]For output and consumption 1970 = 100; for net exports difference between 2000 and 1970 (mill. tons).

Source: Own calculations based on Leontief et al. {1977, Annex VI, Scenario X}.

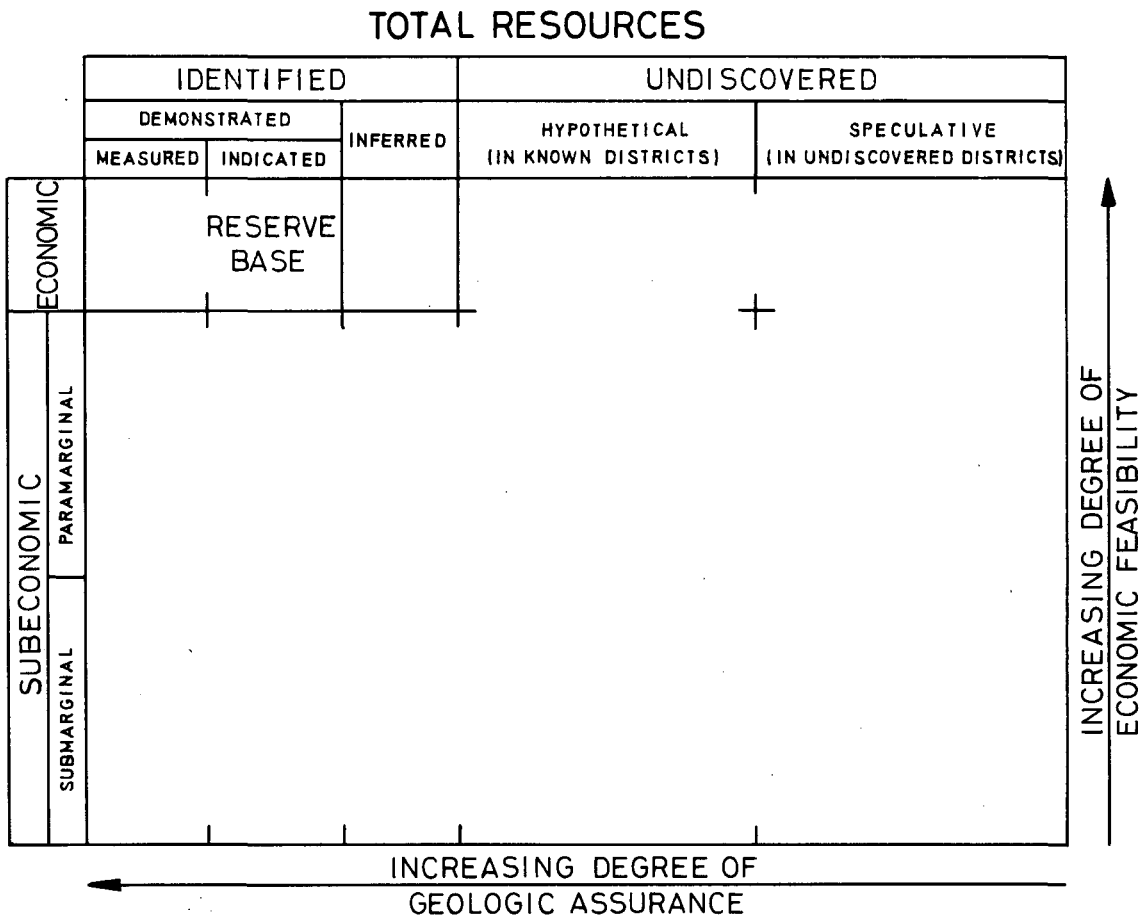
Table A 4 - Relative Changes in Population Production and Yields of Selected Commodities by Major Regions[a], 1961-1965 - 1974-1976

	Population	Production of					Yield				
		cereals				roots	cereals				roots
		total	wheat	rice	maize		total	wheat	rice	maize	
World	25.46	40.94	48.52	33.48	46.85	13.53	28.29	36.48	18.28	26.68	9.07
Developed	-13.26	- 4.34	- 8.64	-21.38	7.65	-36.90	- 2.71	- 9.82	- 3.85	0.25	6.63
North America	-11.86	- 1.84	2.52	41.75	2.68	9.51	- 4.84	-14.18	- 1.45	- 3.79	19.61
Western Europe	-16.96	- 4.62	-19.31	-13.08	34.61	-43.84	10.33	11.11	-10.81	39.74	1.64
Oceania	- 2.61	19.00	- 6.00	164.31	14.81	1.57	- 9.12	-24.51	-27.26	60.79	24.18
Developing	8.37	0.58	20.20	3.51	- 2.31	19.65	- 4.46	- 3.25	1.08	- 6.56	5.69
Africa	13.27	-14.04	- 9.94	10.68	2.00	14.69	-14.82	- 8.48	-15.71	-12.30	6.67
Latin America	13.96	12.33	-12.48	16.23	- 3.69	10.02	- 5.07	-33.33	-10.13	0.08	- 6.38
Near East	12.78	0.75	10.27	4.27	-10.56	42.70	- 7.10	- 3.11	- 1.49	1.70	8.30
Far East	4.75	- 0.04	63.35	2.27	0.28	38.78	- 2.01	19.12	3.01	-12.22	14.75
Centrally planned	- 3.07	3.75	- 0.95	- 0.10	-15.75	4.39	8.17	12.68	2.32	7.38	4.28
Asia	1.87	0.64	32.15	- 1.60	- 2.79	24.47	- 3.55	15.39	1.93	- 7.55	5.22
Europe, U.S.S.R.	-13.88	7.03	-10.41	297.11	-28.65	-11.16	19.45	13.52	35.42	26.02	8.94

[a]Percent change for given region minus percent change for world; - indicates lower than average growth.

Source: Own calculations based on FAO {various vols.}.

Diagram - Classification of Resources



Source: Bureau of Mines, Mineral Facts and Problems 1975, op.cit., p. 16

Explanation: What is generally referred to as reserves is the area below "demonstrated" labelled as "economic", often "inferred" is also included. As prices increase and/or as technology improves identified reserves begin to encompass those areas designated as subeconomic. At the same time explorational activities are increased and "undiscovered" resources are moved in the identified direction (e.g., "hypothetical" becomes "identified").

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