



Long term world prospects for petrochemicals up to 1990 : scenarios of world petrochemicals. 2 : scénarios

- Sema

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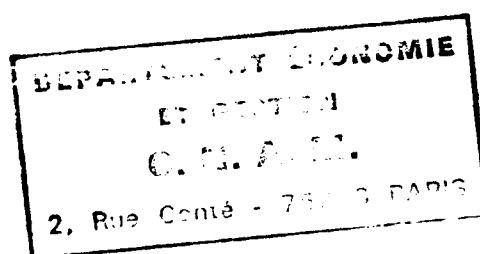
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long term world prospects for petrochemicals up to 1990

scenarios of world petrochemicals

volume 2 - scenarios



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LONG TERM WORLD PROSPECTS FOR PETROCHEMICALS UP TO 1990

-

SCENARIOS OF WORLD PETROCHEMICALS

-

VOLUME 2 - SCÉNARIOS

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INTRODUCTION

This volume is the second part of the report entitled "Scenarios of world petrochemicals", following Volume 1, Construction of the base.

The first chapter sets out the results of the SMIC survey (the questionnaire for which was given as an annex to Volume 1). The second chapter is devoted to presenting the three scenarios which have been retained :

- firstly a reference scenario which corresponds to the most probable set of hypotheses on those changes which may take place in world petrochemicals up to the reference horizon;
- secondly two contrasted scenarios, chosen from amongst the most probable scenarios and fixing the limits within which the situation of the world petrochemicals industry and its environment may evolve.

The reference scenario describes a continuous evolution over the period 1976 - 1982 - 1990, whereas the contrasted scenarios start from the reference scenario in 1982 and lead to two different images in 1990.. It is reasonable to assume that the principal divergences which will lead to the contrasted images will essentially arise from 1982 onwards: the evolution over the period 1976 - 1982 being to large extent predetermined will therefore correspond to that in the reference scenario.

The translation into quantified terms of the 1982 and 1990 images, in respect of demand, production, trading and prices will be given in the report "Forecasts of petrochemicals production and consumption up to 1990". This report is limited to describing, in qualitative terms, the developments in world petrochemicals and its environment within the framework of each scenario. It will deal with the following points :

- the international political context,
- the international economic context (with particular reference to the level and type of economic growth in each geographical zone),

- the energy context (including petrochemicals raw materials),
- the actual petrochemical context itself (including the policy measures which affect it),
- the technico-economic context (including technological developments in various fields and the environmental aspects),
- future prospects in the major sectors which affect the final demand.

Under these various headings are also included the behaviour of the various actors concerned, together with the attitude of consumers, inasfar as they can be clearly distinguished from previous behaviour patterns.

As has already been pointed out the trading patterns will be dealt with in a quantitative manner in the report "Forecasts of petrochemicals production and consumption up to 1990".

I - THE RESULTS OF THE SMIC ENQUIRY

The SMIC questionnaire was sent out on 10 February 1978. By the beginning of April, when processing was begun, 59 completed questionnaires had been received.

Whilst the replies were satisfactorily representative as far as fields of activity were concerned (all the retained groups of actors were represented) they were less so geographically, Europe being over-represented, although in fact many of the replies received from Europe were from subsidiaries of American groups. We have, however, corrected this distortion as far as possible when selecting the experts for the SMIC programme.

| |
|---------------------|
| A - OVERALL RESULTS |
|---------------------|

Detailed histograms relative to each question are given as an annex.

1. GENERAL ECONOMIC HYPOTHESES

Economic growth will be less marked than it has been in industrialized countries (around 3 %), and comparable, in spite of divided opinion, for developing countries.

The price of oil will little increase : a strong majority anticipate an increase of less than 50 % in constant money. It appears quite probable that the average price of oil in the USA will follow the world price, and that the price of natural gas will equal its energy value. Opinions are more divided as to the development of protectionism, and trade with countries of the Eastern bloc, as well as North-South economic cooperation : with regard to each, about half of the experts consider these hypotheses to be little, or only fairly probable.

2. MAJOR HYPOTHESES

H₁ : Supply guarantee

(For the period 1980-1990, petrochemical firms in general will be supplied in raw materials (basic hydrocarbons) in quantities sufficient and at prices which will permit them to conduct their activities in satisfactory economic conditions (for example, by making supply agreements with Western oil firms, or by participating in joint ventures with producing countries)).

This hypothesis has good chances of realization : a strong majority of experts accord it a probability greater than or equal to 0.5, and four out of five believe that it is at least rather probable (chances of probability 70 %).

H₂ - Emergence of new petrochemical producers

(The major OPEC countries will be endowed with a petrochemical industry representing, by 1990, more than 10 % of world capacity (Communist countries excepted)).

On this point the experts are nearly equally divided into two groups : those who consider this hypothesis improbable, and those who find it rather probable. This division is explained neither by the geographic boundaries of the respondents, neither by their professional activities.

H₃ - Organisation of the worldwide petrochemical market

(The world market for petrochemical products (base, intermediate, final) will progressively organize itself during the 1980-90 period : companies will in general observe professional discipline, the exchange value of major products will integrate capital returns, and one can consider that there will exist a world price for major products (e.g. crude oil). The non-realization of this hypothesis (disorganization of the world market) will indicate that the market is disorganized by significant and regular sales at marginal cost (or below economic cost), or that there exist local markets which are artificially protected).

On this question also, the experts are divided, but less markedly than in the preceding case : the votes in favour of the probability of H₃ are much less numerous than those against it. It should be noted, in addition, that over one-fourth of the experts hesitate to answer.

H₄ - Sharing of technological power

(During the 1980-90 period, countries or firms needing it will have access without restriction to the most advanced technologies concerning production processes, methods of transformation, know-how, equipment, etc.).

The answers are very spread out, with the emergence of two approximately equal camps.

H₅ - Sharing of marketing power

(The commercialization of petrochemical products (base, intermediate, final products) will be shared in significant measure (by more than 20 %) by the various producers through the stock markets, or by direct sale. In other words, the captivity of the petrochemical market (that is, international exchanges taking place between affiliates of a same group) will decrease during the 190-1990 period).

Here again are found two schools of thought, but leaning in favour of the non-probability of this hypothesis : less than one-third of the experts believe it to be rather probable, and not one considers it as very probable.

On first analysis, it appears that the image of the worldwide petrochemical industry between 1980-990 is seen by the experts as rather imprecise, and that various quite contrasting developments are to be expected.

3. RELATED QUESTIONS

Q1. Hypothesis H₁ (supply guarantee) is seen to be less probable in the perspective of a constant money price exceeding \$ 20/barrel. (Although the majority of experts believe it to be rather or very probable).

On the other hand, it becomes very improbable in view of an energy shortage ; the hypothetical coincidence of the price of natural gas and its energy value seems not to bear much influence.

Q2. Hypothesis H₂ (emergence of new producers) sees its probability slightly increase if the price of oil rises by over 50 % during '80-'85 ; the alignment of the average price of oil in the USA with the OPEC price, or the coincidence of the price of natural oil with its energy value, are seen to be factors almost without influence.

Q3. Hypothesis H_3 (organization of the world market) is affected by the development of protectionism, as well as by interventions on the part of Eastern countries on the petrochemical market, and becomes therefore improbable.

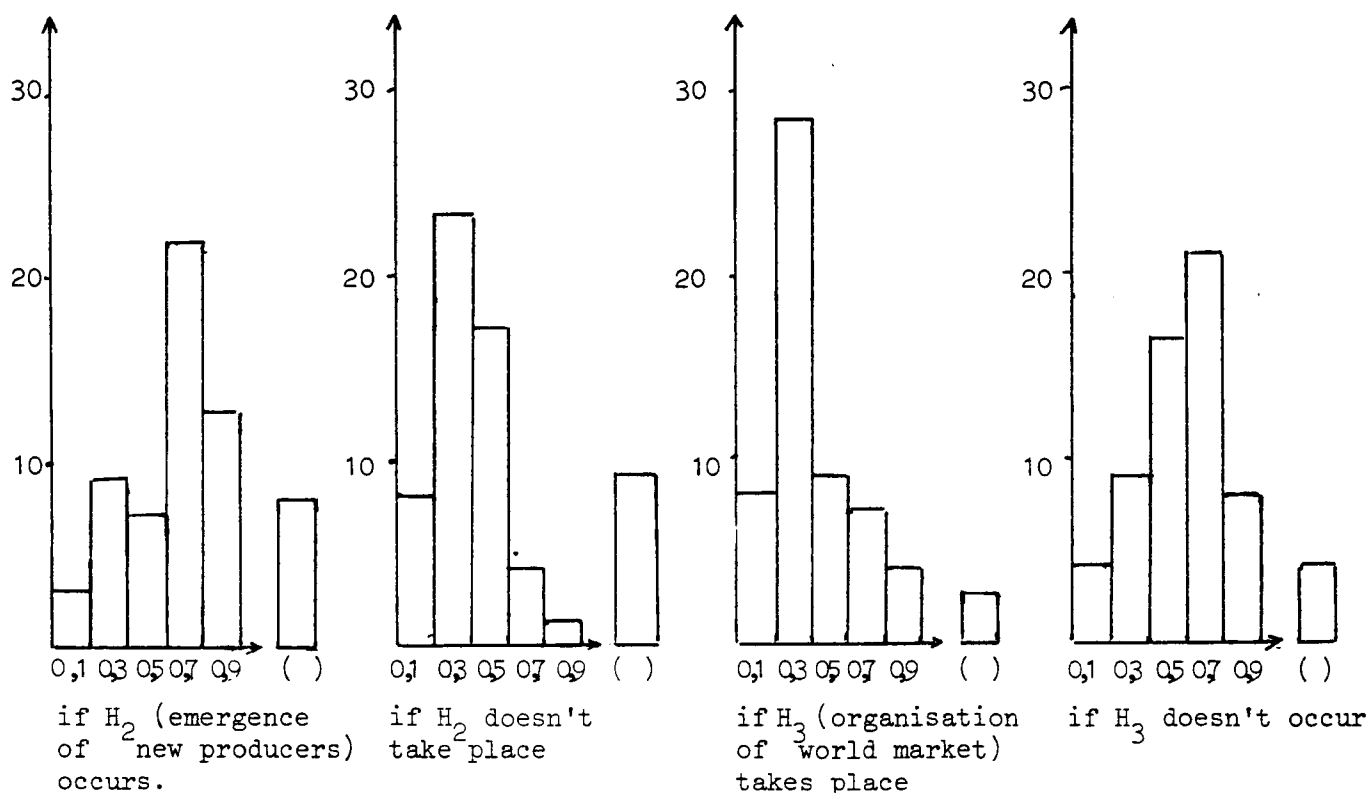
Q4. Hypothesis H_4 (sharing of technological power) is negatively affected by the development of protectionism, and positively by the realization of North-South cooperation.

Q5. Hypothesis H_5 (sharing of marketing power) is also very sensitive to the development of North-South cooperation.

In sum, the development of protectionism (and, naturally, North-South cooperation) will play a rather important role in the future organization of the world petrochemical industry.

Q6. The probability that producing countries realize regular sales of petrochemical products at prices below economic cost is very sensitive to the possible realization, or non-realization, of H_2 and H_3 .

Probability of sales of petrochemical products at prices below economic cost



Q7. Mean capital return after depreciation

The following results are obtained :

| | Mean response | Figure most often quoted |
|--|---------------|--------------------------|
| North America | 10.7 % | between 5 and 10 % |
| Developing America | 10.7 % | between 10 and 15 % |
| West Europe | 4.5 % | less than 5 % |
| Eastern Europe | 6.2 % | less than 5 % |
| Middle-East and North Africa | 8.1 % | less than 5 % |
| Remaining Africa | 6.9 % | less than 5 % |
| Asia-Oceania (excluding Communist countries) | 9.3 % | between 5 and 15 % |

Q8. The probability that the stream factor of plants in developing countries be comparable, by 1990, with that of industrialised countries is very unlikely, even if sharing of technological power is realized ; should the former not occur, this hypothesis is seen to be very improbable by the experts.

4. ADDITIONAL QUESTIONS

Q9. The amounts involved in annual intercontinental trade for the products below by 1990 are seen to total the following :

| | Average amount quoted | Most quoted amount |
|-----------|-----------------------|---------------------|
| Methanol | 150 000 t | 150 000 t |
| Ammoniac | 150 000 t | 150 000 t |
| Propylene | 110 000 t | between 50-100 m.t. |
| Benzene | 150 000 t | 150 000 t |
| Toluene | 140 000 t | 150 000 t |
| Xylene | | 150 000 t |

Q10. To the question, what is the probability that Eastern countries effect massive sales of petrochemical products at a cost below the market cost during the 1980-1990 period, the answers of the experts were quite diverse, with no discernable tendency. As for the products concerned, they were quite diverse, with no discernable tendency. As for the products concerned, they were estimated to be mainly base products (ammonia, methanol, BTX).

Q11. Investment levels according to product categories and by zone :

The average responses are indicated in the table which follows. The first-mentioned level is the one most often quoted ; the level indicated in parentheses is the second most often-quoted level (given where significant).

The levels (or degrees) of investment were defined as below :

- Decrease in investments (reduction of capacity)
- Weak investments (below the average investments for all industries)
- Average investments (identical with average investments)
- Significant investments (superior to average investments)
- Very significant investments (much superior to average investments).

| | Fertilizers | Synthetic textiles | Plastics | Synthetic rubber |
|---|-----------------------------|----------------------|----------------------|-------------------|
| North America | weak (average) | weak (average) | weak | weak-average |
| Developing America | significant | average | signif. | average (weak) |
| West Europe | weak | weak | weak | weak |
| Eastern Europe | significant | aver. signif. | signif. | average (signif.) |
| Middle East and North Africa | significant very signif. | average | signif. | average (signif.) |
| Remaining Africa | ave.-signif. | weak-aver. | weak-aver. | weak |
| Asia-Oceania excluding Communist countries | significant (average) | average (signif.) | average (signif.) | average (weak) |

A certain heterogeneity in the level of investment is apparent with regard to both zone and product categories ; textile and rubber sector appear less attractive than fertilizers or plastics, probably for reasons of saturation on both plant and market levels.

Q12. Investment levels per product category and by zone

For the same above zones and products, the following general results were :

| | Base petrochemical products | Intermediate petrochemical products | Final petrochemical products |
|--|-----------------------------|-------------------------------------|------------------------------|
| North America | average (weak) | average | average (signif.) |
| Developing America | significant (average) | average (signif.) | average (signif.) |
| West Europe | average (weak) | average (weak) | average (weak) |
| Eastern Europe | signif. (aver.) | signif. (aver.) | average (signif.) |
| Middle East and North Africa | very signif. (significant) | significant (average) | significant (average) |
| Remaining Africa | weak (average) | weak (average) | weak (average) |
| Asia-Oceania (excluding Communist countries) | average (significant) | average | average (significant) |

The results seem to indicate that the growth rate of investments in petrochemicals on the whole will be fairly comparable to the general industrial investment rate, except in Europe and Africa. Developing countries will make a more market investment effort, especially in the field of base products.

Q13. On the question :

Estimate the probability of a technical evolution in the field of plastics susceptible to creating a strong increase in worldwide demand (automobile development, for example).

The experts are divided ; however, this hypothesis appears rather improbable.

Q14. To the question, "what would be the exporting zones in 1990, and what would be the principal petrochemical products exported (or imported) for each zone ?", we obtained a relatively limited number of replies. The essential information received is resumed in the table below :

| | Products exported |
|------------------------------|---|
| North America | polyolefines |
| West Europe | plastics |
| Eastern Europe | <u>base products</u> , plastics, fertilizers |
| Middle East and North Africa | numerous products : <u>base products</u> , BTX, intermediate products, <u>fertilizers</u> |
| Remaining Africa | fertilizers |
| Asia | final products : textile fibers, fertilizers |
| Developing America | intermediate products, fertilizers, polymers |
| Japan | converted plastics |

Q15. The demand for final products, expressed in terms of growth rate, is given below. In the first table figure the average results ; in the second, the answers most often quoted.

| | Fertilizers | Synthetic textiles | Plastics | Synthetic rubber |
|--------------------------|-------------|--------------------|-----------|------------------|
| Industrialized countries | GNP - 0.3 | GNP - 0.5 | GNP + 1.4 | GNP |
| Developing countries | GNP + 2.5 | GNP + 1.7 | GNP + 2.3 | GNP + 0.2 |

| | Fertilizers | Synthetic textiles | Plastics | Synthetic rubber |
|--------------------------|---------------------------------|---------------------------|---------------------------|---------------------------------|
| Industrialized countries | between GNP - 2 % and GNP | between GNP - 2 % and GNP | between GNP and GNP + 4 % | between GNP - 2 % and GNP |
| Developing countries | between GNP + 2 % and GNP + 4 % | between GNP and GNP + 2 % | exceeding GNP + 4 % | between GNP - 4 % and GNP + 2 % |

The results are to be compared with those obtained for question 11 : the conclusions are similar.


These results must be considered as a cocktail of different opinions ; they are somewhat contradictory, mainly in the petrochemical industry itself. It will be then necessary to develop another approach for appreciating the evolution of the demand for final products.

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| B - SENSITIVITY ANALYSIS |
|--------------------------|

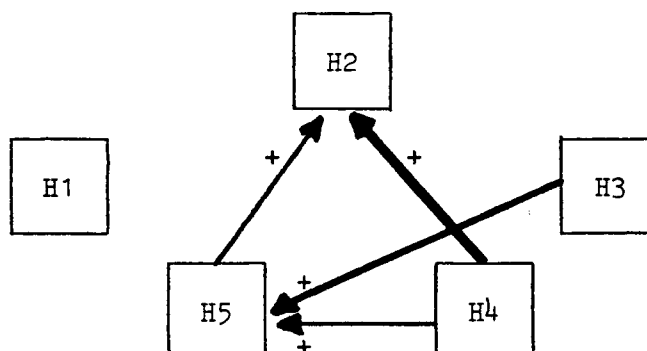
The sensitivity analysis involves determining, on the basis of the conditional probabilities given by the experts, the reciprocal effects of each of the hypotheses on the others.

The method used consists of allocating to each hypothesis an index of motricity, calculated from all the replies, which measures the deformation of the histogram (displacement of the median point). This indicator is the resultant of the algebraic sum of all the displacements found when each of the hypotheses is regarded as being realised and then as not realised.

The table below gives the percentage displacements of the median points: the sign is positive when a shift in the probability of the operative hypothesis results in a shift in the same direction in the probability of the other hypothesis. The sign is negative if the shifts take place in opposite directions.

| Action of  on | H1 | H2 | H3 | H4 | H5 |
|---|-----|-----|-----|-----|-----|
| H1 | | -6 | +10 | +12 | +11 |
| H2 | -9 | | -9 | +11 | -3 |
| H3 | +12 | +4 | | | +24 |
| H4 | +9 | +28 | -7 | | +14 |
| H5 | -4 | +17 | +11 | 0 | |

Retaining only the strongest of these influences leads to the following diagram :



Hypothesis H1, relating to security of supplies, appears to be relatively independent of the four other hypotheses which are fairly closely related amongst themselves, particularly H2 and H4 and also H3 and H5. This means that a scenario in which the hypothesis of the sharing of technological power is realised also has a good chance of seeing the OPEC countries possessing their own petrochemicals industry by 1990. On the contrary, and in the absence of technological transfer, it is less probable that the OPEC countries will emerge in this way. The same applies to H5 (sharing of marketing power) in regard to H3 (organisation of the world petrochemicals market).

| |
|--------------------------------|
| C - SELECTION OF THE SCENARIOS |
|--------------------------------|

1. SELECTION OF THE EXPERTS

The relatively restricted number of replies which were received to the SMIC questionnaire involved selecting carefully those which were to be actually processed :

Certain of the experts showed evidence of a very personal vision of the future, and the inclusion of their replies could have introduced a bias in the selection of the scenarios. Other experts showed a high level of statistical incoherence in their replies, and so it was preferable not to include these.

The actual process involved two stages :

- a typology of the experts was carried out, with an appropriate programme, on the basis of their replies on the basic hypotheses, so as to show up firstly the various classes of experts who each had a similar point of view and secondly those experts who had marginal points of view.
- within each class of expert the most representative one was selected (the central expert or the one coming nearest to this 'ideal' expert). In the case of a large class it was sometimes necessary to choose several experts so that the retained sub-sample would remain as representative as possible*.

One other consideration guided the choice of experts: this was geographical and socio-professional representativeness.

* In order to ensure representativeness care was taken that the distribution of the replies in the sub-sample was comparable to the distribution over the whole of the replies.

This procedure was carried out in parallel on a double sample of experts :

- a sample of fifteen experts selected by SEMA - PROSPECTIVE on the basis of their replies on the principal hypotheses,
- a sample of fifteen experts selected by PDVSA on the basis of their replies to the general economic hypotheses.

The SMIC programme was therefore applied to thirty experts. We consider that the sub-sample constituted in this way forms a largely satisfactory working base.

2. THE RESULTS OF THE SMIC PROGRAMME

Since the SMIC programme was devised for use on a maximum of fifteen experts it was necessary to proceed in two stages.

Despite the precautions previously taken it was necessary to eliminate eleven experts: their replies either led to too high an index of incoherence or were too marginal, leading to a high level of probability being attributed to scenarios which only they cited.

Since the elimination of the experts of low coherence resulted in some distortions we were led to add a further four experts so as to recover the general distribution of the initial histograms.

On the basis of the five basic hypotheses it is possible to obtain $2^5 = 32$ different scenarios. To simplify reference to these they are each coded by means of five binary digits, 1 indicating that the corresponding hypothesis is realised, 0 indicating that it is not.

As an example the scenario '10010' corresponds to the following situation :

- supplies are assured (H1 realised),
- the OPEC countries do not emerge (H2 not realised),
- there is no world organisation of the market (H3 not realised),
- there is a sharing of technological power (H4 realised),
- there is no sharing of marketing power (H5 not realised).

This scenario corresponds to a certain extent to a continuation of the world petrochemicals situation in 1978.

In order to distinguish the most probable scenarios we use four criteria :

- the mean probability,
- the number of times that the scenario is cited in first or second position,
- the number of times that the scenario is cited with a probability of more than 10%*,
- the number of times that the scenario is regarded as very improbable (probability of less than 1.5%*).

The results are set out in the table on the following page.

* The mean probability of one scenario out of 32 is 1/32 or 3.1%.

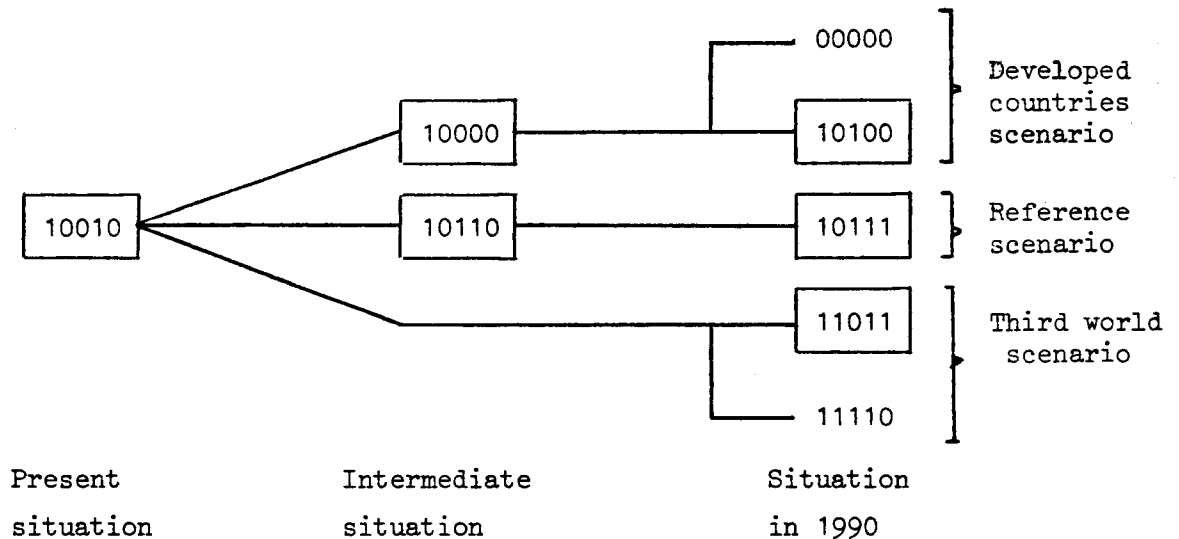
| Scenarios | Mean probability (%) | First and second (number of times) | Probability more than 10% (number of times) | Probability less than 1.5% (number of times) |
|-----------|----------------------------|--|---|--|
| 11111 | 3.1 | 2 | 2 | 16 |
| 01111 | 3.6 | 1 | 3 | 14 |
| 10111 | 8.6 | 8 | 10 | 3 |
| 00111 | 1.3 | 0 | 0 | 15 |
| 11011 | 6.7 | 6 | 6 | 7 |
| 01011 | 2.6 | 0 | 1 | 13 |
| 10011 | 3.0 | 2 | 2 | 12 |
| 00011 | 2.1 | 1 | 2 | 16 |
| 11101 | 4.4 | 1 | 2 | 12 |
| 01101 | 2.9 | 2 | 2 | 14 |
| 10101 | 3.0 | 0 | 2 | 14 |
| 00101 | 1.3 | 0 | 0 | 16 |
| 11001 | 4.4 | 2 | 2 | 12 |
| 01001 | 1.4 | 0 | 0 | 17 |
| 10001 | 1.8 | 1 | 2 | 19 |
| 00001 | 2.6 | 0 | 1 | 14 |
| 11110 | 4.7 | 2 | 2 | 8 |
| 01110 | 1.8 | 1 | 1 | 16 |
| 10110 | 5.1 | 2 | 2 | 12 |
| 00110 | 0.6 | 0 | 0 | 19 |
| 11010 | 2.5 | 0 | 1 | 11 |
| 01010 | 1.5 | 0 | 0 | 17 |
| 10010 | 2.9 | 3 | 4 | 16 |
| 00010 | 3.5 | 0 | 3 | 17 |
| 11100 | 1.5 | 0 | 0 | 12 |
| 01100 | 1.6 | 0 | 2 | 19 |
| 10100 | 5.5 | 3 | 5 | 13 |
| 00100 | 2.1 | 0 | 0 | 14 |
| 11000 | 2.0 | 2 | 2 | 20 |
| 01000 | 2.2 | 1 | 3 | 18 |
| 10000 | 7.8 | 4 | 6 | 6 |
| 00000 | 5.8 | 5 | 5 | 14 |

Three scenarios are clearly distinguished from the rest: these are scenarios 10111 (in the lead), 10000 and 11011. Then follow a group of scenarios (00000, 10100, 10110 and 11110) which justify retention for a variety of reasons, followed by the rest of the possible scenarios with probabilities so low as not to make their examination worthwhile.

These scenarios may be grouped into three families :

- the family of scenarios of conflict (scenarios 10000, 10100 and 00000), characterised by a hardening of the attitude of the major petrochemical companies and leading to a final image where there is no sharing of power with the actors in the Third World and where there is no emergence of the OPEC producers. Amongst these three scenarios there is one which represents a fairly stable situation: this is scenario 10100 where there is an organised petrochemicals market; this is the 'American' scenario where world petrochemicals are dominated by the major groups.
- the family of scenarios of cooperation (scenarios 10110 and 10111), characterised by an organised market and secure supplies and where the sharing of power is progressively achieved. Despite this the contribution of the OPEC countries to the total production remains relatively small (H2 not realised).
- finally the family of the OPEC scenarios, where we find two scenarios (scenarios 11011 and 11110) which are contrasted to the two previous families and which are characterised by the emergence of OPEC and its gradual access to technology and markets. The first of the two scenarios is one of tension and competition, since the world market is not organised; the second is relatively nearer to the second family, inasfar as there is an organised world market and some form of cooperation. It may be considered as the logical result of the previous one.

In this way one arrives at the following tree of scenarios by interposing intermediate scenarios from amongst the seven leading scenarios :



We have used two scenarios cited as being fairly probable as intermediate images: experience in fact shows that the experts do not always have the same views as to the speed of development of phenomena. It is therefore of interest to use, where possible, certain scenarios as intermediate scenarios, which reinforces the probability of appearance of a family of scenarios.

3. THE CHOICE OF SCENARIOS

Scenario 10111 was chosen as the reference scenario, having come in the leading position irrespective of the selection criterion used.

For the contrasted scenarios we have retained 11011, which comes in second position, and 10100 rather than 10000 which is an intermediate image between the existing situation (10010) and scenario 10100.

It seems to us to be more interesting to study this rather than the scenarios of extreme conflict (which are of necessity transient) such as 10000 or 00000, since it corresponds to a situation which is economically more stable: it is the scenario of the western companies, organising world petrochemicals to their own profit and succeeding in considerably limiting the contribution of the developing countries. In addition this scenario seems to correspond fairly well to the petrochemicals strategies as they appear in the table of strategies of the actors.

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II - THE PRESENTATION OF THE SCENARIOS

Three scenarios have been chosen for further analysis, comprising a reference scenario and two contrasting scenarios. Apart from having an intrinsic interest in their own right, these scenarios must also provide the basis for the preparation of the detailed sets of data required to drive the model, and the manner in which the scenarios are presented is therefore partially conditioned by the manner in which the model will be run.

Apart from runs carried out for validation purposes using historical data, the model will be run for 1982 and 1990. The year 1982 was chosen because this is the horizon at which petrochemical capacities will be largely determined by decisions already taken. The scenarios must therefore provide forecasts for these years of the various variables and parameters required by the model.

It is reasonable to assume that the major divergences in events which will lead to the contrasted images in the year 1990 will occur after 1982. While many of the elements or "seeds of change" leading to these divergences will be present earlier, in terms of the concrete parameters required by the model : demand for final products, production capacities, costs, etc., the main difference can be supposed to emerge later. This assumption is consistent with the philosophy behind the choice of the year 1982 in the first place, i.e. that petrochemical capacity at that date will be little influenced by future events.

Four sets of forecast data will therefore be elaborated for input into the model, i.e.

- Data as at 1982 assuming little change from the present situation ; investment capacity as suggested by external enquiry as to present investment projects, economic growth rates in accordance with current forecasts and recent trends, no change in the real cost of energy, and so on.
- Data as at 1990 (the horizon of the study) for each of the three contrasting scenarios selected for analysis.

These data sets are derived and presented in detail in report "production and consumption forecasts for petrochemical products up to 1990". The scenario descriptions which form the bases of these data are presented below.

It should be noted that figures are presented in terms of constant prices in this report, that is, after discounting the overall rate of inflation. Thus an increase in GNP refers to an increase in volume, and an increase in the price of oil means over and above that attributable to overall price rises caused by inflation. This is not to say that inflation can be ignored, as inflation introduces certain instabilities and distortions which cannot be eliminated simply by constant price accounting.

A - THE REFERENCE SCENARIO

The reference scenario is the one for which the mean of the probabilities given by experts is the highest.

By way of reminder, the principal aspects of this scenario in relation to the petrochemical context at the horizon of 1990 are as follows :

- H1 realised - Reasonable continuity of feedstock supply
- H2 not realised - OPEC countries do not achieve 10 % of world capacity
- H3 realised - Well ordered market
- H4 realised - Unhindered transfer of technology
- H5 realised - Decreasing degree of captivity in market.

The picture is therefore of a well ordered market, which has recovered from the various pressures and uncertainties of the mid to late seventies.

As far as the politico-economic environment is concerned, there is no fundamental challenge to the existing international political and economic order, moderate growth being sustained in the industrialised countries. The ascendancy of the industrialised countries in the petrochemical industry is not fundamentally called into question.

In the following sections, the political, economic and energy context, and the picture of the petrochemical industry itself, up to the horizon of the study, 1990, are elaborated.

1. INTERNATIONAL POLITICAL CONTEXT

This is essentially a scenario in which the political statu quo is continued. Any changes which occur in the politico-economic structure and the balance of power in the world will be slow and evolutionary, rather than involving any radical changes.

The economic/ideological map will continue to look very much like at present, with the existing division into free market and centrally planned economies. While the United-States and the USSR will continue their roles as the two super-powers, the move, already established, away from a simple polarisation into two blocs will continue. The emergence of the EEC as a major economic counterweight, if not a political unit, will be consolidated, the power and influence of Japan will increase, and the Peoples Republic of China will begin to assert itself as a political and economic force to be reckoned with.

While developing countries gain an increasing sense of identity and weight in international affairs, their effective power on the world scene remains limited. Cooperation on a regional level between Third World countries is limited by rivalries and local disputes.

The solidarity of oil-exporting countries remains weak at first, with Saudi Arabia blocking attempts by OPEC to raise the real price of oil. Towards the second half of the 1980s, however, as reserves become depleted and pressures build up on the demand side, the common interests of oil-exporting countries become more important than their divergences, and OPEC again begins to operate as a cohesive force.

East-West detente continues to develop, although they come into a certain amount of competition in trying to consolidate and extend their spheres of influence.

2. INTERNATIONAL ECONOMICAL CONTEXT

After the economic uncertainties of the mid-1970s, a reasonable expansion is resumed in the industrialised countries. Although the cyclical phenomena of booms and recessions continue, on average a fair rate of economic growth is maintained in these countries up to the end of the next decade.

Although a new international economic order remains a subject of topical discussion, very little concrete progress is made towards transferring wealth from the richer to the poorer countries, or towards bringing about an acceleration in the rate of industrialisation. Almost no advance is made towards narrowing the gap between richer and poorer countries, since the margin which the latter enjoy in terms of national economic growth is largely absorbed in higher demographic growth rates, leaving little differential on a per capita basis.

As a result of the increasing wealth of the USSR and its partners, and the climate of detente which allows military expenditure to be reduced, the Eastern bloc begins to move slowly towards a more consumerist society. As the expectations of consumers in Eastern Europe increase, the need to earn foreign exchange makes itself felt, and the USSR increasingly seeks to integrate itself into the mainstream of international trade.

Despite continued attempts at monetary reform, the key role of the dollar continues, as does the system of flexible exchange rates. Partly due to the serious attempts made by the United States in particular to come to terms with the world energy situation and thus redress its balance of payments, the decline of the dollar relative to European currencies is halted. So far as the industrialised world as a whole is concerned, exchange rates only diverge in such a way as broadly to compensate for differential rates of inflation (which are held to a moderate level).

As a result of the continued depletion of natural mineral resources, and increasing demand for these and other natural products, these continue their recent past trend of becoming more expensive in relation to manufactured goods. In terms of the international trade, this means a gradual improvement in the terms of trade of the developing countries with mineral resources, or who produce commodity crops such as rubber, cotton, sisal, etc.

Balance of payment problems persist in many developing countries without energy reserves, and also in some industrialised countries. On the other hand, certain OPEC countries continue to be in strong surplus, in spite of their efforts to industrialise. Japan also continues to be in surplus, at least until the mid-1980s, when rising oil prices and her complete absence of natural energy resources, coupled with increasing energy demand, begins to tell against her.

In general, the liberalist ethic remains dominant in international trade relations, with the exception of certain ad hoc measures, for example in relation to Japan which continues its aggressive export policy in order to sustain growth, and in certain difficult sectors such as the metallurgical industry.

The detailed rates of growth adopted in this scenario are set out in the tables 1 and 2 below. They are based on a scenario prepared by the Cavendish Laboratory, Cambridge for the World Energy Conference in Turkey, in 1977.

Table 1 - Macroeconomic assumption : 1978-1982

| <u>Zone</u> | <u>Growth of</u> <u>GNP</u> <u>% p.a.</u> | <u>Growth of</u> <u>population</u> <u>% p.a.</u> | <u>Growth of</u> <u>manufacturing</u> <u>industry</u> <u>% p.a.</u> | <u>Growth of</u> <u>Agriculture</u> <u>% p.a.</u> |
|---------------------------------|---|--|--|---|
| North America | 2.9 | 1.0 | 3.0 | 1.7 |
| Western Europe | 3.4 | 0.6 | 3.7 | 1.5 |
| Communist count. | 4.5 | 2.0 | 5.0 | 2.5 |
| Developing America | 5.0 | 2.5 | 5.6 | 3.0 |
| Middle East and North Africa | 6.0 | 2.7 | 6.9 | 3.0 |
| Other Africa | 4.7 | 2.6 | 5.7 | 2.5 |
| Asia | 5.1 | 2.2 | 5.9 | 2.5 |

As far as the other assumptions in Table 1 are concerned, the assumption has been made that the population growth will be at the rate of 2.0% p.a. in most countries, 1 % p.a. in North America, and 0.6 % p.a. in West Europe. These figures are in accordance with recent trends (assuming some continued further reduction) and with assumption made in other projections.

Agriculture production in volume is to continue its current rate of growth in developing countries (the average was between 2.5 and 3.0 during the ten last years), with a faster growth in developing America and Middle East and North Africa. In other developing countries, the growth of the agricultural sector is handicapped by the absence of any major effort to reform the agricultural systems, but is nevertheless assumed to remain slightly ahead of demographic growth, so that the food situation is not actually deteriorating in these countries, but remain critical in some areas.

The other major sectors (industrial manufacturing, services, and construction) are assumed to expand at about the same rate as one another, as has been the case in the recent past, with the exception of construction in the developed countries, which is assumed to grow more slowly than the rest of the economy. On the basis of the assumptions, and using the figures of the present structure of production in each zone, the rates of growth in the manufacturing industry have been calculated.

Finally, in this scenario, which envisages no fundamental structural changes in economic systems or policies, investment quotas have been assumed to remain roughly constant, and therefore household consumption is assumed to increase at the same rate as economies in general, except in the communist countries, where consumption grows somewhat faster.

As far as the composition of production is concerned, the pattern in developing countries slowly approaches that of industrialised countries, as agriculture and mineral extraction grow more slowly than manufacturing industry and services, and gradually account for a smaller share in the total economic activity of these countries. The increase in agricultural output which does occur is achieved partly by increasing the total area of arable land available and used for agricultural purposes, and partly by improving the productivity of the land already under cultivation, through the use of more extensive irrigation, introduction of higher-yielding varieties, greater mechanisation, and more extensive use of fertilisers and pesticides.

The type of industrialisation in developing countries carried out is limited by problems of capital, limited resources, limited infrastructure and lack of skilled labour. As far as industries which are direct major consumers of petrochemical final products are concerned, apart from agriculture, a major consumer of

On the 1982-1990 period (cf. table 2), the trends are the same as on the 1978-1982 period, except for the growth of population, and the growth of agriculture, when some changes are to occur.

The rate of growth of population shows a slight decrease in developed countries, where the mean age increases.

In the agricultural sector, the global production is in progress in comparison with the former period. In developed countries, this growth is the result of the willing to prepare the "food weapon", for political and economical reasons. On the other hand, the objective of reaching self-sufficiency or an exporting position for same products leads to higher rates in areas like developing America, and mainly Middle East.

Table 2 - Macroeconomic assumptions in reference scenario : 1982-1990

| <u>Zone</u> | <u>Growth of</u> <u>GNP</u> % p.a. | <u>Growth of</u> <u>population</u> % p.a. | <u>Growth of</u> <u>manufacturing</u> <u>industry</u> % p.a. | <u>Growth of</u> <u>agriculture</u> % p.a. |
|---------------------------------|--|---|---|--|
| North America | 2.9 | 0.9 | 3.0 | 2.0 |
| Western Europe | 3.4 | 0.5 | 3.7 | 2.0 |
| Communist count. | 4.5 | 2.0 | 5.0 | 2.2 |
| Developing America | 5.0 | 2.7 | 5.6 | 3.2 |
| Middle East and North Africa | 6.0 | 2.7 | 6.9 | 3.5 |
| Other Africa | 4.7 | 2.6 | 5.7 | 2.5 |
| Asia | 5.1 | 2.2 | 5.9 | 2.7 |

Fertilizers, already mentioned, possibilities are largely restricted in developing Asia and Africa to the textile industry. This industry is labour-rather than capital-intensive, and a large market naturally exists for textiles. The demand of the plastics processing industry is limited in volume in Africa, but its expansion in terms of rate of growth is significant, due to the activity of small transformers. In Asia, a progressive demand in plastic goods; due to a regular development of manufacturing industry stimulates the processing industry. On the other hand, the increasing size of the automobile population favours the development of a rubber processing industry in these areas (but still moderate in Asia, and small-sized in African countries). By contrast Latin America, with a higher per capita income and more developed economies and consumption patterns, has good prospects in all these consuming sectors.

In the Middle East/North Africa, prospects are favorable to the establishment or expansion of plastics and rubber processing industries.

In developed countries, the textile industry is expected to continue its relative decline in view of high labour costs, and prospects for the rubber industry are not bright particularly in the US, in view of the increasing saturation of the automobile market. The plastics processing industry, on the other hand, is likely to continue to grow.

In relation to labour, there is no radical change in working habits, and the standard working week is reduced only very slowly. The cost of labour in real terms evolves broadly in accordance with increases in productivity, i.e. approximately in accordance with per capita G.N.P. There is no appreciable progress in reducing disparities in income distribution, either in the developed or the developing countries.

In the field of the environment, Europe follows in the wake of the United States and Japan in setting more stringent standards for air quality, emissions of liquid, gaseous and solid pollutants, and so on. Meanwhile, the latter go still further in improving the quality of the environment.

3. ENERGY CONTEXT

3.1. General

No serious energy crisis develops during the period under study, and the supply of energy continues to be reasonably balanced with demand. However the period is characterised by an increasing sense of urgency and impending crisis, with a great deal of effort being expended, particularly towards the middle and late 1980s to devising policies which will provide for continuity of energy supply when oil production begins to be run down.

OPEC does not succeed either in forcing substantial increases in the price of oil, or in limiting production at a level below that of world demand. The Gulf States, and in particular Saudi Arabia, block any attempts by other OPEC members to declare substantial increases in oil prices, either through a strong vested interest in ensuring international monetary stability, or by virtue of a tacit agreement with the United States and other Western countries. Similarly, oil production continues to rise in accordance with increasing demand, in the case of countries such as Algeria, Iran and Venezuela in order to generate the increased revenue needed for their industrialisation programmes (since this cannot be done by

increasing prices), and in the case of the Gulf States, as part of their policy of accommodating the requirements of industrialised countries. Such a policy means that by 1990 total production of oil in OPEC countries will be approaching their likely capacity.

The industrialised countries continue to develop non-oil energy sources at a moderate rate, with oil being regarded as the residual fuel required to bridge the energy gap. After a period of vacillation, the construction of nuclear generators is resumed at a moderate rate in most developed countries, and in some developing countries also. Coal is also reintroduced in many industrialised economies, mainly in the electricity generation industry, but towards the end of the next decade, the research into techniques of gasifying coal on a large scale begin to bear fruit, and SNG begins to be introduced as an alternative fuel by the process industries.

While there is a great deal of discussion about the need to use energy more efficiently, only limited progress is made in this direction, apart from the United States, whose present prodigality allows greater scope for economies. In the U.S. the "energy-GNP elasticity", i.e. the percentage increase in energy usage per one percent increase in GNP, is reduced to 0.71 (OECD assumption). Other developed countries are assumed to have a rate of energy growth almost as high as the rate of economic growth, and developing countries, because of their increasing rate of industrialisation, are assumed to have an elasticity greater than unity.

3.2. Oil situation

An essentially well-ordered world market in oil is assured up to 1990, the study horizon. Oil-importing countries and the oil majors seek to, and succeed in, making agreements with oil-exporting countries on a bilateral basis. The U.S. reaches an understanding with Saudi Arabia as well as continuing to import from Western Hemisphere producers. West European countries and Japan also make deals with OPEC countries through their natural oil companies, offering technical assistance as well as market access in exchange for supply guarantees. The multinationals continue to exercise a strong influence in the world oil scene, collaborating with oil-exporting countries in exploration and exploitation activities, providing technical, managerial and commercial assistance, and entering into joint ventures with oil-producing countries for oil-refining and petrochemicals projects.

As already mentioned the cohesiveness of OPEC is weak in the early years in this scenario, due in particular to the unwillingness of Saudi Arabia to jeopardize its relations with the U.S. Thus bilateral agreements with oil-consuming countries preponderate over agreements between OPEC countries. Until 1982 oil prices only rise to compensate for general inflation, and for any slide in the value of the dollar compared with that of other "hard" currencies. After 1982, as demand for oil increases regularly, the common interests of OPEC countries become more apparent, and OPEC oil prices begin to rise in real terms by 5 % p.a., thus reaching a premium of about 50 % by 1990. By 1990, OPEC production is nearing its capacity.

The drive towards energy conservation in the U.S., and the desire to stimulate production means the disappearance of price controls. Thus oil prices in the U.S. are supposed

to converge with world (OPEC) oil prices by 1980, and thereafter to remain in harmony. In spite of increased production in Alaska, overall production in the U.S. increases only modestly compared with its present value (about 15 % up in 1985), due to the gradual running down fairly rapidly in Canada, due to progressive exhaustion of reserves.

In Europe, output increases considerably, with the North Sea production continuing to rise rapidly to 1985 and platforming thereafter until the end of the decade.

Demand for oil in Japan increases rapidly, due to the relatively high rate of growth experienced there, and the virtual complete absence of domestic energy reserves. This is somewhat moderated, however, by an extensive programme of construction of nuclear generators which gets under way at the start of the 1980s, when the various technical difficulties have been surmounted.

In spite of increased oil production capacity in the Soviet Union the Eastern bloc moves from a position of being net exporters of crude to one of net importers during the 1980s, since demand increases more rapidly than production. This is one of the pressures which leads to a greater integration of Eastern European countries into world commerce, since they need hard currencies to finance their oil imports.

On the other hand, exports of crude from China increase considerably as she begins to develop and exploit her oil resources.

While the demand for oil in non-OPEC developing countries increases considerably, some of these countries, for example, Mexico and Egypt, become significant exporters of oil, and new exploration and development mean that other countries, such as Brazil and India, are able to provide for a significant proportion of their domestic demand.

In conclusion, the overall picture of the oil market is one of a well-ordered market, with demand being well matched with supply, and with a single world oil price being a valid concept insofar as differences between prices in different regions are no greater than the transport costs (with the possible exception of Eastern bloc countries).

3.3. Natural gas situation

Many of the established producers of natural gas have already reached or passed their peak production with possibilities declining as reserves are gradually depleted. On the other hand, the newer producers such as Algeria continue to increase their output. As the technology of natural gas liquefaction and transport improves, the Middle East becomes a major producer and exporter, and this tendency is given further momentum by the rises in energy prices occurring during the 1980s.

In both the United States and Canada, natural gas prices are assumed to be decontrolled by 1980, and therefore to rise to a level equivalent to oil prices. In spite of the stimulus afforded by this not insubstantial price increase, production in the U.S. continues to decline. In Canada, production does further increase, but most of the production is reserved for national consumption.

In Europe, the Netherlands remain the largest producers of natural gas, but the government of that country pursues a more active management of supply, with export contracts being run down, and priority being given to domestic households. Significant increases in the production of natural gas from the Norwegian sector in the North Sea occur, placing Norway in the position of an exporter of natural gas.

A number of non-OPEC developing countries also become significant exporters of natural gas, in particular Mexico, which exports natural gas to the United States.

In summary, there is a tendency for countries not self-sufficient in energy to reserve their natural gas resources for their own use. On the other hand, certain OPEC countries, notably Algeria, Saudi Arabia and Iran, become major exporters of natural gas, or consolidate their position as exporters. Although commerce in natural gas on a world scale remains relatively limited, natural gas prices tend to converge with those of oil. The exception to this rule occurs in those countries which possess gas resources substantially greater than domestic requirements, and which have to rely on the more expensive forms of transports, such as cryogenic tankers, rather than pipelines, for exports. In such countries, which would include the Gulf States, particularly Saudi Arabia, and Algeria, gas prices would be depressed below prices elsewhere by an amount reflecting the relatively high transport costs.

3.4. Petrochemical feedstocks

The relative availability and prices of the various petrochemical feedstocks is largely conditioned by developments in the wider energy context, and in particular, that of oil and natural gas. Over the study period, extensive research is carried out into the possible use of new substances as feedstocks for chemical processes, but these have little practical impact on the petrochemical industry as a whole.

A number of routes exist from coal to some of the more upstream petrochemical products, and while the techniques involved are improved, oil prices do not rise sufficiently in real terms

over the study period to make these new processes economic and thus warrant a large-scale switch-over.

Similarly, in spite of the pioneering work carried out by Union Carbide and Dow, the direct cracking of crude oil does not become common before 1990. Technical difficulties, and the high capital and process costs which offset the lower feedstock costs, delay the commercialisation of these processes, and they do not become available on licence in an attractive form until the late 1980s, too late to have a significant impact in the time horizon considered.

Thus the tendency is for the basis petrochemical transformation processes to continue to rely on the classic feedstocks, even though the pattern of energy utilisation generally is moving towards different sources, such as coal and nuclear energy. Thus certain uses of oil and gas will become "premium" in the surge that they will enjoy priority of supply, reflecting the fact that a switch from certain uses (such as petrochemical feedstocks and transport) will be more difficult or costly than others.

Looking at a more local level, feedstocks prices and availability will move to reflect local conditions, and in particular, the emphasis between the different classic feedstocks will change due to expected energy developments. Thus, in North America the following effects can be expected :

- Naphtha and gas-oil prices rise by 1980 to reflect the alignment of American crude prices with world (OPEC) prices,
- Naphtha and gas-oil prices rise from 1982 onwards, to reflect the increasing real price of crude in the world market,

- The price of natural gas liquids and methane rises to reflect the alignment of gas prices with oil prices in the United States in addition to the above,
- In addition to the afore-described rise in the price of compounds from natural gas, the availability of ethane (and propane) decreases to reflect the fact that its production is diminishing while demand continues to increase. Although new petrochemical plant adapts to this situation by providing themselves with the capacity to accept naphtha and gas-oil, the prices of ethane and propane will rise even further than that accounted for by the above ; on the other hand, the supply of methane for the manufacture of ammonia and methanol will remain adequate for the needs of the North American petrochemical industry, and no further price increase, other than those already described, is to be expected (a qualification to the foregoing is that no shortage of natural gas is expected in Canada in the time span considered, but Canada only accounts for a small proportion of the total North American petrochemical activity).
- As the North American petrochemical industry moves away from ethane as the main feedstock for olefins and aromatics manufacture, the chronic shortage of naphtha is accentuated ; furthermore as naphtha becomes scarce in other industrialised countries, it becomes increasingly difficult to fill the gaps by importing, in spite of increased availability from Africa, the Middle East, and the Far East. Thus the price of naphtha relative to gas oil rises in North America.

In Europe, prices of feedstocks also rise to reflect rising energy prices. Furthermore, automobile use, and therefore the demand for gasoline, continue to increase at a fair rate, while demand for gas-oil tends to stagnate in the mid to late 1980s, due to the increasing use of coal and nuclear fuels for the generation of electricity. These developments are unfavourable to the production of naphtha. As a result, the price of oil relative to naphtha rises. The theoretical possibility of using refinery processes such as catalytic cracking and hydrocracking to upgrade the heavier hydrocarbons and thereby redress the gas-oil/naphtha balance does not become reality, due to the adverse economies, which make it cheaper to produce ethylene by cracking gas-oil. A certain amount of gas liquids (ethane, propane, butane) become available during the 1980s from the North Sea.

In developing countries with oil reserves, since any such country which establishes a base petrochemicals industry can be assumed to possess a commensurate refining industry producing adequate quantities of naphtha as well as gas-oil, availability of these feedstocks will be satisfactory, reflecting prevailing crude oil prices, but not any particular rarity value. However, a lower limit on local naphtha prices is represented by the price of naphtha in the developed countries less transport costs.

So far as gas prices in developing countries are concerned, these depend on the circumstances applying in particular regions. In the Middle East and in North Africa, where production is considerably higher than demand in the region, and where the gas has to be liquefied and transported in cryogenic containers, the local price is limited by the price of LNG in the receiving

country and the (high) cost associated with liquefaction and transport. Where, however, national production remains within demand, or can be exported by pipeline (as in the case of Mexico, to the United States), natural gas prices rise to approximately those of oil (per unit calorific value).

4. PROSPECTS FOR SOME SECTORS DIRECTLY AFFECTING DEMAND FOR FINAL PRODUCTS

4.1. Agriculture

The agricultural industry has reached a fairly mature state in most developed countries, so that fertilizer consumption grows at only a relatively moderate rate in these countries. Consumption is price elastic, since the use of fertilizers is the result of an economic calculation. However prices of nitrogenous fertilizers rise rather than fall, due to increased energy prices, particularly in the United States.

In developing countries, on the other hand, more intensive farming methods are required to increase the yield of agricultural land, and thus to fill the food gap. These include the increasing use of fertilizers. Increased demand for fertilizers, however, is moderated by the limited availability of finance for farmers, meaning that only the wealthier among them can afford fertilizers. However a stimulus is received to consumption from the increased local production of nitrogenous fertilizers and, in particular, from the production of lower-price fertilizers in the Middle East and Comecon countries for export.

4.2. Automobiles

In the U.S. the car population grows only very slowly, as it approaches saturation level for the population as a whole. Despite the (small) increase in oil prices in the U.S., little progress is made in making the American car more economical, nor does the government succeed in introducing a penal tax on gasoline, until the second half of the 1980s, when the urgency of the situation makes itself felt. At that time a serious attempt begins to be made to make cars smaller and lighter, with plastics finding increasing use in place of metals, and tyres becoming lighter (hence requiring less rubber).

In Europe and Japan, car ownerships continues to increase in accordance with past trends, with no fundamental questioning of the role of the motor car in society, i.e. significant shift from private to public transport.

In developing countries, motor car ownerships enjoys a higher growth as income levels rise.

Radial tyres increasingly take over from cross-ply as standard equipment, thus increasing the demand for rubber in those countries with a fast growing car population, but conversely reducing it as demand flattens out.

4.3. Textiles

The consumption of textiles as a whole grows at a very modest rate in industrialised countries. What growth in demand for fibres there is however, tends to be in the area of non-cellulosic fibres, with acetate and rayon usage declining, and consumption of cotton expanding only slowly.

In developing countries consumption of textiles increases with national income, but there is an increasing trend towards the use of non-cellulosic fibres, with the share of cotton declining.

4.4. Building

The building sector continues to develop faster than the economy as a whole in most developing countries, but the rate of growth slows down in developed countries. There is no major breakthrough in the use of plastics (or other petrochemical products) in the industry, which remains dependent on traditional materials such as concrete, bricks, wood, steel and glass.

4.5. Packaging

Plastics continue to make further progress in packaging in developed countries, further displacing paper. There is no serious attack on the packaging industry by anti-waste legislation, and no greater tendency towards the recycling of containers than in the present situation.

As income increases in developing countries, demand for plastics for packaging also grows rapidly.

5. PETROCHEMICAL CONTEXT

5.1. Organisation of production

The period to 1982 is characterised by continuing and chronic overcapacity (see section 5.2), as the resumption in the growth in demand is offset by the substantial new capacity coming on-line, particularly at the upstream end of the industry. Two types of actor contribute particularly to this new capacity, i.e. :

- a) The petrochemical subsidiaries of the oil majors, and other oil companies. As growth in the oil industry inevitably flattens out, oil companies are increasingly anxious to diversify into new fields, and the petrochemical industry presents an obvious direction for them. This particularly applies to the European oil companies, whose potential in the field of other energy types is limited, but it also applies to the American majors. The prospects of worldwide overcapacity and poor profitability do not deter them, the more important consideration being to increase their stake in the industry. While their attack is particularly centred on the manufacture of base products, and in particular olefins and aromatics manufacture, it is by no means exclusively in these areas, but includes large scale intermediates, plastics and others.
- b) The developing countries with hydrocarbon resources, eager to find suitable outlets for their drive towards industrialisation, establish substantial petrochemical projects. While not pressing ahead with some of their more ambitious plans, they are not

impressed with the arguments (mainly issuing from the developed countries) warning of overcapacity and low profitability, and exhortations for restraint. They reason that if they are to establish themselves in petrochemicals, it must be sooner rather than later, while they still have some petroleum, and that they will enjoy certain advantages, such as security of feedstock supply and preferential access to local markets, which will allow them to operate successfully.

In the face of this situation of continuing overcapacity and the determination of new producers to carve out (or consolidate) a share in the market, the established petrochemical industry goes into the defensive rather than the offensive. It tends to retreat during the course of the 1980s from the areas particularly favoured by the newcomers, in particular moderating its new plans for the manufacture of base products, and trying to concentrate its activities more in the area of high value-added, high technology, "quality" petrochemicals.

At the same time, both established chemical firms and the oil majors try to get a stake in the new petrochemical projects in developing countries. While some firms are reticent about cooperation, or dubious about the economic viability of the new plans, most are anxious to participate. On their side, the new producers do not feel sufficiently strong to go it alone, and the political climate is not such as to favour the formation of cooperatives of producers strong enough to stand on their own. Therefore, there is a proliferation of joint ventures between, on the one hand, OPEC countries, and other oil-producing developing countries, and, on the other hand,

established chemical companies including petrochemical subsidiaries of oil companies. The joint ventures will be of many different types ; the latter will contribute technical and managerial expertise, in some cases capital, in some cases provide a market, or at least marketing know-how. In return, they will have a share in the venture, and also increased security of supply of petrochemical feedstock and/or crude oil.

While the host-countries have nominal control of these ventures, the multinational partner(s) in many cases enjoy(s) de facto control, by virtue of their greater expertise and sophistication. This is particularly the case in countries which have little experience of petrochemicals, for example in the Middle East.

The mood of uncertainty which prevails in the petrochemical industry at the turn of the decade gives rise to a number of pressures in the industry. Traditional producers, in addition to moving towards greater specialisation and seeking to enter into joint ventures with the newly emerging producers, also seek to diversify geographically, and to spread their risks, often by concluding agreements with, or entering into joint ventures with, oil companies.

Thus, during the 1980s, the petrochemical industry becomes progressively more distributed, more decentralised, less monolithic, with the industry becoming more specialised.

5.2. Location of production

As has been seen in the preceding section, there is a progressive shift in the international pattern of petrochemical production, during the 1980s, towards the developing countries, in particular those with resources of oil and natural gas. This shift, is however, rather gradual, reflecting the problems which developing countries have in providing force conjunction of the four main essentials for the establishment of a successful petrochemical industry, i.e. capital, feedstocks, markets, and technical know-how (including access to labour with suitable-skills).

Capital is a problem for all but the richer OPEC countries, especially in relation to the very capital intensive upstream transformation processes such as steam crackers. Many developing countries who wish to develop their chemical industries feel that this problem is best solved on the bases of a partnership with established chemical companies, particularly the oil company subsidiaries who have access to the necessary funds. In other cases, bilateral agreements are reached with developed countries. For some countries the less capital-intensive, more labour intensive sectors are more attractive, but these tend to be processes at the downstream end of the industry, and therefore more logical for countries without oil and gas resources.

The problem of markets provides a further limitation. Very few developing countries have a sufficiently large domestic market to justify by virtue of itself alone a petrochemical industry, and must therefore be able to count on access to their neighbours' markets. In some cases, lack of a good framework of effective regional cooperation agreements inhibits the establishment of petrochemical industry in developing countries.

Finally, technical knowhow and expertise provide another constraining factor. While the technology is freely available in the market place, successful commercial operation nevertheless depends on access to the appropriately skilled work force. Many of the emerging petrochemical producers go into partnership projects with American and European companies as a means of solving this problem.

As has already been mentioned, the pattern of petrochemical capacity in 1982 is largely determined by decisions already taken, and in the same way the total level of world capacity in 1990 and its distribution between the different geographical zones will be the result of investment decisions made between now and, say, 1986/7. These decisions will be such as to obtain the following :

a) Middle-East/South Mediterranean

- Large capacity for the manufacture of fertilizers by 1990. Apart from satisfying its own needs, it aims to meet a significant proportion of the growing demand from African and Asian countries. The huge resources of natural gas in this zone, together with its strategic physical situation in relation to Third World markets, make fertilizer manufacture an excellent direction in which to move.
- Large new olefin capacity in 1990. This zone accounts for a significant part of the increased olefin capacity coming into service in the period 1982-1990. Apart from satisfying local demand, the output is aimed at export markets in, in particular, South Europe, but also the rest of Europe, Japan and the U.S.

Because of the high cost of transporting ethylene, much of it is transformed into the intermediate products next downstream, for example : styrene, etc.. This activity is also well suited to this zone in view of its access to large quantities of naphtha and ethane, and the considerable financial resources of countries such as Saudi Arabia and Kuwait.

- As for other branches of the petrochemical industry, the Middle East and North Africa develop enough capacity to be largely self-sufficient, with particularly significant activity in Iran, Algeria and Egypt.

b) Developing America

This zone is characterised by large reserves of oil and natural gas, a mean per capita income considerably higher and faster growing than other developing countries, a substantial consumption of petrochemical products, and significant petrochemical industries in several countries, notably Brazil, Mexico, Argentina and Venezuela. This zone reaches a position of self-sufficiency in the main petrochemical products the mid-1980s, and this situation continues to apply up to the end of the decade.

c) Asia

This zone is extremely heterogeneous, including both Japan, one of the major world centres of petrochemical consumption, and many developing countries with low per capita incomes. The zone is not very well endowed with hydrocarbon resources, with the exception of Indonesia, which has substantial oil and natural gas reserves.

Although there is a reasonable growth in the demand for petrochemicals, the base figure (excluding the developed countries) is low, and therefore even by 1990 demand is relatively modest. This region therefore continues to be dominated by Japan, and developments in other Asian countries are partial and piecemeal. Thus, for Asia (ex Japan) :

- Moderate growth in capacity, partly consolidation on existing production lines and partly moving outwards into complementary products.
- Establishment of a significant ammonia/nitrogenous fertilizers industry, mainly in those countries with hydrocarbon resources, such as Indonesia, India, Pakistan, Bangla Desh.
- Establishment of a significant synthetic fibres industry, to feed the growing textiles industry in Asia ; in particular, development of the more labour intensive branches of the synthetic textiles industry.

d) Africa (excluding North Africa)

Petrochemical activity in this zone remains extremely limited, South Africa and Nigeria being the only countries which succeed in establishing a proper petrochemical industry. In general, markets remain too limited to justify the establishment of a petrochemical industry, and no real political cooperation between African countries develops sufficient to overcome the other disadvantages.

e) Communist countries

Investment policy and demand developments in the communist countries remain outside the scope of this study, but imports and exports of this zone (which represent the consequences of the former) are of interest, and enter exogenously into the model. For convenience, these are dealt with here.

The period up to 1982 is characterised by an extension of the practise of "buy-back" deals with Eastern bloc countries, with Western engineering firms cooperating in the construction of petrochemical complexes in Eastern bloc countries, and payment being made by (petrochemical) products, rather than cash. This results in the periodic placing on the spot market by brokers of additional batches of petrochemical products, with conjectural disruptive effects on the market. Such deals affect a wide range of petrochemical products. In addition, Eastern bloc countries increase their trade through orthodox channels, continuing during this period to be net exporters of base products, particularly ammonia, methanol and aromatics, and also fertilizers (mainly developing countries), and to be net importers of final products, industry quality plastics and textiles. Neverthelen, exported volumes remain marginal.

Later during the 1980s, as the petrochemical industry in the Eastern bloc countries becomes progressively stronger and more widely based, and as they seek greater acceptance as respectable trading partners, the "buy-back" deals tend to disappear, and East-West trade develops in volume across a wide range of products.

These more structural flows represent in volume a weak part of the consumption of importing zones (less than 1 %), except for fertilizers towards Africa and Europe, plastic commodities towards Europe, and polyisoprene (due to overcapacities developed for facing an occasional lack of imported natural rubber).

f) Developed countries(North America, Europe, Japan)

As a result of the situation of continuing overcapacity in the industry during the late 1970s and early 1980s, the developed countries tend to moderate their investment plans in such a way that, after taking account of the likely projects in developing countries, a return to reasonable equilibrium between supply and demand is reached by the mid-1980s, this equilibrium continuing through until the end of the decade.

From amongst the developed countries, there is a transfert of capacities, from Japan towards East Asia (Taiwan, Korea) reflecting the faster growth of demand in these countries. In the earlier years, new investment plans favour North America over Western Europe, as a result of lower feedstock costs in North America, environmental uncertainties in Europe, and the increasing drive on the part of European producers, in particular, to diversify their activities geographically. In the 1980s the American advantage in feedstocks disappears, thus partly reducing the difference, but this is offset in the mid-1980s by the greater competition experienced in Europe than in the U.S. from base chemicals coming from the Middle East.

In summary, after an extended period of surplus capacity on world markets, the situation stabilised around the mid-1980s with investment plans being moderated to allow demand to catch up with supply, and with developing countries, particularly in the Middle East and Latin America, increasing their share of world production.

5.3. Organisation of markets

The structure of the markets in petrochemicals products is affected by the trends in the organisation of production already referred to, i.e. :

- Increasing share of production of base products by the oil groups ;
- Increasing share of petrochemical production (particularly base products) by developing countries ;
- Tendency for traditional producers to move downstream and to specialise.
- Establishment of joint ventures concentrating on particular areas of the market.

As these structural changes come about, there is a decentralisation in marketing power, with intermediate products being exchanged between companies and/or countries to an increasing degree ; the incidence of a single company controlling the whole chain of production from petrochemical feedstock to final products decreases. A break occurs particularly after the primary transformation stage, with chemical companies increasingly buying in their ethylene, propylene, benzene, toluene and xylenes from the subsidiaries of the oil majors, from Arab countries, etc.. Thus the proportion of the market in base products, particularly, becomes less captive, more transparent, making entry easier for the newcomer.

This is not to say that there is an enormous increase in the transactions on the spot market. There is an increase in the volume of the spot market, but much of the new exchanges between

companies occurs through reasonably flexible supply/purchase agreements providing the parties with a degree of security as to supply or outlets as the case may be.

Just as there is a generalisation in agreements relating to the sale of base and intermediate agreements, so also feedstock supply agreements become widespread. Often the two are related on a quid pro quo basis. Thus, oil producing countries agree to supply surplus naphtha from their refineries to chemical groups in developed countries, and in exchange, the latter agree to purchase a given level of petrochemical products from the former.

The evolution described above is progressive, occurring gradually over the time span under consideration.

Thus, in 1982, while there is still over-capacity in the industry, and with both the oil groups and the new producers, particularly in the Arab world and North Africa, anxious to increase their market shares, even at the cost of their profits, there continues to be a downward pressure on prices. This is aggravated, particularly in Europe, by the arrival on the market of substantial quantities of cheap petrochemical products, particularly aromatics, synthetic rubbers, and commodity plastics. However during the mid-to late-1980s, the competition engendered by the excess worldwide capacity gradually gives way to a more harmonious situation, characterised by equilibrium between world supply and world demand for petrochemicals, confidence on the part of producers as to their ability to sell the products which they manufacture, and to buy the feedstocks and intermediate products which they need to carry on their activity. During this period, competition on prices reduces, and thus prices rise back to a level at which they meet operating costs and provide a return on capital commensurate with the expectations of the producers in the different zones.

As far as marketing is concerned, in developing countries marketing on the home market is carried out by the (usually state or joint-owned) producer. Where these countries are exporters, help is often forthcoming from the foreign partner, who either brings his own marketing experience and channels into play, or actually uses associated companies in other countries as outlets. While widespread regional cooperation is not a feature of this scenario, such cooperation continues successfully in Latin America (Andean Pact), providing complementarity in marketing effect and mutual access to domestic markets.

6. TECHNICO-ECONOMIC CONTEXT

While the petrochemical industry has been marked by fairly rapid technological change in the past, there is a widespread belief that the rate of change has now diminished and that the industry is reaching a period of relative maturity. Over the next twelve years or so there will undoubtedly be some changes in the processes, with new products emerging, some intermediate processes possibly being cut out, new by-products being valorised, and so on. It would however be extremely speculative to try to assess the consequences of such developments, and it is also reasonable to assume that any that do occur in the future will have only limited impact.

It is nevertheless possible to outline changes of a more evolutionary nature which will affect the industry up to 1990.

6.1. Mean size of units

The trend towards ever larger production units is assumed to be halted, and indeed even slightly reversed during the period. The massive increase in feedstock costs during 1973/4 reduced the share of capital costs in the total production costs, thus rendering economies of scale less important. Furthermore the climate of uncertainty and chronic overcapacity ruling during the late 1970s and early 1980s means that the risk associated with, for example, a very large steam cracker more than vitiates any gain due to scale. Similarly, producers in developing countries decide to play safe and go for somewhat smaller units, rather than to add to other problems by trying to introduce plant near to the limits of technology. Thus, for example, steam crackers with a capacity of 300,000 tons per annum become common.

6.2. Feedstock policy

New primary transformation plants reflect the changing pattern of local feedstock availability. Thus, in the United States, steam crackers capable of processing ethane only become a thing of the past, all new crackers having the flexibility to crack naphtha and gas-oil as well as ethane. Similarly the European industry becomes less totally reliant on naphtha, an increase in the flexibility to crack gas-oil, and to a lesser extent liquid gases such as ethane being produced from the North Sea, being realised. A similar trend is noted in Japan, with almost no native hydrocarbon resources.

In Arab countries and North Africa, flexibility is not a requirement, as these countries have full control of their feedstock supplies. In the early years methanol and ammonia production are based on the methane in their natural gas, and other base products on naphtha, from their refineries. As ethane recovery plants are established in the mid-1980s, the appropriate steam cracking capacity based on ethane so that little of the ethane needs to be exported. A similar situation applies in Latin America.

6.3. Energy

Apart from its feedstock requirements, the petrochemical industry is a considerable consumer of energy. The costs of this energy will rise in accordance with price rises already discussed. However, the chemical industry succeeds in using energy more efficiently, resulting from increased energy costs and Government exhortations and incentives to save energy. A reduction of 0.5 % p.a. in energy use per unit of production is achieved throughout the whole term of the study.

However the industry continues to use oil and gas as its main sources of primary energy. No large scale switching to coal occurs.

6.4. Stream factor

The stream factor is the proportion of time for which plant is available for production, as opposed to out of service for maintenance, because of breakdown, lack of spares, etc.. As stream factor drops, the cost of capital increases, as it must be amortised over a lower production.

As is to be expected, the stream factor is lower in developing than in industrialised countries, but the difference is not great, except as new capacity comes into service, when its commissioning time is substantially longer. Furthermore towards the end of the 1980s the gap narrows further. This is brought about by the existence of a free flow of technology, not only in the form of the ready granting of licences but also through the existence of training facilities for technicians in the developed countries. Most important of all, however, is the fact that since many of the new projects are run on a joint venture basis with an established petrochemical enterprise, experienced personnel are always available on site, and many of the key functions will be carried out by skilled and experienced technicians.

6.5. Cost of labour

The cost of skilled labour in developing countries will tend to be higher than in industrialised countries, reflecting the fact that many of the technicians will be expatriates on service contracts. Skilled nationals will command high wages similarly. Unskilled labour, on the other hand, will generally be cheaper than in developed countries, although this will not be the case in all countries, e.g. Saudi Arabia.

6.6. Environmental protection

Standards regarding the discharge of gaseous, liquid and solid pollutants into the atmosphere and the creation of other nuisances become more stringent in developed countries, particularly in Europe with its high demographic density. This affects both

the capital costs of chemical plant (installation of flue-gas scrubbers, noise shields, etc.) and also operating costs (use of more expensive desulphurised oils, incineration of toxic wastes, etc.).

In developing countries, on the other hand, less priority is attached to environmental protection, partly because less demands are made anyway on the assimilative capacity of the environment in these countries, and partly because the relative preference attaching to environmental improvement is lower. Thus costs associated with environmental measures will be lower in developing countries.

6.7. Transport

To assure exchanges of petrochemical products on an international level, the availability of adequate shipping capacity is necessary. In the past the shipping sector has been typified by a strongly cyclical nature, both in regard to available capacity and in relation to price. This tendency has been aggravated by crises such as the closing of the Suez Canal.

While this cyclical behaviour is likely to recur in the future, it is not realistic in a long-term study to try to represent these in the time dimension, as the behaviour is not sufficiently regular. Cyclicity is merely a result of the lack of perfect foresight of planners in the transport sector, and deficiencies and excesses of capacity tend to be self-rectifying.

It is assumed, therefore, that over the term of this study, transport capacity will be adequate to meet demand, and that the price of transport will remain constant in real terms for most products.

There is some slight reduction in the real cost of transporting gases by sea, due to improved technology, but the intercontinental shipping of ethylene by ethane tanker does not become an attractive proposition, due to the still high costs involved. Ethylene pipeline grids become more extensive in zones where ethylene is manufactured, but there is no pipeline link of the Middle East with Europe, due to strategic problems.

| |
|--------------------------------------|
| B - THE DEVELOPED COUNTRIES SCENARIO |
|--------------------------------------|

This is the second contrasted scenario chosen for further analysis, to which a relatively high probability was allocated by the experts. The principal features of this scenario in relation to the petrochemical industry in the year 1990 are as follows :

- | | | |
|----|--------------|--|
| H1 | realised | - Reasonable continuity of feedstock supply |
| H2 | not realised | - OPEC countries do not achieve 10 % of world capacity |
| H3 | realised | - Well ordered market |
| H4 | not realised | - Transfer of technology inhibited |
| H5 | not realised | - High degree of captivity of market persists |

In this scenario the traditional producers in developed countries largely succeed in regaining control of the petrochemical market, containing the challenge from the developing countries, and by 1990, ensuring a reasonable balance between supply and demand for petrochemicals. Prices recover to a level sufficient to cover costs and provide a satisfactory return on capital, partly due to the resumption of a reasonably high rate of growth in demand, and partly due to a successful policy of excluding newcomers.

As for the "Third World" scenario, developments up to 1982 are assumed to be as in the reference scenario, and the following describes events which have an impact after that date.

1. INTERNATIONAL POLITICAL CONTEXT

This scenario is very similar to the reference scenario as regards the international political situation. As far as the major powers are concerned, the period is one of continuing stability, with East and West reaching a satisfactory understanding as to their respective spheres of influence. Western Europe gains greater coherence and influence through the development of the E.E.C. and Japan, and China increasingly emerges onto the world scene as a major political and economic force.

While stability is evident at the level of the major powers and in the industrialized world generally, things are less settled in developing countries. Attempts at regional cooperation and political solidarity are undermined by factionalism, territorial disputes, and rivalries. The de facto American alliance with Saudi Arabia is reinforced, thus weakening the power of OPEC. In the face of this disarray of the Third World, no real attempt is made by the industrialized nations to change the international order in favour of the developing countries.

2. INTERNATIONAL ECONOMIC CONTEXT

In this scenario the industrialized world realises that the main factor inhibiting future economic growth is the problem of its energy supply. It therefore launches a large-scale attack on this problem, both on the supply, and on the demand side. This is discussed in the next section. Their efforts result in a considerable improvement in the energy prospects of developed countries.

This permits a higher rate of economic growth to be resumed and sustained until the end of the 1980s.

One of the consequences of the higher rate of growth in industrialized countries is that economic growth in developing countries is stimulated as compared with the period up to 1982. Large corporations, encouraged by the new confidence, begin to look overseas for profitable investments, and investment in developing countries increases, largely as a result of the activities of multinationals. In addition, higher growth in industrialised countries means more demand for imports from the developing countries, particularly of primary materials.

As in the case of the reference scenario, Eastern bloc countries develop along more consumerist lines, and become increasingly integrated into the international trade scene.

The dollar remains the foundation-stone of the international monetary system. As the U.S. succeeds in reducing its bill for energy imports and thus restoring its balance-of-payments to health, the dollar appreciates with respect to other international currencies, eventually stabilising out at a higher level. Apart from this, international exchange rates are assumed to move only in accordance with differentials in internal rates of inflation.

Compared with the reference scenario, there is no real improvement in the terms of trade of raw materials exporting countries, because of a lack of cohesion at the level of producers' associations ; nevertheless, commodities and minerals continue to become slowly more expensive, for the benefit of occidental firms.

Many developing countries, in particular those without hydrocarbon reserves, see their balance-of-payments on current account deteriorating further during the 1980s as energy becomes inexorably more expensive. They attempt to offset these deficits by encouraging

foreign investment in their countries.

The 1980s sees a period of moderate liberalism in international trade; the resumption of high growth in developed countries creating an atmosphere of greater confidence, liberalism increases at the end of the decade.

The rates of economic growth are as in the reference scenario up to 1982, and then as set out in Table 2 below. Overall growth rates are based on a scenario elaborated by Leontieff and presented in "The future of the world economy" by Leontieff, Carter and Petri.

Table 3 - Macro-economic assumptions in "developed countries scenario"
1982 - 1990

| | <u>Growth of</u> <u>GNP</u> | <u>Growth of</u> <u>population</u> | <u>Growth of</u> <u>Agriculture</u> | <u>Growth of</u> <u>manufacturing</u> <u>industry</u> |
|---------------------------------|--------------------------------|---------------------------------------|--|---|
| | % p.a. | % p.a. | % p.a. | % p.a. |
| North America | 3.6 | 0.9 | 2.0 | 3.7 |
| Western Europe | 4.6 | 0.5 | 1.7 | 5.0 |
| Communist Countr. | 4.9 | 2.0 | 2.5 | 5.4 |
| Developing America | 4.9 | 2.7 | 3.0 | 5.9 |
| Middle East and North Africa | 6.9 | 2.7 | 3.5 | 7.9 |
| Other Africa | 4.5 | 2.6 | 2.4 | 6.4 |
| Asia | 5.8 | 2.2 | 2.6 | 7.8 |

As far as the other assumptions are concerned, population growth is as in the reference scenario. The agricultural sector also grows at an moderate rate compared with the others scenarios as in the reference scenario, the higher rate of growth overall being reflected in other sector, particularly industrial manufacturing.

No major change in the distribution of final expenditure between the different categories is envisaged, except in the case of the communist countries, where investment slows down somewhat to give more scope for domestic consumption. The latter is therefore assumed to grow at the same rate as GNP in all zones except that of the communist countries, who enjoy a somewhat higher rate of growth of consumption.

Growth in developing countries in this scenario tends to be stimulated by the increases in investments from developed countries, in various sectors of their economics including commodities. Much of the economic effort in developing countries with mineral resources is therefore devoted to expanding their mining, smelting and refining industries, establishing industries of primary transformation of agricultural commodities, and establishment of necessary services, such as electricity generation, water purification or desalination, etc...

In other areas, industrial policy is not very innovatory, but concentrates particularly on developing the sectors already established. Thus, apart from agriculture, with its demand for fertilizers, the only major sector which is a direct consumer of petrochemical final products which enjoys a high rate of growth in the poorer developing regions, Asia and Africa, is the textiles industry. By contrast in Latin America, and in the Middle East and North Africa, there is also a reasonable growth of the rubber processing and plastics processing industries.

As higher growth is resumed in developed countries during the 1980s, there is a tendency for the substantial pools of unemployed to drop to more reasonable levels. Unemployment in developing countries continues to be high. There is no appreciable drop in the standard working week, and the cost of labour increases in parallel with per capita GNP. Incomes within countries increase at a more or less uniform rate, so that there is little change in the distribution of income.

Finally, progress in environmental protection is as in the reference scenario.

3. ENERGY CONTEXT

3.1. General

While in the preceding scenario, a more active policy of energy management comes about as a response to resolute action on the part of OPEC, in this scenario it is the large energy-consuming countries who take the initiative. This initiation follows from the realisation that unless the energy situation is taken in hand, they will become increasingly vulnerable to events outside their control, and that their increasing energy import bills could so upset their balance-of-payments equilibrium as to threaten international monetary stability.

Their strategy in relation to energy comprises three elements, namely :

- a) Accelerate and encourage new prospection and exploration with a view to increasing known hydrocarbon reserves as fast as possible, and diversify the geographical sources of these materials.
- b) Hasten the introduction of energy types alternative to oil and gas, in particular more abundant and strategically secure types such as coal and nuclear energy.
- c) Bring about a more economical usage of energy by industry and private consumers without jeopardising prospects for continued economic growth.

In relation to a) above, exploration is intensified not only in promising zones already found to be oil-bearing - Alaska, the North Sea, Mexico, but also in zones relatively unprospected to date - Africa, both onshore and off-shore, Asia, and so on.

A special effort is made to hasten the granting of concessions and authorisations of production, and to overcome environmental objections. In particular, the potential of Alaska is developed more extensively, and ecological problems are mastered, and permits are given for extensive exploration in off-shore regions of the U.S. coast. Techniques are developed for extracting and bringing ashore economically natural gas occurring in deep-sea locations, in the Norwegian sector of the North Sea.

At the same time, extensive research is carried out into improving the proportion of oil recovered from oil wells. More advanced techniques of secondary and tertiary extraction are developed.

Governments in developed countries see that a stimulus can be given to these developments by allowing the prices of the "problem" hydrocarbons, oil and gas, to rise, and this occurs during the 1980s.

In relation to the second point above, a crash programme is introduced, particularly in the United States, but also in Western Europe and Japan, aiming at (re)-introducing alternative energy types into the economy as quickly as is feasible. Which much effort is concentrated on the more exotic types of energy, wind, solar, geothermal, fusion, which have no impact before 1990, a great effort is also devoted to the re-introduction of coal as a source of industrial heat, and of nuclear energy as a base for electricity generation. It is assumed that by

1990 coal enjoys an extensive use in industry outside its traditional usage in the iron and steel and electricity generation industries. This is particularly so in the process industries. The price of coal is kept well below those of oil and gas in order to provide an incentive for switchover.

Similarly, developed countries accelerate their introduction of nuclear energy in the short term, overcoming their reservations about this form of energy.

Finally, steps are taken towards securing extensive economies in consumption. Energy price rises occurring in the 1980s play a role in this, but more direct measures are also introduced, including the setting of standards for automobile fuel consumption (especially in the U.S.), the setting of more stringent standards for the insulation of private houses, improvement in service levels of public transport systems, surveillance of energy practices in industry, etc...

The net effect of the above measures is to greatly reduce the energy dependence of the industrialised countries on OPEC countries in 1990.

3.2. Oil situation

In spite of the measures outlined above, few of the developed countries become self sufficient in energy, and the major part of the imported energy consists of oil. However a decreasing share of this oil comes from OPEC countries, with a progressively larger part coming from areas with new discoveries such as Central America, Africa and Asia.

OPEC is divided, with Saudi Arabia unwilling to agree to any action disagreeable to the Americans, so that the former cases to function as a militant cartel. Nevertheless, with the tacit encouragement of the governments of industrialised countries, oil prices do rise steadily from 1982 to 1990, reaching a premium of 50 % in real terms over 1982 prices.

Such a price increase is accepted by the governments of developed countries as being a necessary regulator of consumption.

It will be remembered that U.S. oil prices have already converged with OPEC prices (in 1980). After 1982 the U.S. price continues to be tied to the OPEC price, also for reasons of regulating consumption. Similarly, the prices of other non-OPEC oil follow those of OPEC.

The oil supply position in the U.S. is much more healthy than in the reference scenario, both because of higher supply and lower demand. The switch away from oil, particularly into coal and nuclear energy, together with the serious attempt to bring about economies in energy usage wherever possible, significantly reduces the demand for oil below that envisaged in the reference scenario. At the same time, supply is increased, with all the constraints to full exploitation of the Alaskan fields being overcome, extractive techniques being improved and significant oil being brought ashore from newly-established off-shore wells. During the late 1980s, the U.S. reaches a level of production 50 % higher than at present.

In Europe also, the oil situation looks brighter than in the reference scenario, with significant new discoveries of oil being made in the North Sea boosting production levels during the latter part of the 1980s well above those presently anticipated.

Finally, the extensive new exploration activities undertaken from the early 1980s on begin to pay dividends during the second half of the decade, as, apart from countries such as Mexico, Venezuela, Brasil and Egypt, significant production emerges in Africa and Asia.

While Japan continues to be highly dependent on imported oil, she has no problem in obtaining the crude she needs for her industry during this period, with the greater worldwide availability and reduced demands made on it by the developed nations.

In conclusion, in spite of the fairly high growth of the developed countries, no shortage of oil develops during this period, due to determined efforts made both on the supply and the demand sides. Crude is traded freely on world markets, with a single world price (apart from transport cost differences) applying. Prices increase after 1982, rather as a result of price management than because of the play between supply and demand.

3.3. Natural gas situation

The general world picture is similar to that in the reference scenario, with production in developed countries, i.e. the USA and Europe tending to stagnate, but with major new producers appearing in the Middle East in particular, but also in Latin America.

In North America, by virtue of the more attractive profitability of natural gas production, and the increased efforts to prospect and to ensure early production in respect of new discoveries, production is pegged at its present level, approximately.

In Europe there is also a limited increase in production up to 1985, but running down thereafter.

Algeria continues to develop her natural gas industry, and Saudi Arabia also establishes, with the help of the multi-nationals, an important natural gas liquefaction industry. As in the case of the reference scenario, the price of gas in these more remote gas-exporting countries is limited by the costs of transporting this product to its markets.

Mexico becomes a major producer of natural gas, with substantial exports passing by pipeline to North America.*

As in the reference case, prices of natural gas are assumed to have converged in most countries in the world with those of oil by 1982, and thereafter the two remain in step, the exception to this being afforded by those countries in the Middle East, Indonesia, etc... where it must be liquefied and shipped expensively to its markets.

3.4. Petrochemical feedstocks

In spite of the increased emphasis on developing and introducing new energy types into the economy, as far as petrochemical feedstocks are concerned, the traditional materials retain their complete ascendancy during this period. The price of oil relative to coal does not become sufficiently great to stimulate significant switching to coal. Similarly, as in the reference scenario, the direct cracking of crude does not become a widespread practice during the study period.

Again, developments as regards supply and availability of feedstocks are largely conditioned by what is occurring upstream, i.e. in the oil and natural gas sectors.

Thus in the United States, feedstock prices behave very much as in the reference scenario, but with the following modifications :

- The rise in naphtha prices is somewhat less steep, reflecting the low rate of growth in the automobile sector and, in particular, the greatly increased economy of automobiles that is brought about during the 1980s in the U.S.
- Because of the higher production of natural gas as compared with the reference scenario, the prices of natural gas liquids do not rise quite to the same extent as in the latter.

In Europe, developments are again similar to those in the reference scenario, with the exception that there is a larger throughput of crude through European refineries, and at the same time, the automobile sector grows more slowly, with increased emphasis on public transport. This means that the shortage of naphtha in Europe does not develop as rapidly as in the reference scenario, but Europe continues to be in deficit with regard to naphtha. Furthermore, in view of the success of the North Sea exploitation, the quantity of natural gas liquids being recovered increases.

In most developing countries, the demand for petrochemical feedstocks is limited, and in general the prices of feedstocks in those countries producing them are limited by the prices ruling in the countries which constitutes their markets, less transport costs.

4 - PROSPECTS FOR SOME SECTORS DIRECTLY AFFECTING DEMAND FOR FINAL PRODUCTS

4.1. Agriculture

The situation in the agricultural sector is very similar to that in the reference scenario, with developed countries returning only very slow growth rates, in accordance with the maturity of their agricultural industries, and progress in the developing countries being impeded by the socio-economic systems in those countries, in particular, problems of finance, and of diffusion of knowledge and information.

4.2. Automobiles

The number of cars in the U.S. continues to grow very slowly, as in the reference case, but unlike the latter, the awareness of the need to seriously tackle the problem of the petrol consumption of automobiles downs much earlier ; taxes on petrol are increased considerably with the result that by 1990 American cars are made more similar to their European and Japanese counterparts, i.e. considerably lighter than at present, and with much improved fuel consumption. Plastics are by then finding an important usage in place of metals, and types are correspondingly lighter.

In Europe and Japan, the growth in the population of automobiles while still faster than in the U.S., is slower than in the reference scenario, with the authorities taxing private which usage more heavily, and at the same time making public transport systems more attractive.

In developing countries, while ownership grows moderately with rises in income levels.

As in the reference scenario, radial tyres continue to supplant cross-ply tyres.

4.3. Textiles

Although household consumption grows more rapidly in this scenario than in the reference scenario, growth in consumption of textiles is only somewhat higher, reflecting the relatively low income-elasticity of consumption in the northern countries. This growth is, however, particularly concentrated in the area of non-cellulosic fibres.

In developing countries, there is a larger growth in demand in Asia as compared with the reference scenario, due in particular to the development of export-oriented activities. Natural fibers reinforce their position, because of their lower cost.

4.4. Building

Similar remarks apply here as in the reference scenario, appropriately higher growth rates applying here because of the overall higher rates of economic growth. However plastics achieve a somewhat better rate of penetration into the building sector, replacing wood increasingly in a number of applications.

4.5. Packaging

The boom in packaging continues in this scenario, reinforced by the relatively high rates of economic growth in developed countries. The environmental lobby does not make much progress in bringing about a change in manufacturers' practices and consumers' preferences in relation to packaging, recycling, etc.

Demand for plastics for packaging in developing countries increases rapidly with increases in income.

5. PETROCHEMICAL INDUSTRY

5.1. Organisation of production

As in the reference scenario, we have a situation in 1982 where, in spite of a resumption in economic growth generally, and in the demand for petrochemical products in particular, the petrochemical industry has not completely recovered from the chronic overcapacity with which it has been plagued for a number of years. Developing countries are just beginning to make their challenge, with new capacity, particularly in base product manufacture, beginning to come on-time.

In this scenario, however, instead of accommodating the petrochemical ambitions of the developing countries with oil resources, the established petrochemical industry goes for a more confrontationalist position. On an organisational level, established chemical companies refrain from entering into joint ventures with

developing countries in the field of petrochemicals. This means that developing countries wishing to establish petrochemical units are obliged to do so without active outside cooperation.

Meanwhile the (petro)chemical industry in the industrialised countries sets about reorganising itself so that it is more robust, and more able to meet the vicissitudes of international competition. Smaller units either disappear or are absorbed by the larger companies and the multinationals. Agreements with the larger oil companies proliferate as chemical companies realise the greater financial security which such arrangements can confer on them.

The reluctance of established chemical companies to enter into joint ventures with developing countries extends itself to a will to exclude any land of technical or other cooperation. Technical assistance contracts become more rare, and companies try to retain higher control of their knowhow and expertise. Chemical companies in industrialised countries are beginning to use their technological advantage as a weapon in the competitive situation which is developing. Furthermore OPEC (or other similar groupings) lacking of political cohesiveness, do not react effectively against this restrictive behaviour on the part of established chemical firms.

5.2. Localisation of production

Up to about 1982, those developing countries with suitable hydrocarbon resources look towards the petrochemical industry as being an appropriate pole on which to focus a part of their drive towards industrialisation. Instead of associating themselves with these new plans and moderating their projects in the industrialised coun-

tries accordingly, as in the reference scenario, however, the already established chemical companies tighten their ranks, refrain from cooperation in the new ventures, impede the free flow of technological knowhow as far as they can, and themselves launch into an aggressive policy of new investment in the traditional sites.

Projects in developing countries experience delays in getting under way and there are problems in the operation of the new plant. Moreover, since the competitive situation which develops leads to heavy investment, the situation of world surplus petrochemical capacity continues through into the mid 1980s. Those developing countries who were basing their petrochemical plans on hopes of exports, particularly to the developed countries, find the situation particularly difficult, with stiff competition being encountered in their prospective markets. Profitability proves to be disappointing as a result of downwards pressure on prices. The result is that in many cases the newer producers become disillusioned with the petrochemical industry, and moderate their plans downwards. These factors have an important bearing on the localisation of productive capacity during the 1980s, and on the geographical distribution of production which is established in 1990. At the level of the zones, the situation at this latter date is as follows :

a) Middle East/South Mediterranean

- Capacity in nitrogenous fertilizer manufacture is as in the reference scenario. As this can be regarded as a "natural" industry for many countries in this zone, providing an outlet for their investment funds utilising natural gas which would otherwise remain unused, and exporting to Third World countries rather than the markets of industrialised countries. Since this

type of investment is considered relatively unthreatening by the established petrochemical industry, it is also the least resisted or impeded.

- Other activities are reduced as compared with the reference scenario. This is particularly true of olefine and aromatic manufacture where investment is very significantly reduced during the second half of the 1980s, as a result of the problems referred to earlier. Thus the picture in 1990 is one of a much more partial petrochemical industry than in the reference scenario.

b) Developing America

In spite of expanding markets and favorable prospects, the growth of the petrochemical industry slows down, particularly in the second half of the 1980s. Financing problems present themselves, and poor performance of the already existing establishments provides a further disincentive to invest. Investment policy is thus more orientated towards consolidating and complementing existing petrochemical lines, rather than going for a comprehensive and reasonably self-sufficient petrochemical industry, as in the reference scenario.

c) Asia

Excluding Japan for the moment, which is in a quite different position from other countries in this zone, the synthetic fibres manufacturing industry provides a natural direction of industrialisation for these countries, in view of its lower capital and higher labour requirements, and the substantial market provided by the textile industries established there. There is also some

investment in nitrogenous fertilizer capacity in this zone, although not as much as in the reference scenario, the high financing costs and technological difficulties providing some discouragement.

Investment in other areas is really very limited, state concerns or local entrepreneurs finding it difficult to acquire a foreign partner with the necessary knowhow, and unwilling to accept the risks above.

d) Africa (excluding North Africa)

As in the reference scenario, there is very little petrochemical development in Africa up to 1990. Markets remain limited, problems of finance remain difficult to overcome, and difficulties associated with access to current technology and the availability of the requisite skilled manpower constitute further important obstacles. Finally, political differences prevent the development of effective economic cooperation between countries which would to overcome some of these difficulties.

e) Communist countries

Developments here are similar to those in the reference scenario, with communist countries during the early and mid-1980s being net exporters of base products, particularly fertilizers and aromatics and net importers of final products, particularly plastics, and becoming, in the course of the 1980s, increasingly integrated into the flows of world petrochemical trade. But these flows are quite small, compared to the volumes of the demands in importing zones.

f) Developed countries (North America, Europe, Japan)

In contrast with the reference scenario, investment continues unabated during the early and mid-1980s in the developed countries, but by virtue of the rather high rate of economic growth in these countries throughout the 1980s, and generally good performance of demand for petrochemicals, in particular plastics, and the scaling-down of projects in developing countries, total capacity is nearing equilibrium with demand by 1990.

As far as the distribution of the additional developed countries capacity between North America, Europe and Japan during the period 1982-1990 is concerned the efforts made in Europe, and particularly the United States, to achieve greater energy self-sufficiency, make them increasingly attractive for the petrochemical industry ; on the other hand the Japanese firms make a greater effort to achieve true multinational status and to diversify geographically.

As in the case of the reference scenario, there is little relative advantage as between the U.S. and Europe after 1980, with the convergence of energy prices, with the decline of the importance of ethane as a primary feedstock in North America, and with naphtha shortages occurring both in the U.S. and in Europe.

In summary, surplus capacity continues into the mid-1980s, until the cutting back of plans in developing countries, and a well sustained increase in demand, restores a reasonable equilibrium between supply and demand by 1990.

5.3. Organisation of markets

As a response to what they see as a threat from new petrochemical products in developing countries, there is a realignment of the established petrochemical firms during the mid-1980s, with a tendency to form larger, more powerful groupings covering the whole chain of transformation. The result of this is that the market displays a high degree of captivity in respect of base and intermediate products, the greater part of such products not reaching the market at all, but simply being transferred to the next downstream process or between associated companies. This has the result of making entry into the market even more difficult for a new entrant.

This strategy proves to be successful from their point-of-view, in that they do manage to effectively exclude newer producers, so that by 1990 they have succeeded in regaining control of world markets, and operating on quasi-cartel lines. Before this situation is reached however, during the mid-1980s, while there is still considerable overcapacity, there is a period when prices are forced well below economic levels, the situation being exacerbated by the intermittent arrival on Western markets of substantial quantities of petrochemical products from Eastern bloc countries, as a result of "buy-back" deals earlier discussed. In this price-war, however, the strengthened firms in industrialised countries find they are better able to withstand the various pressures placed on them than the newer producers in developing countries. The price-war therefore hastens the arrival of the situation in which the large nationals and multinationals gain control of petrochemical markets. With the reduction in competition, and the continuing growth in demand particularly in developed countries, prices climb back up to a level at which they provide a comfortable margin over total costs.

The large chemical companies are able to use their international marketing and distribution networks in order to promote their worldwide sales. Smaller companies and those in developing countries are able to market within their own national boundaries, but the climate of international relations is not such as to allow producers in developing countries to have ready access to regional markets outside their own frontiers.

6. TECHNICO-ECONOMIC CONTEXT

No radical changes occur in the technological field during the period under review. Nevertheless, advanced technology is regarded as a key weapon by the large chemical companies in industrialised countries in maintaining their control over the industry. Thus, for example, progress is made in improving the specifications of quality products, in valorising some of the heavier fractions from steam cracking and catalytic reforming, improving energy consumption efficiencies, and so on, with the result that certain cost savings are achieved.

Some specific aspects are considered below :

6.1. Mean size of units

As engineering technology improves, the construction of even larger units than at present becomes possible. In industrialised countries, such a continuing evolution in size does in fact occur, its importance being as much as anything a symbolic gesture, designed to demonstrate technical superiority. Petrochemical units established in developing countries tend to be smaller.

6.2. Feedstock policy

Developments here are as in the reference scenario, with greater flexibility in respect of feedstock being necessary in developed countries as the continued availability of the traditional feedstocks is increasingly called into question. In developing countries with their own hydrocarbon resources such flexibility proves to be less necessary.

6.3. Energy

Price rises in oil and gas from 1982 on affect the cost of energy. However increased energy-consciousness particularly in developed countries, succeeds in increasing the mean efficiency of energy utilisation by 1.0 % p.a. over the period 1982-1990. In developing countries, by contrast, problems of energy-saving occupy a much lower position in the list of priorities, and in any case there are difficulties in keeping abreast of the latest techniques, so that no change in energy efficiencies is experienced. However, a further factor operates in favour of the developed countries, in Europe and North America, and this is the increased usage found by coal as a source of energy to the chemical industry. In spite of the higher cost of solid-fuel furnaces and boilers, or alternatively the conversion of coal to a more easily usable form, coal usage nevertheless becomes more economical and perfectly practicable for the industry. On the other hand, in developing countries there is a reluctance to cede energy at below market costs, in view of the opportunity cost of such a practice.

6.4. Stream factor

Because of the technological problems faced by new producers in developing countries, and the reluctance on the part of experienced producers to help them overcome these problems, stream factors are substantially lower in developing than in industrialised countries. The poorest performance occurs in those zones such as Africa and Asia (except Japan) with the least experience in operating petrochemical plants.

6.5. Cost of labour

The same remarks apply as for the reference scenario.

6.6. Environmental protection

In developed countries, the resumption of a relatively sustained growth in industrial sectors induces higher standards in pollution controls.

The same situation occurs in some developing countries, where industry is located near by housing areas.

6.7. Transport

No main differences with the reference scenario. Crisis in shipbuilding vanishes with the development of world trade, and capacity is assumed to meet demand.

| |
|------------------------------|
| C - THE THIRD WORLD SCENARIO |
|------------------------------|

This is a contrasted scenario, to which the experts also allocated a relatively high probability.

The principal features of this scenario in relation to the petrochemical industry in the year 1990 are as follows :

- | | | |
|----|--------------|--|
| H1 | realised | - Reasonable continuity of feedstock supply |
| H2 | realised | - OPEC countries achieve over 10 % of total world capacity |
| H3 | not realised | - Market not well ordered |
| H4 | realised | - Unhindered transfer of technology |
| H5 | realised | - Decreasing degree of captivity in market. |

In this scenario, OPEC countries seize a significant proportion of total petrochemical activity in the world, and because of this and other structural changes in the world trade picture, the petrochemicals market is in a state of disequilibrium and readjustment.

At a wider level, the world is finally trying to tackle positively the problem of the unequal distribution of wealth between rich and poor nations, the former agreeing to accept a lower growth in their standard of living in order that the gap can be lessened.

The development up to the first milepost year, 1982, is assumed to proceed broadly as in the reference scenario. What follows therefore elaborates developments from that date until 1990, or those which occur earlier, but do not have an impact until the later period (for example, the taking of decisions to invest).

1. INTERNATIONAL POLITICAL CONTEXT

The assumption in this scenario is that a significant restructuring of the international economic order is brought about by the year 1990. In order that such a restructuring should occur, it is necessary that some catalytic event(s) should occur to push development in that direction.

There are obviously many combinations of such events which could be instrumental in this way. One plausible such set is as follows :

1. The North-South dialogue is resumed but little concrete progress is made towards reshaping the prevailly international economic order. Third World countries break off the talks.
2. The failure of the talks produces strong reactions of disappointment from all quarters, together with dire forecasts of what will happen if the world fails to come to terms with international economic inequality.
3. OPEC countries announce a selective increase in oil prices aimed at doubling prices gradually over the period 1982-1990 (i.e. a price increase per annum of 9 % in real terms). Concessions will be made for poorer countries, either through a too-tier (or multiple-tier) price system, or by making low-interest loans available

in respect of oil purchases by such countries, which have an equivalent effect. Such a policy is justified as a way of penalising those countries who consume a disproportionately high share of the world's limited energy patrimony.

4. OPEC sets up a part of the extra revenue so collected as a fund for investment projects in poorer countries designed to stimulate economic development.
5. The richer countries, while not actually welcoming the oil-price increases, see them as one of the most likely ways of bringing home to all consumers the urgency of economies in energy consumption, and of stimulating the search for substitute fuels without the politically unacceptable step of imposing heavy taxes.
6. The OPEC action serves as an example to other developing countries, giving rise to other producers' organisations, covering, for example, copper and other minerals, tropical products, etc.
7. The above events coincide with a current of feeling in developed countries away from consumerism. Energy problems create a feeling that economic growth cannot continue indefinitely in the richer countries. The adverse movement of terms of trade is accepted with good grace, and furthermore a fund is established to aid those developing countries not benefitting from the increased raw material prices.

As already mentioned, the above set of events is one set which might serve as a backcloth to the present scenario. There are others, but this is of no consequence. The important point is that they lead to an acceleration of the rate of growth in the developing countries, a retardation in developed countries, a doubling of world oil prices by 1990.

On balance, East-West tension continues to relax, although neither side can resist the temptation to make political capital out of the new developments. The emergence of China as a major world power is confirmed, and the influence of Japan in world affairs increases. At the same time, the European Community discovers a reasonable economic coherence, although it abandons its objectives of political unity.

2. INTERNATIONAL ECONOMIC CONTEXT

Economic developments are dominated by the upheavals referred to above, that is, significant changes in the terms of trade favouring raw materials producers, and greater availability of funds for investment and other aid to developing countries.

As a result, developing countries succeed in achieving higher rates of investment than previously, and thus higher rates of economic growth. This new investment is concentrated in three main areas, i.e. agriculture, infrastructure, and manufacturing industry. In relation to agriculture, many countries embark on large-scale projects to improve the efficiency of land use. This includes land reform, and the introduction/extension of irrigation projects, higher use of fertilizers and agricultural chemical. Ssystems of agricultural credit are established allowing farmers the possibility of mechanising, using fertilizers, etc..

Expenditure on infrastructure is carried out with a view to eliminating some of the infrastructural bottlenecks in the way of a successful industrial development, thus improvment of communications, roads, waterways, utilities such as electricity and water, and the improvment of port facilities.

Finally, investment in manufacturing industry would be carried out in the areas most suitable for particular countries, in view of its requirements and resources.

There is a proliferation of regional agreements between developing countries covering economic and technical matters. These include free trade and common external tariffs, the adoption of joint industrialisation plans with rational division of activity, the exchange of technical and commercial information, and so on. Emphasis is placed on reducing dependence on industrialised countries, and the development of techniques methods and consumption patterns adapted to the local situation. Fledgling industries are protected by suitable systems of tariffs or quotas.

In industrialised countries, the new economic trends give rise to certain internal pressures. The increased costs associated with imported oil and raw materials lead, as the 1980s progress, to some reduction in the volume of these imports, and increased exports, particularly of capital goods to developing countries, to finance the higher prices. Both of these tendencies give rise to the need to reduce domestic consumption and for investment in these countries (or at least to reduce the rate of growth of these quantities).

The change in emphasis in developed economies, in particular involving a tendency to stagnation in the services and consumer-orientated sectors creates problems in some industries, and this is exacerbated, in the second half of the 1980s, by the competition of the new industries in developing countries, or at least the closing of certain export markets. There are calls to the governments of industrialised countries for protectionism, but governments recognise that this would have adverse, rather than positive effects, and protectionism does not increase significantly in these countries.

The United States (and the USSR) are less adversely affected by the new developments in raw material prices than Europe and Japan, because of their wealth of minerals and other raw materials.

In so far as the Eastern bloc countries are concerned, developments are very similar to those of the reference scenario, with these countries becoming increasingly integrated into normal patterns of world trading during the course of the 1980s.

The rates of growth are assumed to be as in Table 3 below over the period 1982-1990. These figures are based on a scenario constructed by UNIDO.

Table 4 - Macro-economic assumptions in "Thirdworld" scenario : 1982-1990

| <u>Zones</u> | <u>Growth of GNP</u> | <u>Growth of population</u> | <u>Growth of Agriculture</u> | <u>Growth of manufacturing industry</u> |
|---------------------------------|--------------------------|---------------------------------|----------------------------------|---|
| | % p.a. | % p.a. | % p.a. | % p.a. |
| North America | 2.5 | 0.9 | 1.7 | 2.7 |
| Western Europe | 2.7 | 0.5 | 1.5 | 3.4 |
| Communist countries | 4.1 | 2.0 | 3.0 | 4.6 |
| Developing America | 6.2 | 2.7 | 3.5 | 6.8 |
| Middle East and North Africa | 7.9 | 2.7 | 3.7 | 8.9 |
| Other Africa | 6.1 | 2.6 | 2.8 | 7.3 |
| Asia | 4.9 | 2.3 | 3.0 | 5.2 |

As far as the other assumptions in Table 3 are concerned, population growth is as in the reference scenario.

Agricultural growth in the developed countries is as in the 1976-1982 period. In the developing countries it is increased by a margin of 0,5 % as a result of the measures in the agricultural sector referred to above. In developed countries, most of the cutback as compared with the reference scenario occurs in the services and construction sectors, manufacturing activity being sustained to a greater extent, particularly in the heavy industrial sectors, which become more export-orientated, in view of developments already described.

In developing countries a level growth rate is assumed to occur in the non-agricultural sectors, and the growth rates for manufacturing industry are calculated accordingly.

In industrialized countries distribution of final expenditure between the different categories is assumed to remain similar, and household consumption is therefore assumed to grow at the same rate as G.N.P., but in developing countries the proportion attributable to household consumption drops, so as to finance the higher rate of growth.

The growth of manufacturing industry in developing countries includes in particular, in the earlier years, the various client industries of petrochemical, and later, as local markets for petrochemicals reach the threshold size required to justify petrochemical installations, the latter develop. The widespread occurrence of regional cooperation providing effectively for the pooling of markets, ensures that these threshold sizes are reached earlier rather than later.

In concrete terms, textile industries continue to develop, or are established in many countries in developing Asia, Africa, the Middle East and developing America, where low labour costs and a rapidly growing market for textiles are favorable to the establishment of

such industries. The new emphasis on the achievement of regional self-sufficiency where possible leads to the establishment of rubber processing industries catering for local demands, in particular, fabricating the tyres for imported or locally assembled vehicles. By 1990 rubber processing industries have been introduced into developing Asia, the Middle East and North Africa, and developing America, but not black Africa, where markets are not yet sufficiently large. Finally, the fair rate of industrialisation and evolving patterns of consumption in developing countries make feasible the introduction of plastic processing industries in developing countries, although in Africa, such possibilities remain limited.

3. ENERGY CONTEXT

3.1. General

The key event in this scenario from the energy point of view is the OPEC initiative in declaring their intention of raising the price of oil to industrialised countries by 100 % over the period 1982-2000.

The announcement higgers off a whole wave of activity at government, corporate and household level looking at possible economies in energy use, and also on the part of government and the oil companies, exploration activity is increased, and research activity is intensified in the field of alternation energy sources, including techniques such as coal gasification. The prospect of much higher oil prices, which would make the extraction of hydrocarbons from bituminous shale and tar sands, stimulates research into extractive techniques in respect of the latter, although these have little effect, in production terms, before 1990.

The nuclear generator building program gains impetus from the OPEC decision, research into the hazards associated with nuclear generators being intensified, and many developed countries swallowing their doubts about the nuclear industry. The reintroduction of coal as a base fuel in industrialised economies is intensified. Almost no further oil-fired electricity generators are constructed in Western industrialised countries, new capacity being based on coal or nuclear energy (or hydro-energy where available). In the earlier years coal is used in conventional boilers, giving way towards the late 1980s to fluidised bed applications. The use of coal extends not only to electricity generation, but also into the process industries. This is particularly so after techniques for gasifying coal have been developed on a commercial scale.

As energy price increases begin to make themselves felt the energy saving campaign gains momentum. In the United States, motoring becomes an expensive activity, and the "gas-guzzlers" begin to disappear, giving way to more economical European-style cars.

New electricity generation techniques with greatly increased thermal efficiencies begin to appear, with waste heat being used for "city heating". Industry begins to take greater care in its use of energy, switching, when possible, to less energy-intensive techniques.

By virtue of these developments, industrialised countries succeed in securing significantly greater economies than in the reference scenario, but they nevertheless are incurring, by 1990, greatly increased costs for their oil required.

3.2. Oil situation

Demand for oil in the world does not run into any quantity limitations during the study period. Instead, consumers in developed countries are squeezed through cost. The doubling in the real price of oil in developed countries means that pressure to reduce consumption comes from the consumers rather than from the supply side.

OPEC countries gain increasing control of operations within their national boundaries, and increase their downstream activities, in particular refining. The status of the oil majors in OPEC countries is progressively reduced, their activities consisting mainly of transport, distribution and marketing, although they are also involved in exploration activities in OPEC and other countries.

Although American oil prices converge with OPEC prices in 1980 (see reference scenario), there is a considerable debate in the United States about whether American prices should continue to follow OPEC prices after 1982 as the latter begin to rise rapidly. However the interests of limiting consumption of oil and stimulating new research and exploration prevail, and American oil prices advance together with those of OPEC. While the prospects for North American oil production during the study period are only slightly better than in the reference scenario. The U.S. succeeds in reducing its dependence on imported oil by virtue of the economies it achieves, and the accelerated introduction of coal and nuclear energy.

In Europe, prices of North Sea produced oil follow those of OPEC. This has a significant effect on production of oil in the North Sea, as it makes certain oilbeds economic to exploit which would not otherwise have been so. Europe also succeeds in cutting her energy consumption relative to the reference scenario, although not as much as the United States.

It is Japan which is the worst hit of the developed countries by the increases in oil prices, with her high dependence on oil as primary fuel in the economy, and lack of indigenous resources.

In oil-exporting countries, while the price of oil exported to industrialised countries is rising, it remains stationary in respect of exports to developing countries. Similarly, the price premium does not apply to oil for the home market. New oil-exporting countries such as Mexico apply the same policy as OPEC members.

3.3. Gas situation

The natural gas situation in developed countries is similar to that in the reference scenario, both in regard to price and availability. Natural gas prices stay in step with oil prices. However, even with the much higher gas prices applying in the second half of the 1980s, only very limited new domestic resources become available as compared with the reference scenario. On the other hand, the high price of gas does provide further incentives to the import of LNG, since transport costs begin to assume a smaller relative share of total costs.

In those countries with surplus natural gas not capable of export by pipeline, notably Algeria and Saudi Arabia, gas prices remain low in the early 1980s, with a ceiling related to gas prices in their export markets less the shipping and other transport costs. As gas prices in Europe, the United States and Japan during the 1980s, however, export of gas becomes increasingly interesting, and before 1990, gas prices are expected to align themselves with oil prices in these countries, this still leaving a sufficient margin to cover the cost of transport to markets with much higher gas prices.

In the other developing countries with gas resources, gas prices will converge with those of oil before 1982, and remain in step thereafter.

3.4. Petrochemical feedstocks

As in the reference scenario, there will be no large-scale developments in the types of feedstock used by the petrochemical industry, in particular, no significant advent of coal as source of feedstock, or direct cracking of crude oil. The petrochemical industry thus continues to rely on the classic feedstocks; petrochemical feedstock becomes a "premium" usage of oil (and natural gas).

As in the reference scenario, feedstock prices will move to reflect, in particular, local oil and gas prices. Thus, in North America, prices of all five basic feedstocks, methane, ethane, propane, naphtha and gas-oil will rise after 1982 in accordance with rises in oil and natural gas prices. In addition, ethane and propane prices will rise at a somewhat faster rate, because of the increasing scarcity of these commodities.

In respect of oil-derived feedstocks, however, the gain in the relative price of naphtha compared with gas-oil which occurs in the period up to 1982 is halted, however, as the degree of fuel economy achieved is greater in the automobile sector than in other sectors. Thus, prices of naphtha and gas-oil increase precisely according to those of crude oil.

In Europe, the picture is similar to that in the reference scenario, subjects to the proviso that oil and gas prices increase at a higher rate. The trend for naphtha and gas-oil prices to diverge slowly continues in this scenario, since the European car population continues to increase faster in Europe than in the United States, and there is also less scope for economy in car design in Europe.

In Japan and Asia generally, naphtha prices rise rather faster than those of oil, reflecting worldwide demand pressure, whereas those of gas-oil rise somewhat more slowly, reflecting worldwide surplus.

In developing countries with hydrocarbon resources prices of hydrocarbons are more or less insulated from international market pressures from 1982 on. All oil-producing countries will have refinery capacity producing sufficient naphtha and gas-oil to satisfy local requirements for petrochemical feedstocks. These requirements will be satisfied as a first priority at prices which, like oil, are constant in real terms. Only then will the surplus be exported to world markets (at the higher prices).

The evolution in prices of methane, ethane and propane in developing countries with gas resources will be according to the same criteria as the reference scenario, i.e. they will be largely determined by movements in the local price of natural gas.

4. PROSPECTS FOR SOME SECTORS DIRECTLY AFFECTING DEMAND FOR FINAL PRODUCTS

4.1. Agriculture

Demand for fertilizers in developed countries grows only slowly, as in the reference scenarios. On the other hand, due to the special efforts made to boost agricultural production in developing countries, consumption in the latter increases strongly.

4.2. Automobile

It becomes apparent in the early part of the 1980s that fuel costs for private motorists are going to increase considerably during the course of the decade, and that governments in the industrialised countries will do nothing to alleviate the situation through their fiscal policy.

In the U.S. the automobile industry embarks on a serious campaign to make car engines more economical. Cars become smaller and lighter, and plastics find increasing use in automobiles (i.e. to a greater extent than in the reference scenario). Which the automobile tradition is too firmly entrenched in the American way-of-life for any serious reduction in the car population to occur, cars become more sparingly used. The combined effects of lighter cars, moderation in automobile usage, and increasing use of longer life radial tyres, mean a shrinking demand for rubber in North America.

In Europe and Japan, prospects of further increases in gasoline costs bring about a real shift in travelling habits away from private and towards public transport, bringing about lower rates of growth in the car population than would otherwise have occurred. Demand for synthetic rubbers is therefore tending to stagnate by the end of the 1980s.

Although growth is higher in developing countries in this scenario, car ownership grows at a similar rate to that in the reference scenario, with emphasis placed on capital investment rather than on consumerism, and with a movement towards a less imbalanced distribution of income.

4.3. Textiles

Developments in textiles demand are weak in developed countries due to lower income and decreasing consumerism attitude. In developing countries, demand increases strongly, because of higher standards of living.

4.4. Building

Similar remarks apply as in the reference scenario.

4.5. Packaging

As part of the phenomenon of increased awareness of environmental and conservation problems in industrial countries, there is a reaction against the wasteful use of plastics by the packaging industry. There is a movement towards the elimination of unnecessary packaging, and a greater emphasis on recycling, the use of returnable containers, etc.. This tendency acts as a damper on the growth of demand for plastics in industrialised countries.

As far as developing countries are concerned, similar remarks apply as in the reference scenario, but the rate of growth in demand is higher, due to the higher general economic growth.

5. PETROCHEMICAL CONTEXT

5.1. Organisation of production

The situation up to 1982 is as described in the reference scenario. By way of reminder, the position is one in which the surplus capacity and uncertainty of the mid-1970s has persisted as the oil companies have tried to increase their market share in the petrochemicals industry, and developing countries have begun to press ahead with their own investment plans.

In the context of their new-found solidarity, and of their significant step towards the installation of an international economic order more favorable to developing countries, OPEC members decide to press ahead with the development of their own petrochemicals industries on the basis of self-sufficiency and regional cooperation, rather than in partnership with Western countries. During the course of the 1980s, regional agreements are established or consolidated in the Middle East/North Africa, Latin America, and Asia providing for technical and economic cooperation in the area of petrochemicals, harmonisation and integration of petrochemical investments, not only amongst themselves, but also with plans for downstream industries such as textile manufacturing and rubber processing, and also marketing networks, etc...

In keeping with their policy of maximising autonomy, developing countries in general abstain from joint ventures with established chemical companies, preferring complete control of the new enterprises. The technology is purchased from engineering companies in the industrialised countries. Where necessary, expatriates with suitable skills and experience are recruited to supplement local expertise, but emphasis is placed on training up local personnel for the skilled as well as the unskilled jobs as quickly as possible.

In industrialised countries there is increasing disquiet on the part of the established chemical industry about the prospects for the industry. The oil majors, feeling themselves squeezed by OPEC countries at the upstream end of their activities, and progressively losing influence, intensify their efforts to increase their market share in the petrochemical industry, particularly in the area of base chemical manufacture. The chemical multinationals, increasingly alarmed about the prospects of competition from developing countries, but for the most part unable to secure participation in these new projects, refuse to relinquish their own expansion plans, hoping that they will have the advantage over developing countries in a competitive situation, and that the system of differential oil-pricing will collapse before it begins to create a real advantage for developing countries.

Thus, while the large chemical companies place particular emphasis on the more specialised plastics and other high-technology high-added-value petrochemical products, they continue to contest the more traditional areas of petrochemical manufacture from the oil company affiliates and the new producers in the developing world.

As in the case of the reference scenario, there is a tendency for chemical companies to strive after greater geographical diversification, with, in particular, European companies continuing to seek to develop their activities in North America. Joint ventures between oil companies and chemical companies also become more widespread as financing problems become increasingly more severe for the latter.

5.2. Localisation of production

The period 1982-1990 sees a great thrust forward on the part of developing countries on the road towards industrialisation. In considering which should be the more important poles of development, the petrochemical industry comes under scrutiny because it is one of the sectors with the highest apparent potential growth rates, with good prospects in developing countries. Countries, or groups of countries concentrated on those sections of the petrochemical industry most suited to their own particular needs, markets, and resources. Because of their improved access to capital for investment, their growing advantage in relation to energy and feedstocks, and their improved growth prospects, they are able to pursue a more ambitious programme of investment than in the reference scenario.

Development of different branches of the petrochemical industry is carried out in parallel with development of the corresponding downstream consuming industries, such as textiles, tyre manufacture, etc.. since it is these latter industries which will determine the local growth in demand.

Investment planning is often carried out at regional, rather than national level, due to the extensive development of regional agreements already referred to (these regional agreements are assumed, reasonably, to occur within the zones considered in this study).

At a zonal level, investment strategies are such as to achieve the following in the year 1990 :

a) Middle East/North Africa

This zone becomes a major producer (and exporter) of all base products. During the period 1982-1990 it accounts for a large part of the increase in world capacity for the manufacture of olefins, methanol, ammonia and aromatics.

Plant will be installed for the transformation of some of the ammonia into nitrogenous fertilizers (mainly for export), but much of the ammonia will be exported as it stands (mainly to Third World countries with fertilizer factories, and without any hydrocarbon resources).

Similarly, part of the olefins (particularly ethylene) could be transformed to intermediate products further downstream, but a major part will probably be exported (mainly to developed countries). The cost advantage on feedstocks enjoyed in these countries will make the shipping of ethylene to developed countries by cryogenic tanker more economically viable.

Similarly, most of the aromatics manufactured will be exported to markets in developed countries.

Apart from the large increment in base product manufacturing capacity, sufficient capacity is established in this zone to make it self-sufficient in petrochemicals.

b) Developing America

As in the case of the reference scenario, this zone becomes self-sufficient in petrochemicals by 1990. Translated into absolute figures, however, this means a considerably greater increase in petrochemical capacity than in the reference scenario, since the rate of economic growth, and the rate of development of the client industries of petrochemicals, is higher in this zone in this scenario.

c) Asia (excluding Japan)

Manufacture of nitrogenous fertilizers is higher than in reference scenario, in response to higher demand, due to improved credit facilities for farmers, etc. In addition to the transformation from hydrocarbons carried out in countries such as India, Indonesia, Pakistan, and Bangladesh, a certain amount of capacity is installed in these and other countries in Asia for processing ammonia, which is imported from Arab countries.

Installed capacity for manufacturing synthetic fibres is substantially greater than in the reference scenario, corresponding to the greater activity of the textiles industry in this scenario.

In addition, capacities for the manufacture of commodity plastics and synthetic fibres are established to meet a major part of the growing demand for these products.

d) Africa (except North Africa)

By 1990, Africa establishes a substantial fertilizer industry, partly based on locally occurring and on imported hydrocarbons, and partly based on ammonia imported from the Middle East/North Africa.

In addition, there is moderate investment in the synthetic fibres and plastics industries, putting this zone in a position to meet a significant part of the increasing demand for these products.

e) Communist countries

Developments in this scenario are assumed to be very similar to those in the reference scenario, but with a somewhat slower development of capacity, corresponding to the lower rate of economic growth.

f) Developed countries (North America, Western Europe, Japan)

Investment in the period 1982 to 1990 reflects the desire on the part of established producers to maintain their market shares if at all possible, and also the rather low rate of realised economic growth compared with expectations. It is therefore such as to produce substantial overcapacity at a world level by the year 1990. This overcapacity is most acute in those areas where investment in the developing countries has been heaviest, that is, in base petrochemical capacity.

Out of the three main developed areas, North America, Western Europe, and Japan, none emerge as being particular poles of new investment, and the activity is therefore spread evenly over these areas, roughly in proportion to the already existing activity.

5.3. Organisation of markets

In the early to mid-1980s the steadily increasing share of the oil companies in the manufacture of base chemicals in developed countries brings about some opening up of the markets, as a market is increasingly created at the interface between upstream and downstream production processes. Purely chemical companies do not cease to manufacture their own olefins, etc., but the proportion which is bought in form the petrochemical arms of oil companies continues to rise.

This tendency is strengthened in the second half of the 1980s when increasing quantities of attractively priced base products from the Middle East and North Africa, and also from the Eastern bloc countries, appear on Western markets.

Similarly, which the petrochemical industries are developing in Latin America and the Middle East and North Africa, they must complement their production patterns by importing those base and intermediate chemicals not produced locally. Even by 1990, when the petrochemical industries in these zones are largely self-sufficient there is still a need to import some of the more specialised intermediate products. Much of the petrochemical industry in 1990 in Asia and Africa (other than North Africa) consists of final product manufacture (fertilizers, textiles) based on imported intermediate or base products.

Worldwide, therefore, there is a tendency to more open, or transparent markets, with captive transfers accounting for a smaller proportion of supplies of base and intermediate petrochemicals.

As was seen already, the 1980s are characterised by developing solidarity in Third World countries, this taking the concrete form of the development and consolidation of regional agreements on technical and economic cooperation. Because of the special characteristics of the petrochemical industry, its capital-intensiveness, need of large-scale markets, its highly technological nature, these agreements are of special importance for this industry. In particular the emerging producers in developing countries succeed to a large extent in coordinating their activities, pooling their markets, removing mutual customs tariffs, and erecting common tariff barriers to protect their fledgling industries.

As already mentioned in the reference scenario, exporters of base products in the Middle East, and also the petrochemical subsidiaries of oil companies are pursuing in 1982 a somewhat aggressive pricing policy, creating some downward pressure on prices. This pressure is intensified as the price advantage on energy and feedstocks in developing countries becomes more evident, i.e. as base petrochemicals at increasingly competitive prices begin to be imported from the Middle East and North Africa. By 1990, producers of base products in industrialised countries are unable to maintain prices at a level which will cover operating costs and amortise the capital cost of plant over a reasonable period. Competition is stiff due to world overcapacity and low cost imports from Eastern bloc countries and the new exporting producers. Markets are thus in a state of some disorganisation. While there are some appeals to governments in developed

countries to take measures to protect their chemical industries, these are rejected by the latter, partly because these would be contrary to the spirit of the times, but partly also because they dare not take steps which might prejudice their oil supplies. This does not apply to developing countries where, as already mentioned, measures are taken at national or regional level to protect the emerging industries.

6. TECHNICO-ECONOMIC CONTEXT

As in the case of the reference scenario, the petrochemical industry enters a phase of technological maturity during the 1980s in which only minor changes occur.

6.1. Mean size of units

In developed countries, in accordance with the aggressive policy pursued by companies, the mean size of petrochemical units does not reduce, in spite of the persistent overcapacity in the industry. However neither do they get any larger than at present. The continuing rise of energy and feedstock costs, i.e. the variable part of the total costs, reduces the potential benefit from further increases in size.

In developing countries, by contrast, there is a tendency towards somewhat smaller units, on the basis that it would be unwise to try to be too ambitious technically.

6.2. Feedstock policy

As in the reference scenario, feedstock flexibility becomes common in industrialised countries, in view of the changing patterns of feedstock availability. In the United States steam crackers capable of using naphtha and gas-oil are constructed, while in Europe there is an increasing capability to process gas-oil, and in some cases ethane and propane.

During the mid-1980s, as oil and gas prices continue to rise, an increasing interest is shown in using coal for the production of feedstock, the economics becoming increasingly more attractive as prices diverge. Within the time-span considered, however, there is no significant impact on feedstocks from coal.

Feedstock policy in developing countries is similar to that in the reference scenario.

6.3. Energy

The trend towards the more economical use of energy occurs as in the reference scenario.

Although the price of gas in industrialised countries is allowed to follow that of oil, the price of coal remains much lower. Thus oil prices continue to rise, coal becomes increasingly attractive, and by the end of the 1980s, the chemical industry has switched significantly into coal as an energy source, both consumed conventionally, and using new technologies such as fluidised bed combustion.

In developing countries, oil and gas remain the predominant forms of energy, whose costs, as has already been seen, remain constant.

6.4. Stream factor

Developing countries have free access to current technology from engineering firms, and also establish training schemes to train up technicians required by their new industries, but because of their policy of going for self-sufficiency as far as possible, and thus not going into partnership with Western firms, technical problems are encountered and, particularly in those countries less experienced in the petrochemical industry, these problems are reflected in stream factors lower than in the reference scenario.

Similarly longer start-up periods are required for installation of new plant.

6.5. Cost of labour

As in the reference scenario, however, in addition, because of the evolution in the distribution of income in developing countries, unskilled labour becomes somewhat more expensive in relation to skilled labour in these countries, the cost of which is in diminution, because of greater part of local skilled workers.

6.6. Environmental protection

Trends generally are as in the reference scenario. Increased emphasis on the "quality of life" in developed countries is offset by the more limited means available in this scenario to finance the expensive measures required to improve environmental quality.

On the other hand, where chemical firms switch over to coal as an energy source, additional costs are incurred for abatement of air pollution, since coal is in general a "dirtier" fuel than its hydrocarbon competitors.

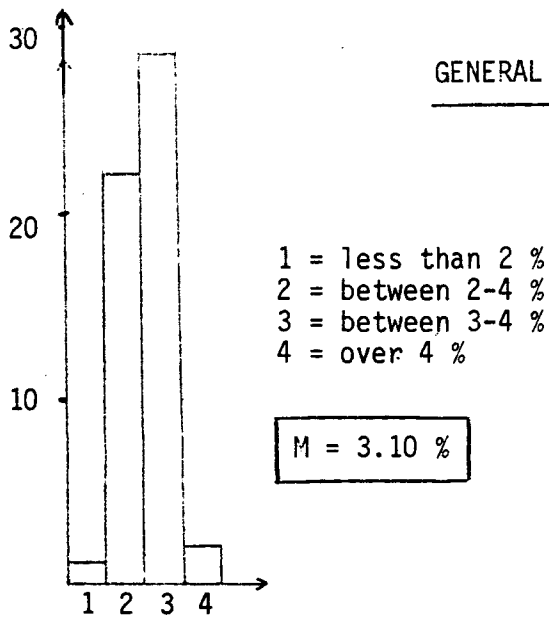
6.7. Transport

As in the reference scenario, except that in the latter part of the 1980s, the intercontinental transport of ethylene by cryogenic tanker becomes an increasingly viable proposition as Middle East ethylene becomes more competitive in price. There is therefore a considerable increase in the number of such tankers in service.

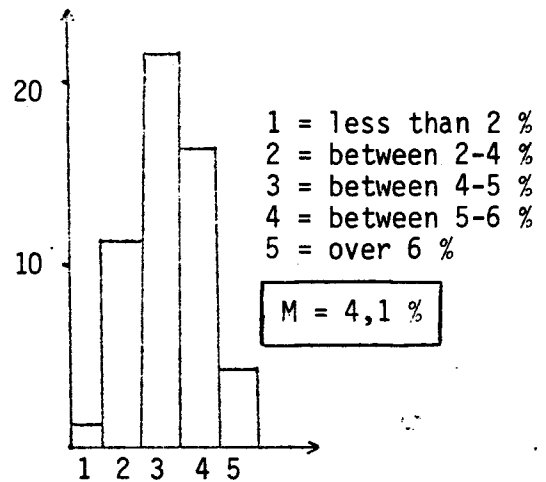
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- RESULTS OF THE SMIC SURVEY

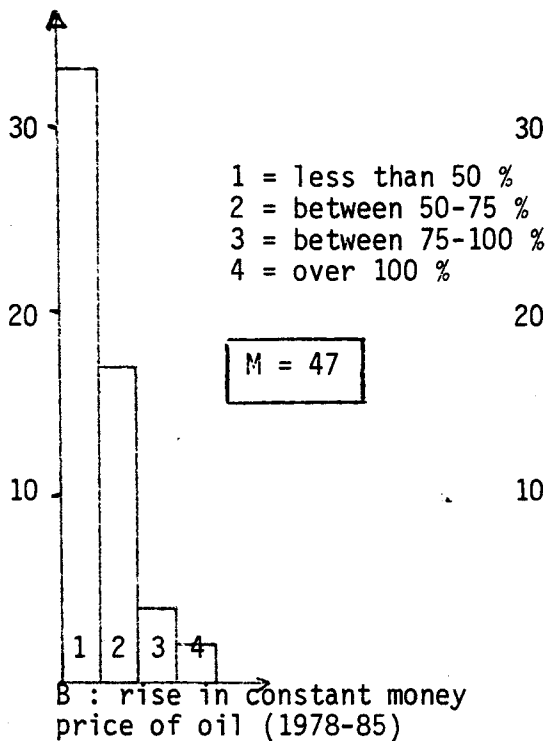
Related to the general economic hypotheses, to the major hypotheses (simple and conditional probabilities), to the related questions and to the additional questions, histograms (number of experts) and mean answer are given.



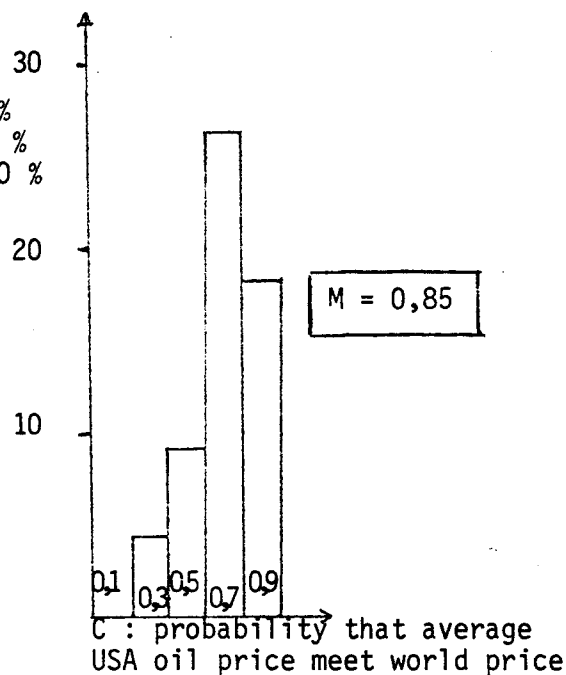
A1 : GNP growth rate : industrialized countries



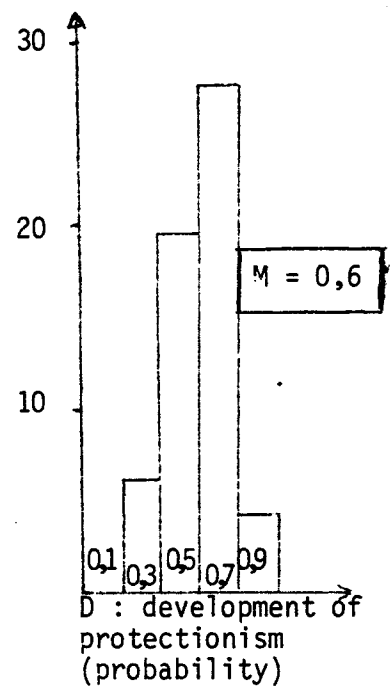
A2 : GNP growth rate : developing countries



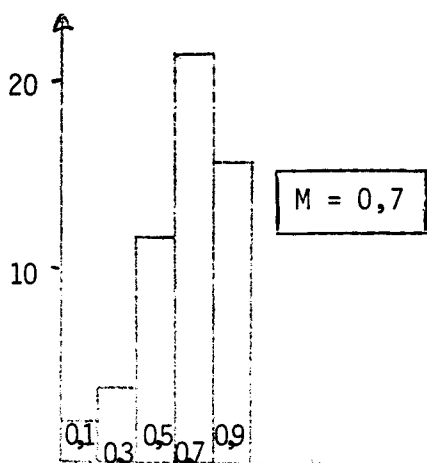
B : rise in constant money price of oil (1978-85)



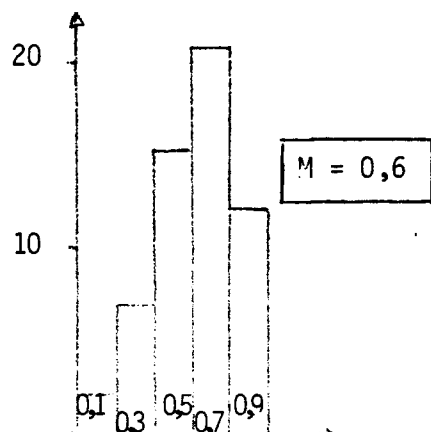
C : probability that average USA oil price meet world price



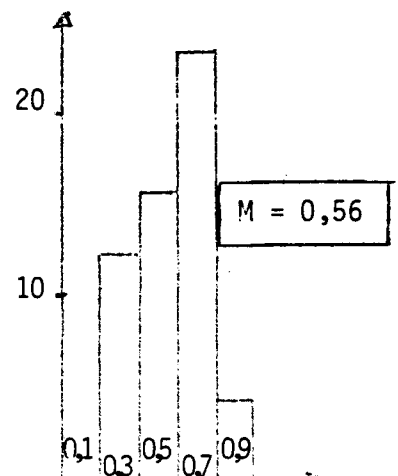
D : development of protectionism (probability)



E : 1990 natural gas price equal to its energy value (prob.)



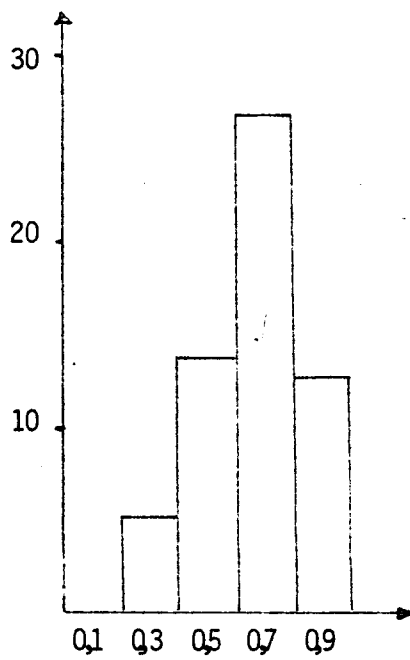
F : Communist country trade increase (prob.)



G : North-South economic cooperation

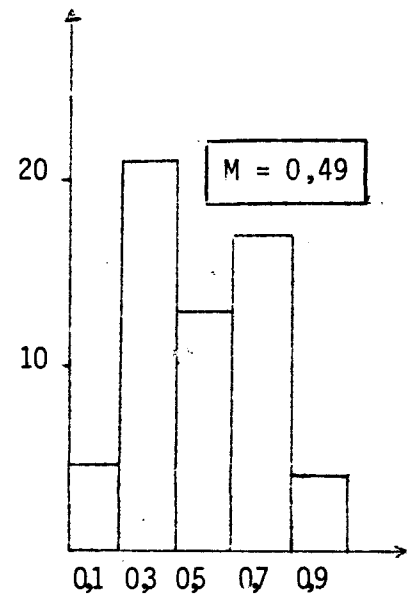
MAJOR HYPOTHESES
(simple probabilities)

114.



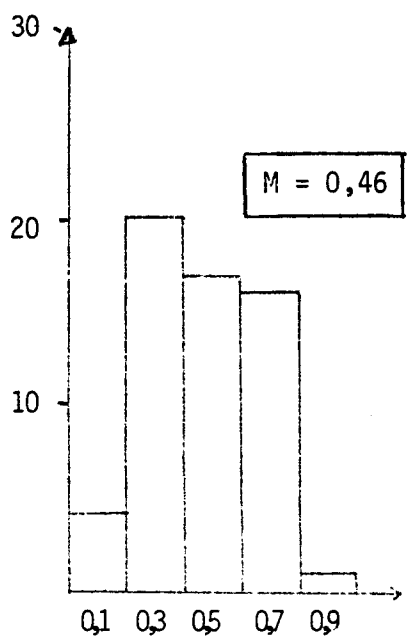
$M = 0,66$

H1 : Supply Guarantee



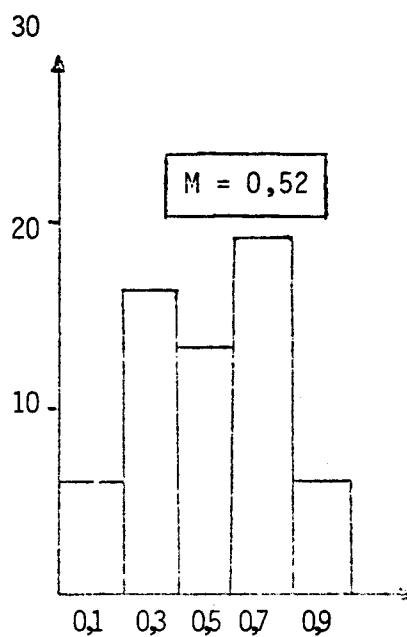
$M = 0,49$

H2 : Emergence of new producers



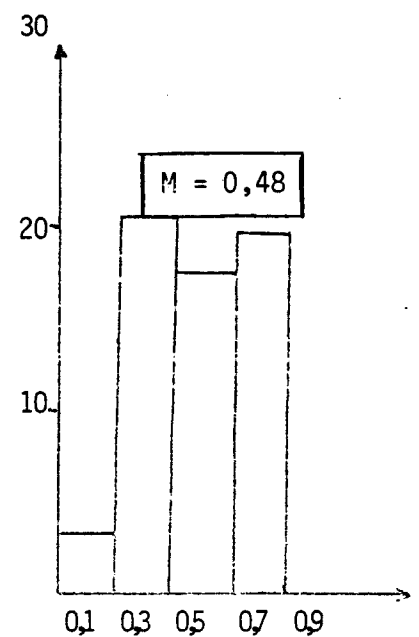
$M = 0,46$

H3 : Market organisation



$M = 0,52$

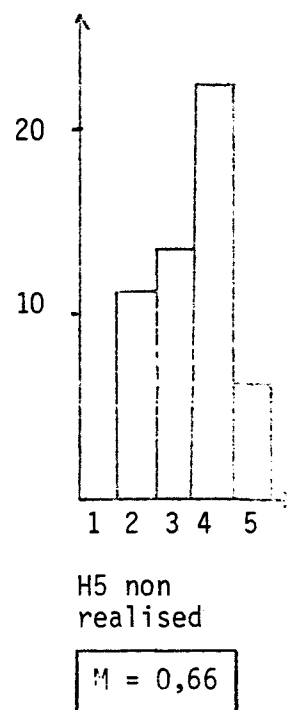
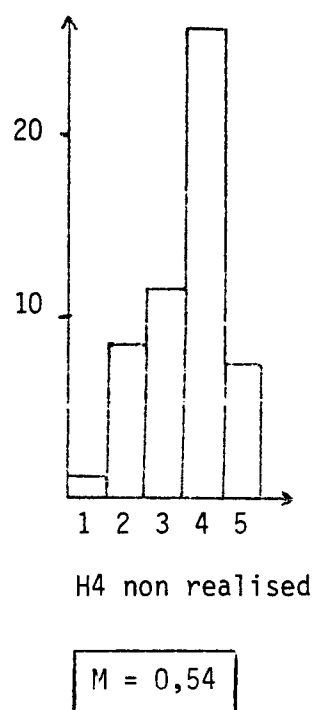
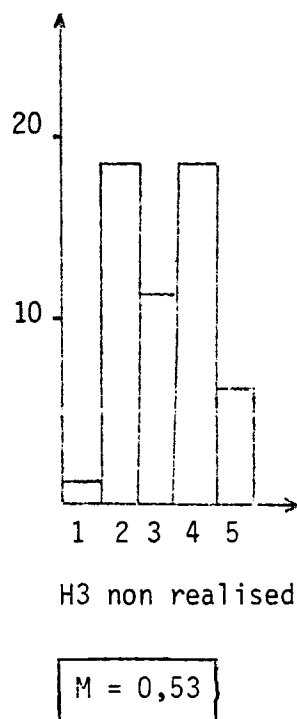
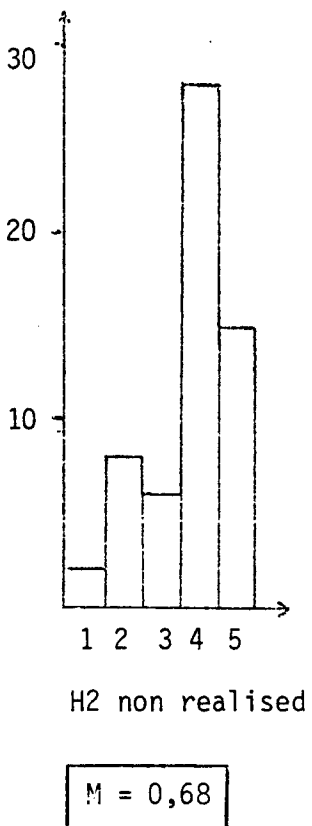
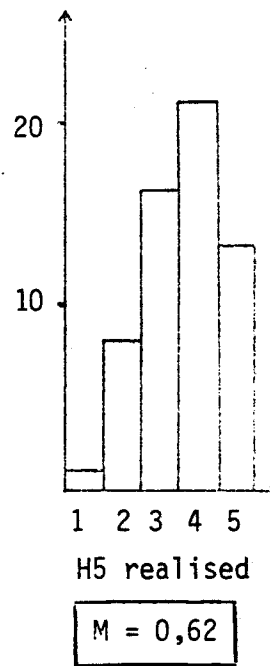
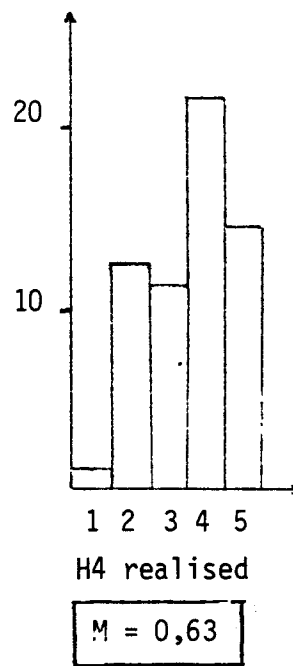
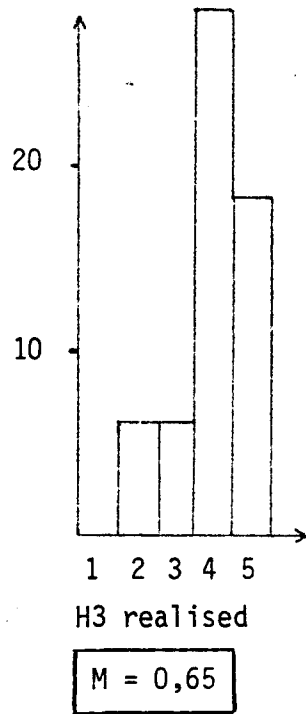
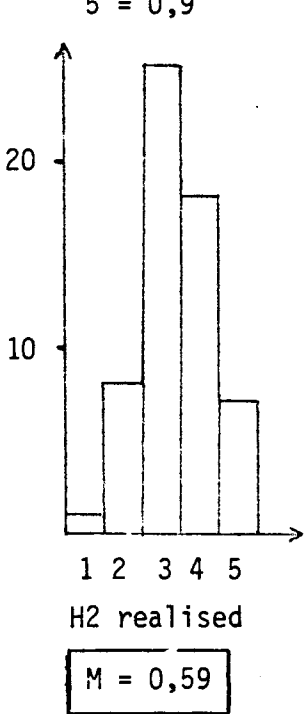
H4 : Sharing of technological power



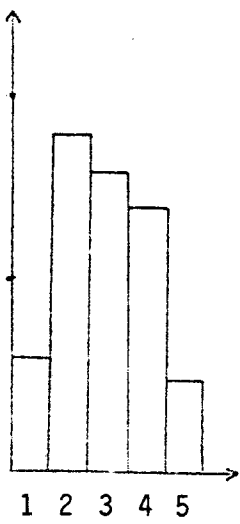
$M = 0,48$

H5 : Sharing of marketing power

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5 = 0,9

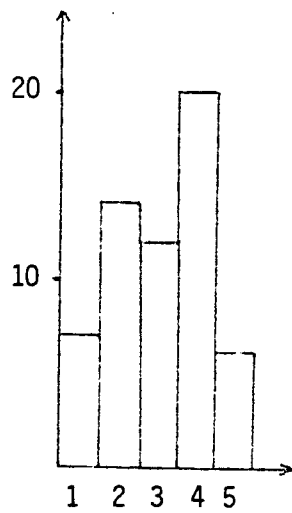


1 = 0,1
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3 = 0,5
4 = 0,6
5 = 0,9



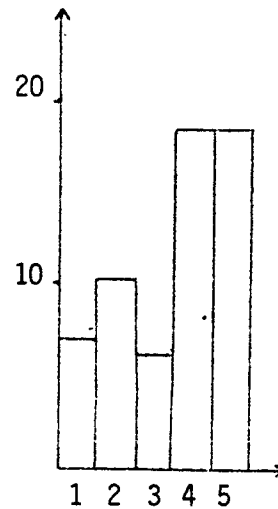
H1 realised

M = 0,47



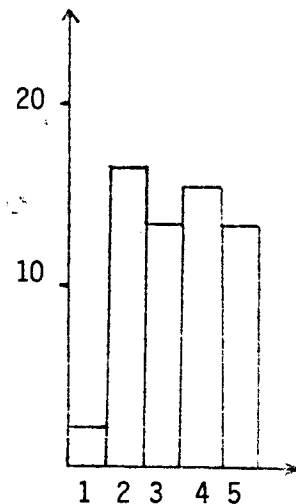
H3 realised

M = 0,51



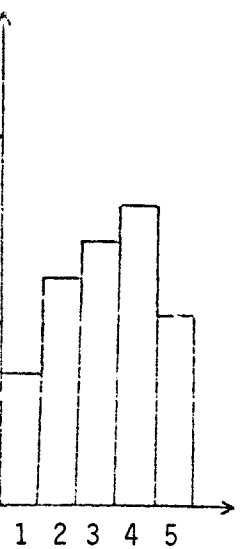
H4 realised

M = 0,6



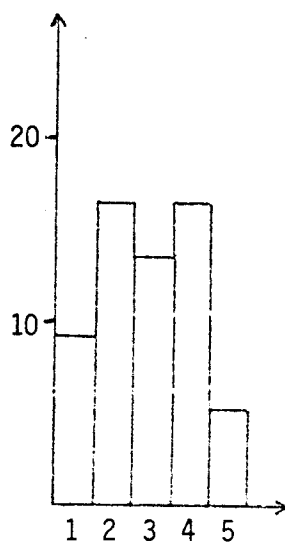
H5 realised

M = 0,57



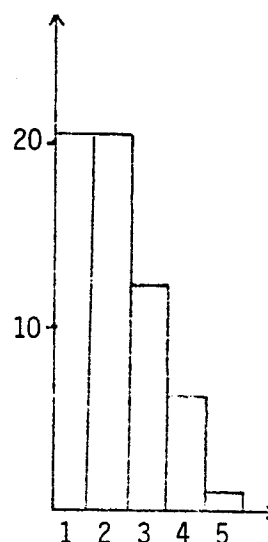
H1 non realised

M = 0,53



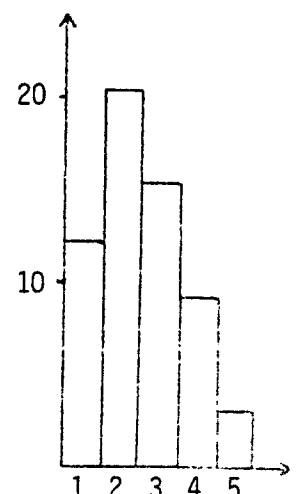
H3 non realised

M = 0,47



H4 non realised

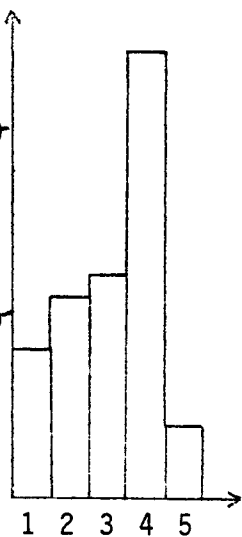
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H5 non realised

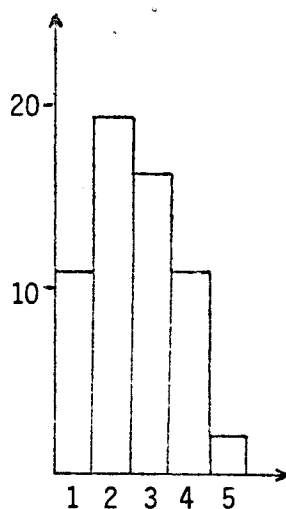
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5 = 0,9



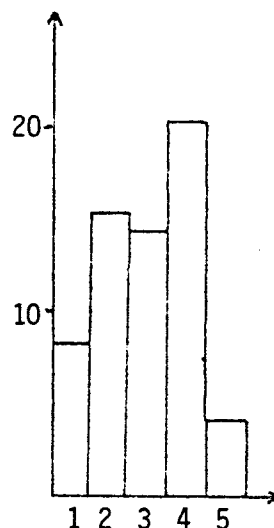
H1 realised

M = 0,51



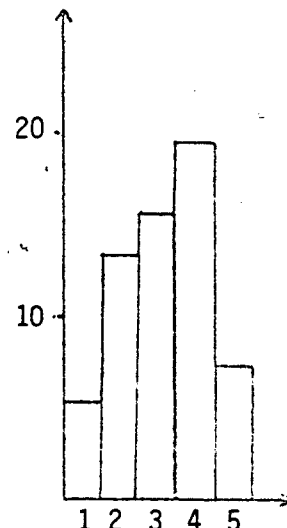
H2 realised

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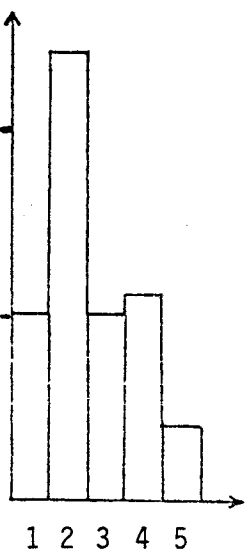
H4 realised

M = 0,37



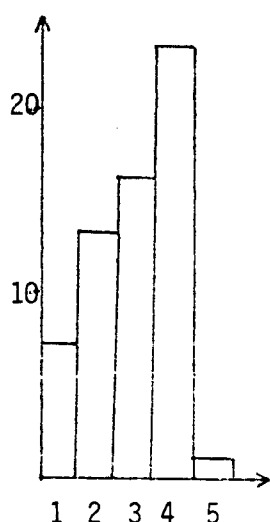
H5 realised

M = 0,53



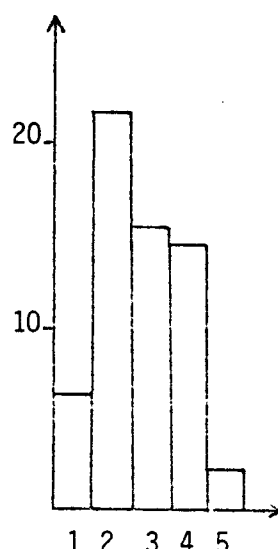
H1 non realised

M = 0,41



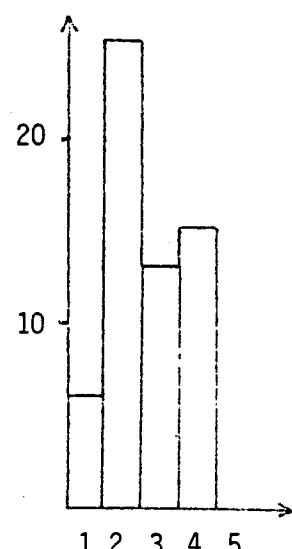
H2 non realised

M = 0,5



H4 non realised

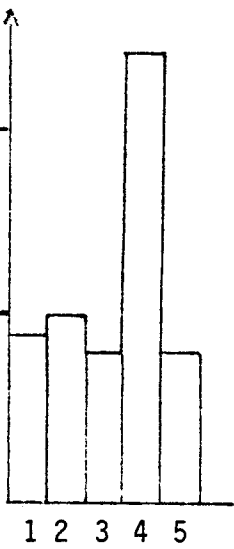
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H5 non realised

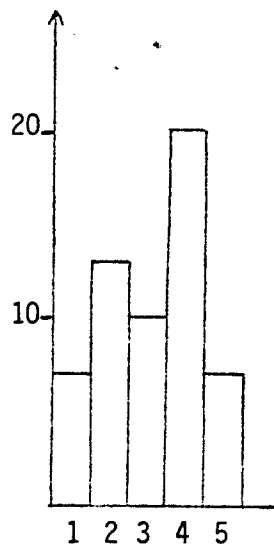
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5 = 0,9



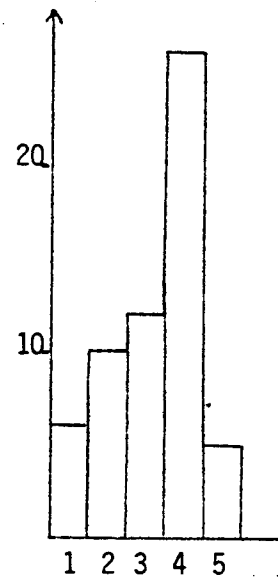
H1 realised

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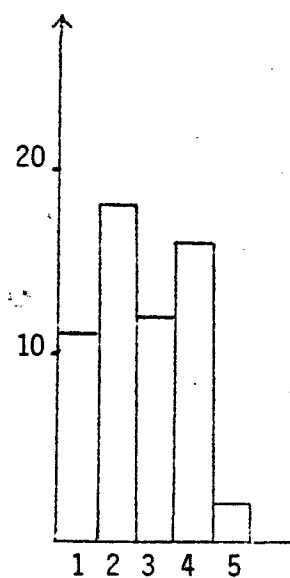
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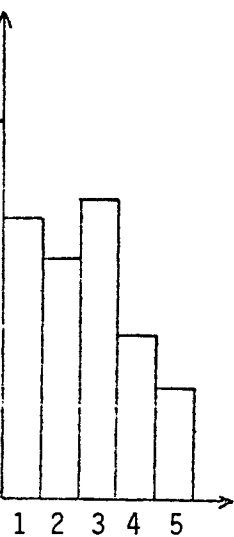
H3 realised

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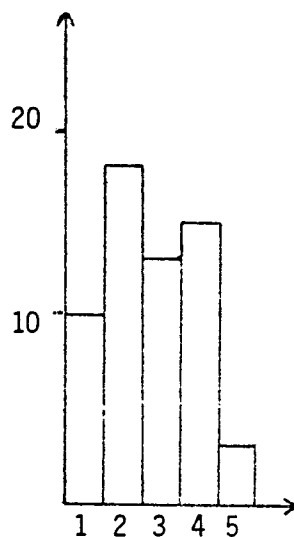
H5 realised

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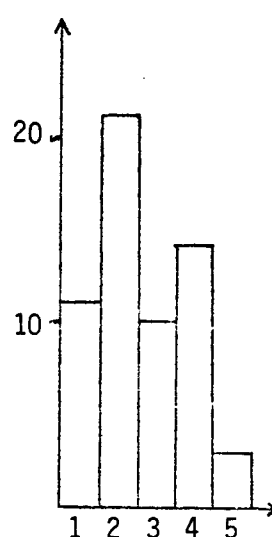
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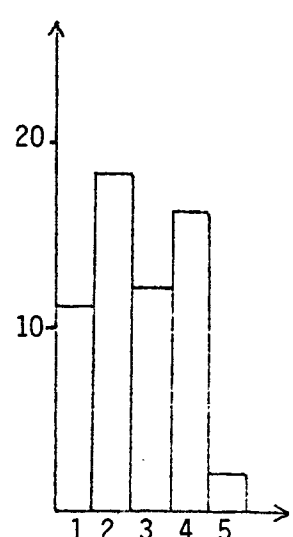
H2 non realised

M = 0,44



H3 non realised

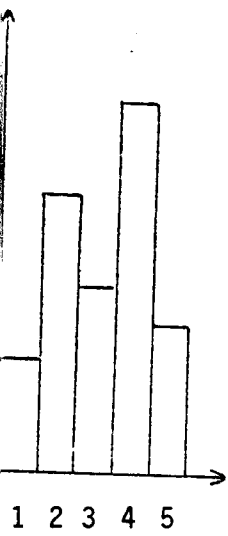
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H5 non realised

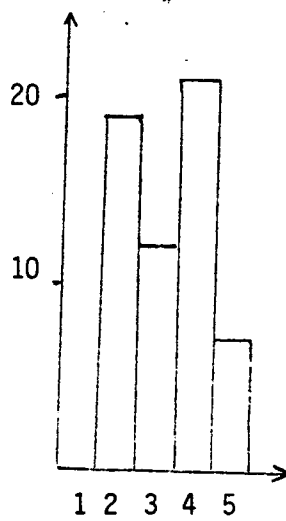
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5 = 0,9



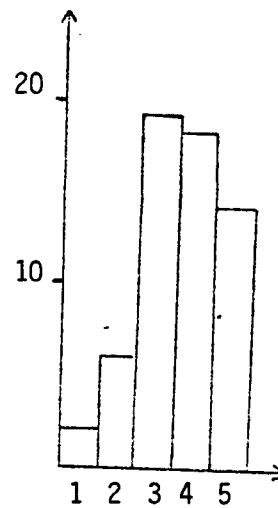
H1 realised

M = 0,53



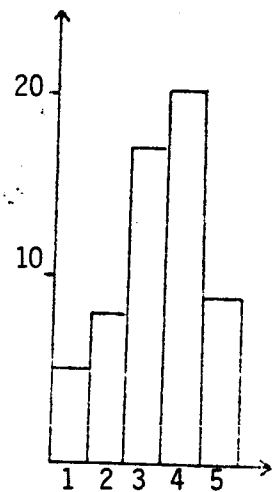
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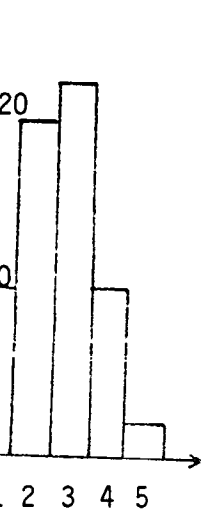
H3 realised

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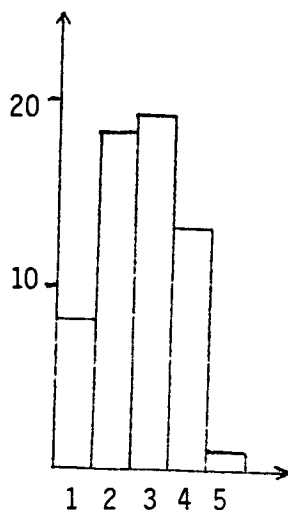
H4 realised

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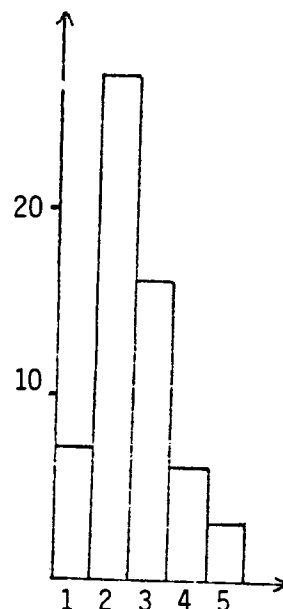
H1 non realised

M = 0,42



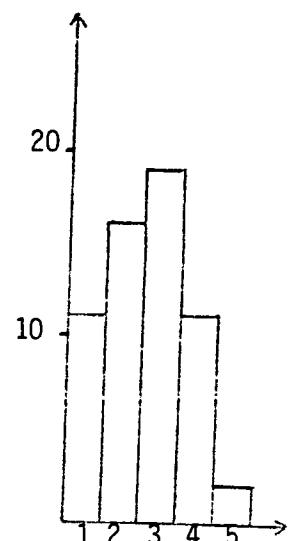
H2 non realised

M = 0,42



H3 non realised

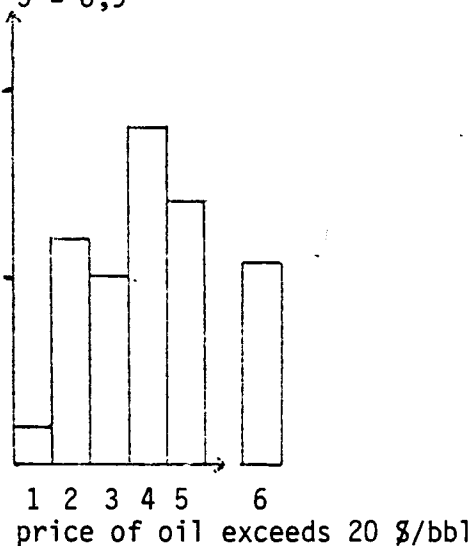
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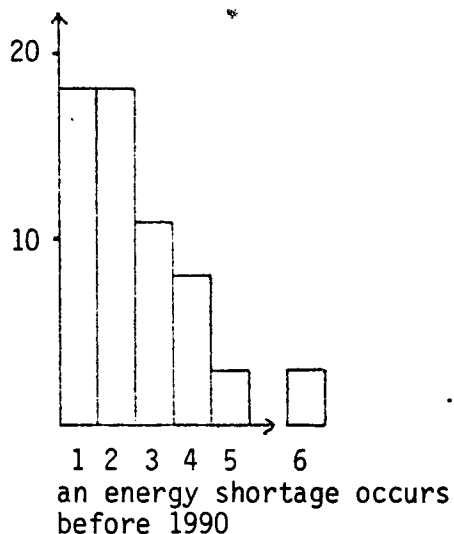
H4 non realised

M = 0,42

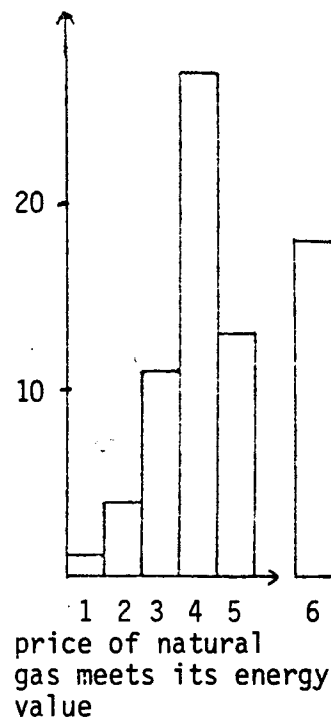
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5 = 0,9



M = 0,6

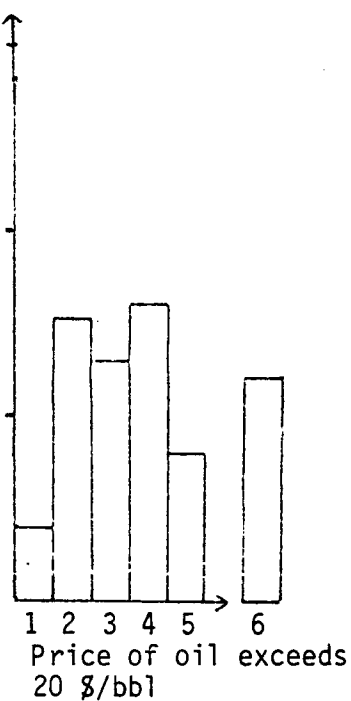


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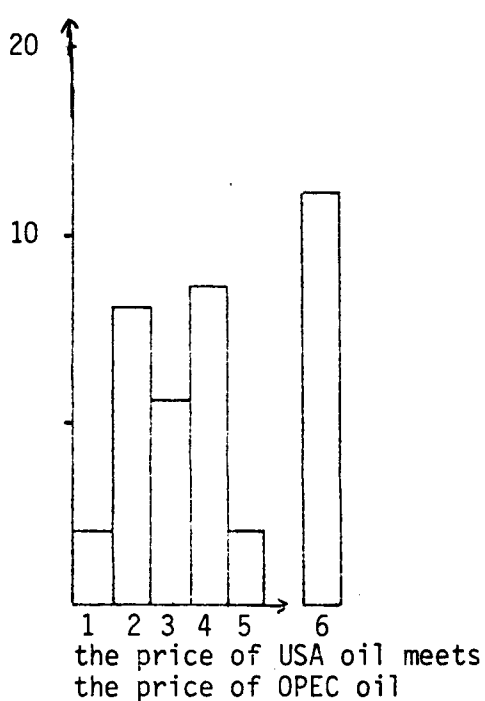


M = 0,87

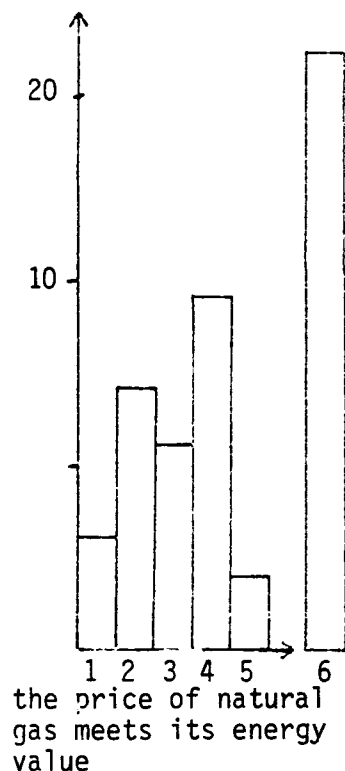
PROBABILITY OF H2 (emergence of new petrochemical producers) if :



M = 0,46



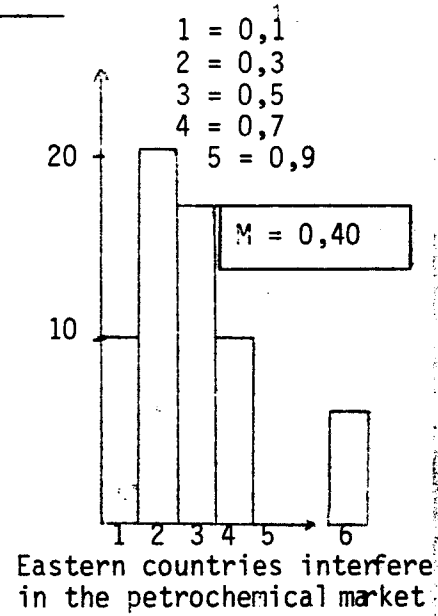
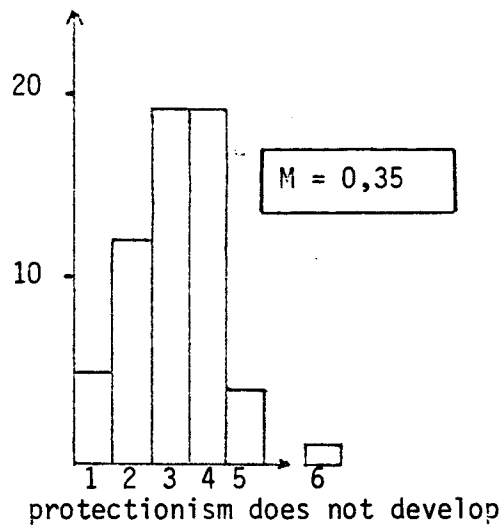
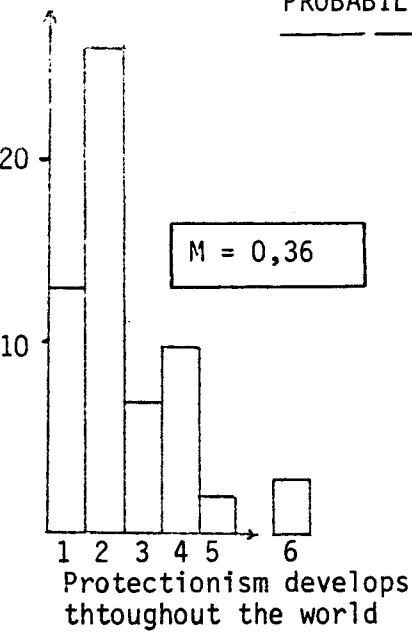
M = 0,5



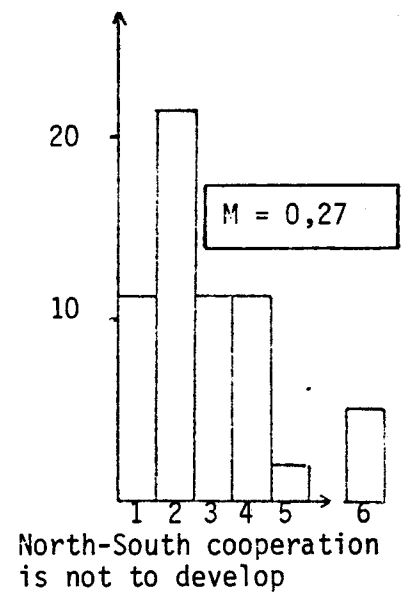
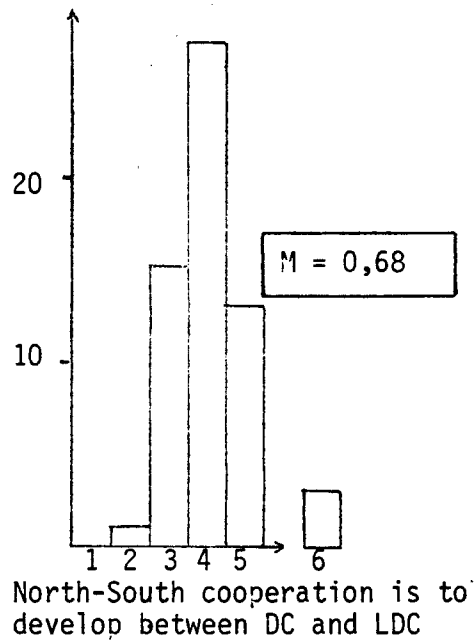
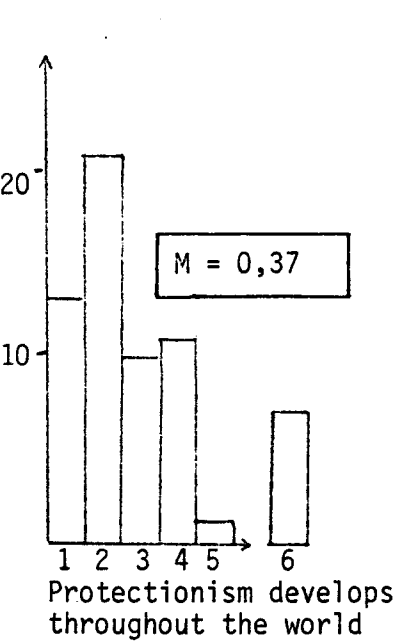
M = 0,5

PROBABILITY OF H3 (organization of the world market) if :

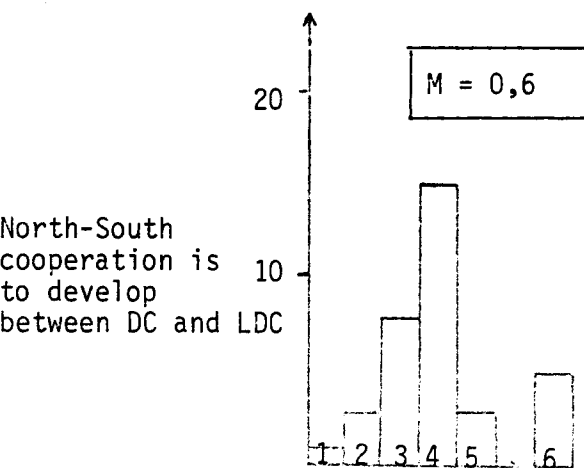
121.



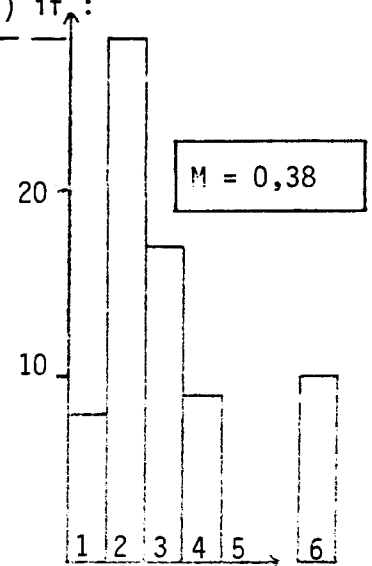
PROBABILITY OF H4 (sharing of technological power) if :



PROBABILITY OF H5 (sharing of marketing power) if :



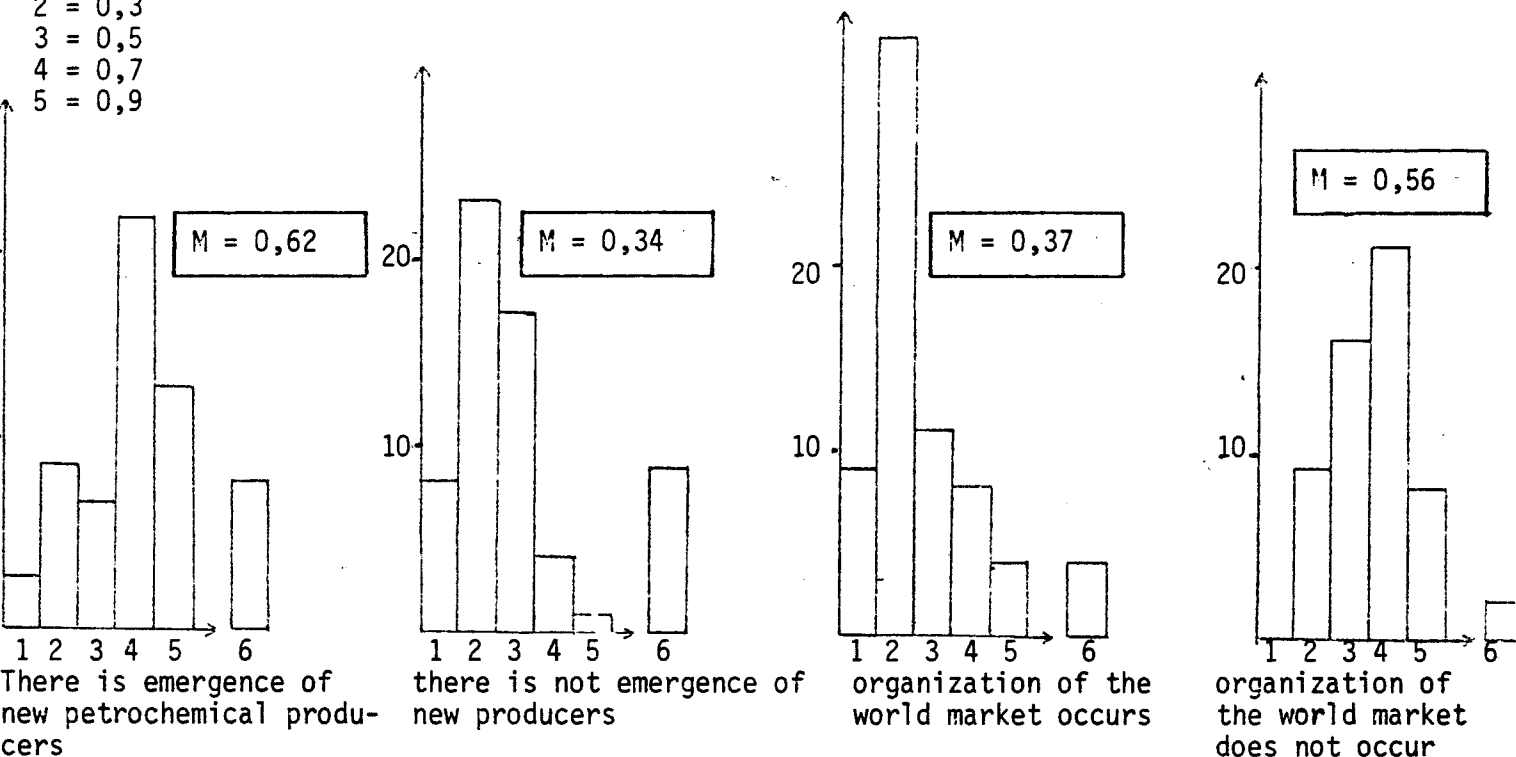
North-South cooperation is not to develop



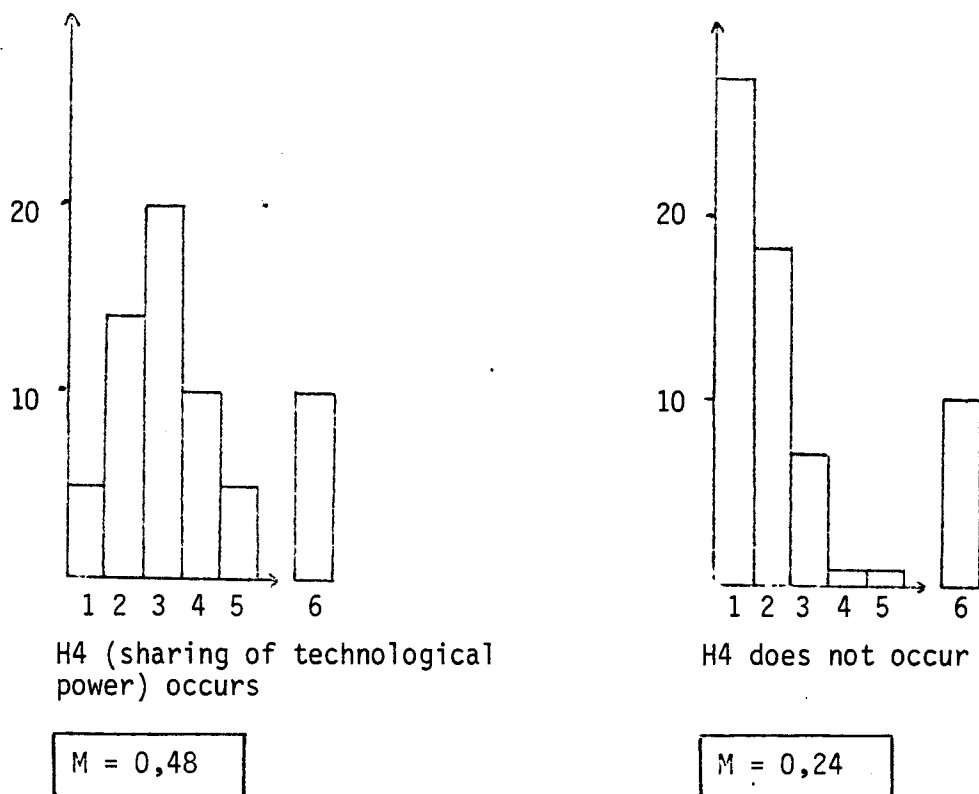
PROBABILITY THAT PRODUCING COUNTRIES EFFECT REGULAR SALES
OF PETROCHEMICAL PRODUCTS AT PRICES BELOW ECONOMIC COST IF :

122.

- 1 = 0,1
- 2 = 0,3
- 3 = 0,5
- 4 = 0,7
- 5 = 0,9

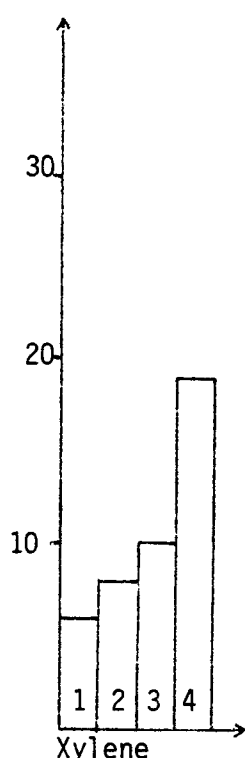
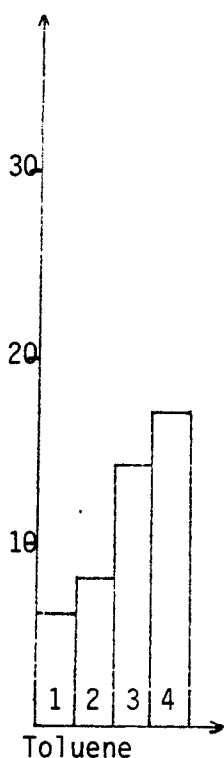
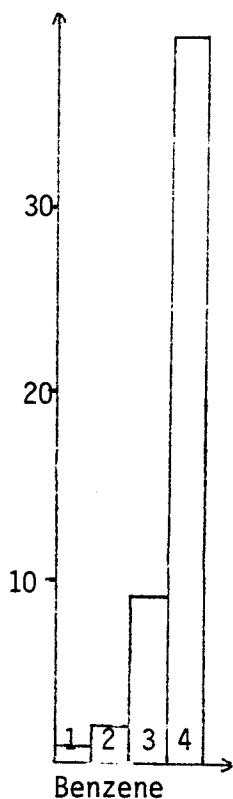
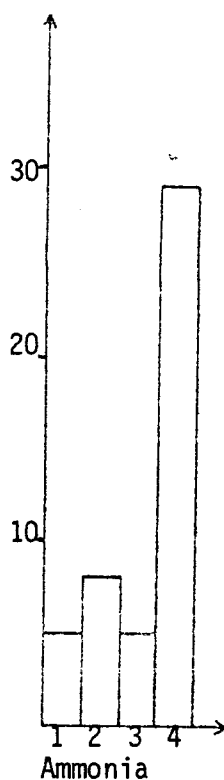
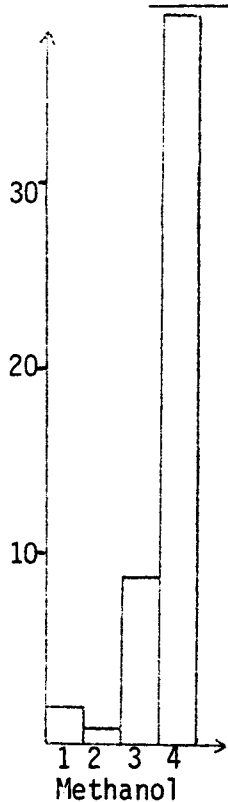


PROBABILITY THAT STREAM FACTOR OF PLANTS IN DEVELOPING COUNTRIES BE COMPARABLE,
BY 1990, WITH THAT OF INDUSTRIALIZED COUNTRIES IF :



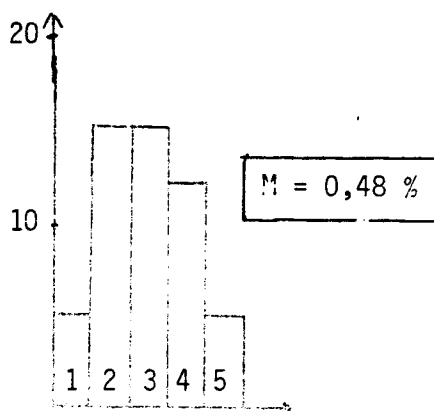
ANNUAL FIGURE FOR INTERCONTINENTAL EXCHANGES

1 = 30 000 T
 2 = 75 000 T
 3 = 125 000 T
 4 = 200 000 T



PROBABILITY THAT EASTERN COUNTRIES EFFECT MASSIVE SALES OF PETROCHEMICAL PRODUCTS AT A LOW COST

1 = 0,1
 2 = 0,3
 3 = 0,5
 4 = 0,7
 5 = 0,9





sema

société de conseil, d'études et d'ingénierie
informatique, marketing, organisation, formation