THE BARILOCHE WORLD MODEL AS AN INFEASBILITY
STUDY

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By making the right assumptions, I suppose it is possible to
prove just about anything one might want.

The Bariloche group have made the right assumptions to "prove"
that the world can be saved only with a relatively considerable
sacrifice on the part of the developed countries and not other-
wise. Let us see how this has happened.

I am not going into the merits of the various sub-models
proposed by Bariloche group: notably the demographic model,
the agricultural model, the urban model, the natural resources
model, the energy model, and the education model. The scientific
world abounds with experts who would make a last stand for or
against these. I am not an expert in any of these fields and
thus feel somewhat indifferent over the details. However I did
feel that if any of these submodels made assumptions beyond the
realm of reality, then surely these would amount to only second
order effects on the final results.

We were given to see a lot of deliberate pessimism. I can
anticipate however that the Bariloche model was pessimistic
where it could have been optimistic and optimistic where it
should have been pessimistic. The general consensus was that
pessimisms and optimisms balanced out, but this view is prob-
ably over-optimistic, as we shall see.

In this note I am going to concentrate basically on some of
the implicit socio-political assumptions of the model. Most
of the participants at the 2nd IIASA Global Modelling Con-
ference were quite content with the level of disaggregation
of the Bariloche model. The world was disaggregated into
four blocks, not quite as many as the Pestel-Mesarovic model,
but more than the Meadows model. Unfortunately however, the

the Bariloche group made another assumption some of whose
implications for the level of aggregation adopted, seem to
have slipped by almost unnoticed.

The crucial point of the model is the supposition that once
a year each block optimises its economic allocation as a
single unit.

The idea of myopic optimisation introduced by the Bariloche
group was widely acclaimed as an innovation in world model-
ling and some over-enthusiastic people even spoke of a "learn-
ing capacity" of the model. The one-year myopic optimisation
was a fair enough simulation of reality. After all, Govern-
ments optimise over such short time horizons. What they
optimise is of course another matter.

The Bariloche group assumed that once every year capital and
labour within each block were allocated between the five
economic sectors: agriculture, housing, education, consumer
goods and capital goods, in order to maximise life-expectancy
at birth.

No qualms about the objective function. It will do for a
start. A utility approach could have been better, but there
are no real difficulties since, as the Bariloche people
pointed out on more than one occasion, it was absolutely no
problem to change the objective function.[1] They could have

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(1)   GNP/capita, houses/family, calories/capita, enrollment etc.
      were all available and calculated in the model. Although
      these are all tied up with one another in a highly cor-
      related matrix, it would probably have been meaningful
      to weight different utilities in a general objective
      function. Because all these variables are highly cor-
      related, life-expectancy at birth is probably a good
      proxy to a manifold of objectives.

plugged any other objective function into the model at the
whim of anyone in the audience. We were even asked if we
had any other preferences.

The real trouble was with the level of aggregation over
which the optimisations were carried out.

The four blocks are shown in Fig. 1. The criteria for par-
titioning were partly geographical and partly based on level
of development (or some proxy to it such as GNP/capita).
So block no. 1 contained all the developed countries but also
some countries which would not normally classify as partic-
ularly developed such as Greece, Lebanon and Portugal. Block
no. 2 contained all of Latin America and the Caribbean.
Block no. 3 contained all of Africa west of the Suez canal
and Block no. 4 all of Asia (excluding Japan), Turkey and
Oceania.

At this point the Bariloche people assumed that once every
year each block would allocate capital and labour *anywhere*
within the block, consistent with maximising average life-
expectancy at birth of the block and subject to a large
number of reasonable constraints relative to the whole block.

This methodology implicitly contains a fundamental socio-
political assumption which is crucial to the results of the
Bariloche model. If we were to make a more reasonable as-
sumption about the level of spatial resolution for which
optimisation is socio-politically feasible, anything could
happen, almost certainly not what did happen.

The Bariloche people saved the world within 40 years or so
only by making the further assumption of 2 % development aid
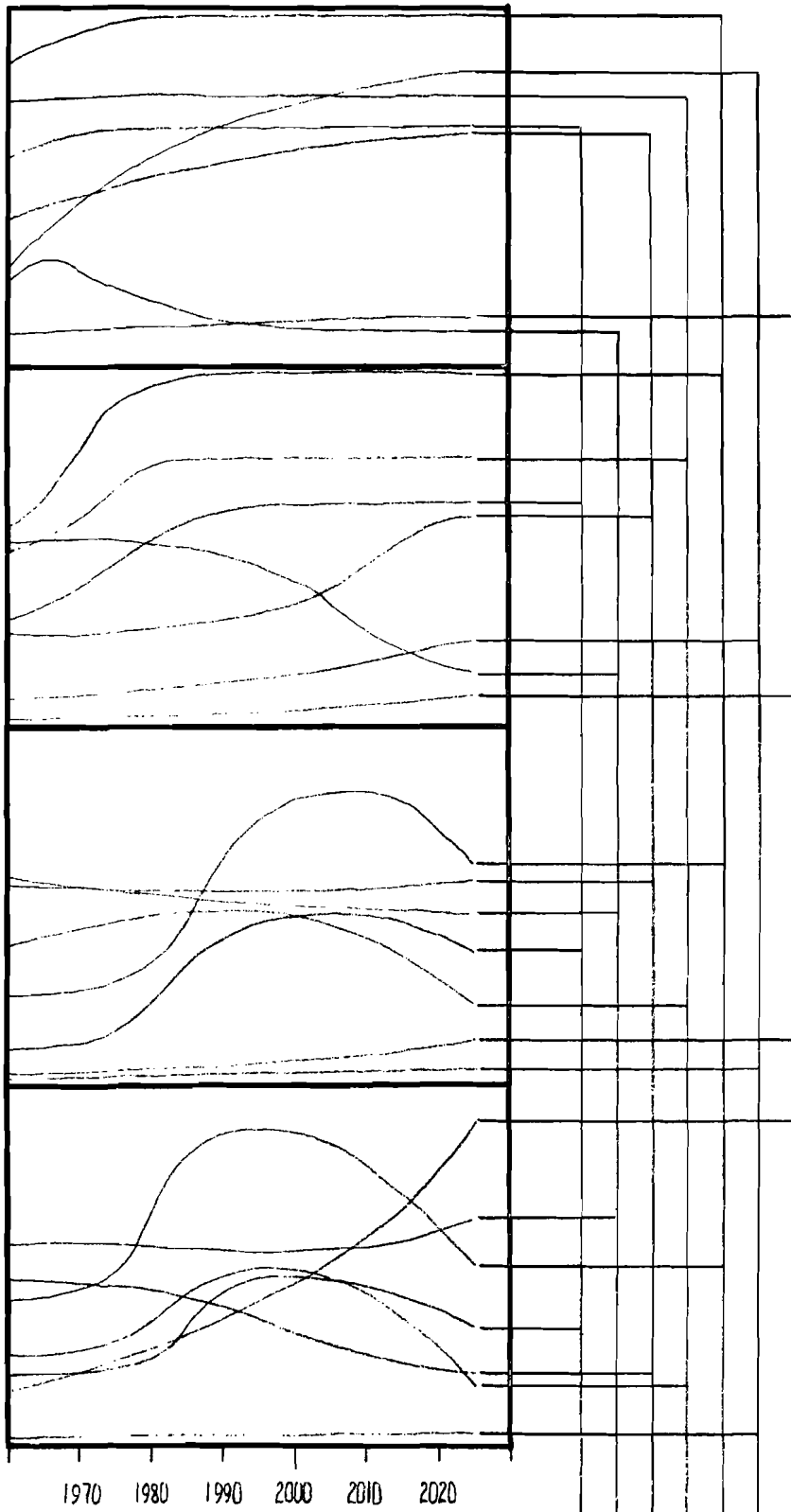from Block no. 1 to Blocks no. 3 and 4. Fig. 2 and 3 show

FIG. 1

BARILOCHE PARTITION OF THE WORLD
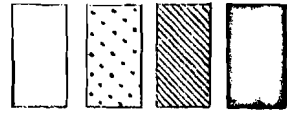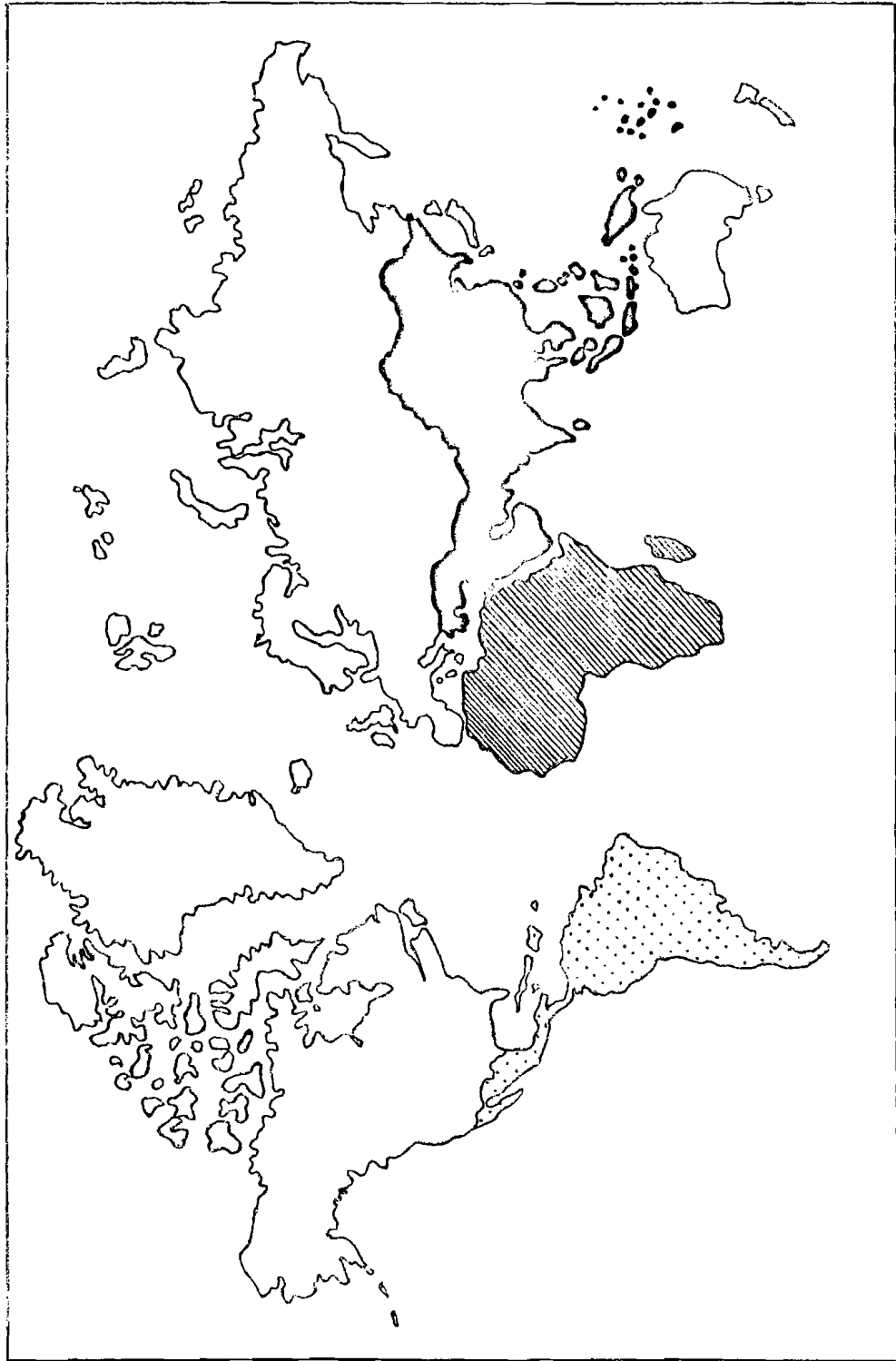
☐	BLOCK NO.1
⣿	BLOCK NO.2
▨	BLOCK NO.3
■	BLOCK NO.4

Nations with fewer than 10^6
inhabitants are not considered
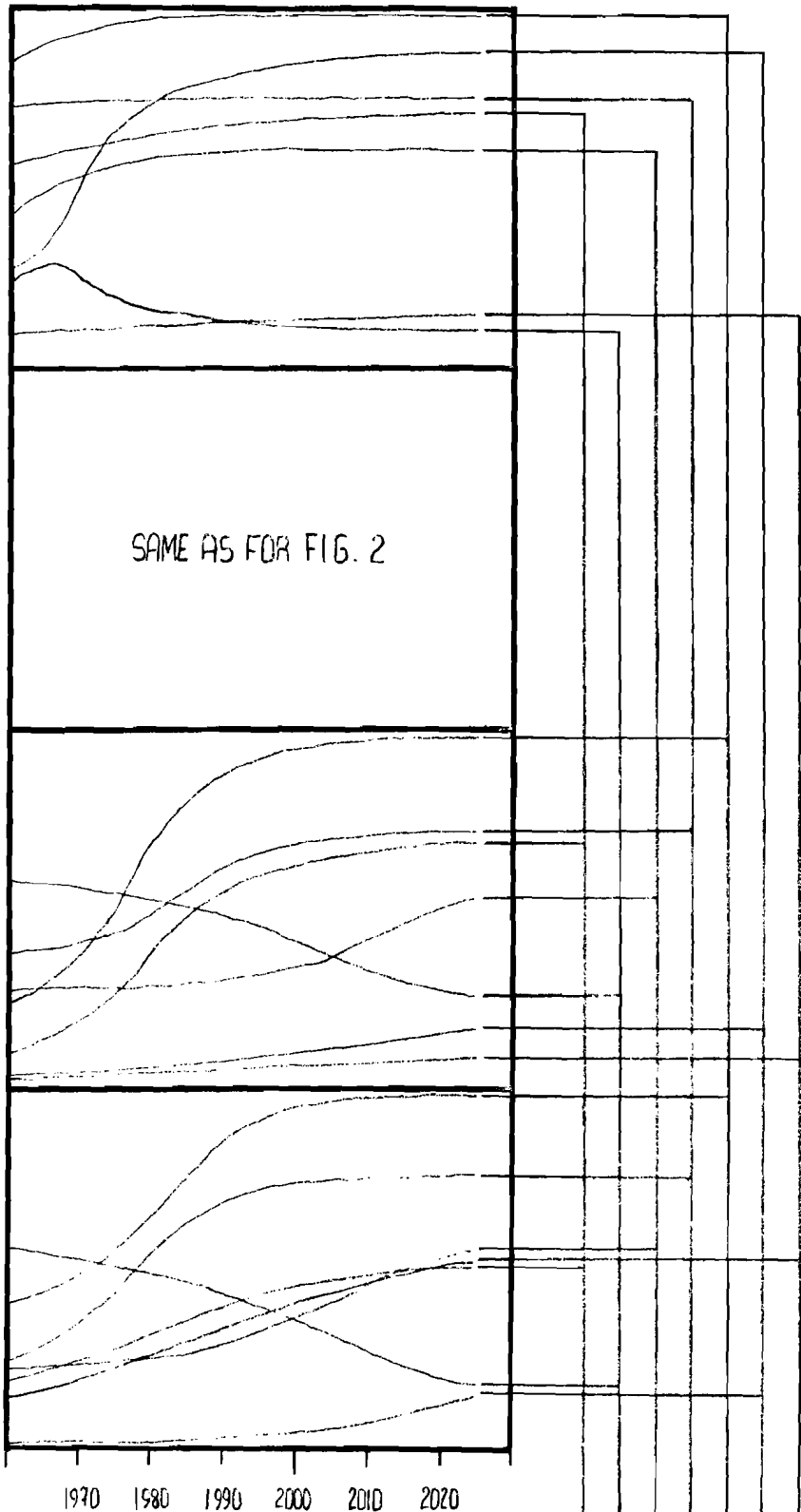in the Bariloche Model.

BLOCK NO. 1

BLOCK NO. 2

BLOCK NO. 3

BLOCK NO. 4

1970   1980   1990   2000   2010   2020

RUNS WITHOUT ECONOMIC AID

(NO TECHNOLOGICAL CHANGE)

FIG. 2

SCALE

POPULATION	0	10^{10}
GNP/CAPITA($)	0	5×10^3
ENROLLMENT(%)	0	100
CALORIES/CAPITA	1500	3500
HOUSES / FAMILY	0	2
POPULATION GROWTH RATE(%)	0	5
LIFE EXPECTANCY AT BIRTH (YR.)	40	90

BLOCK NO. 1

BLOCK NO. 2

SAME AS FOR FIG. 2

BLOCK NO. 3

BLOCK NO. 4

1970 1980 1990 2000 2010 2020

RUNS WITH ECONOMIC AID

(NO TECHNOLOGICAL CHANGE)

FIG. 3

SCALE		
POPULATION	0	10^{10}
GNP/CAPITA($)	0	5×10^{3}
ENROLLMENT(%)	0	100
CALORIES / CAPITA	1500	3500
HOUSES / FAMILY	0	2
POPULATION GROWTH RATE(%)	0	5
LIFE EXPECTANCY AT BIRTH(YR.)	40	90

the trial runs of the Bariloche model with and without
development aid.   The criteria for apportioning the 2 %
development aid among Blocks no. 3 and 4 was life expectancy
at birth and GNP/capita within the Blocks.

Block no. 2 got along well enough even without development
aid.   Within 40 years or so the Bariloche people predicted,
Block no. 2 would have no more problems.   The implication
in all this is of course, that allocation of resources is
made according to the Bariloche optimising criterion.   Well,
it's good to know the developed world doesn't need to have
any guilty conscience about not giving development aid to
Latin America!

But can Latin America save itself by itself, within 40 years
or even sixty for that matter?   The fundamental question is,
can Latin America optimise once a year or thereabouts *as one
block*, intelligently, rationally, philanthropically, altruis-
tically?   Unfortunately the Bariloche model contains the extra
hidden assumption of intra-block development aid.   Capital
and labour reallocation imply capital and labour mobility.
Can we see a spatial equilibration of capital and labour
within the Latin American block by small constrained permis-
sible yearly steps taken to maximise average block life-
expectancy at birth?   Can we see Venezuelan capital flowing
over the border to Equador and Bolivia, Mexican labour
wandering through the Isthmus off to Colombia, Peruvians into
Chile, Cubans to Brazil?   Its not just a question of migra-
tion costs.   Can we really imagine Honduran labour crossing
over to El Salvador?   What about the minor war they had in
1970 over a soccer game?

Maybe it's not useful to attempt an answer to these questions.
There are more however.   What about Asia and Africa?   According

to the Bariloche model they won't be saved unless the developed
countries pump at least 2 % development aid into them begin-
ning sometime around 1980[2]. And this assuming immediate
total homogenisation of political structures, races, creeds,
petty nationalisms, mores and the like, as the Bariloche
model implicitly does.

If one misses *this* "minor" point the blame for any future
collapse of Africa and Asia lies not partially, but *entirely*
with the developed countries.

Of course people used to dealing with high levels of aggrega-
tion will say well, it doesn't really make *that* much difference.
Sure, the curves won't be quite superimposable. Maybe more
disaggregation would have been better but more or less things
will go like that. But what about proving this?

At the rate things are going Argentina and Venezuela will
soon classify as developed countries and Mexico will be a
minor India. That's as good a proof as any!

A high level of aggregation may be relevant in purely projec-
tive studies but should be treated with some circumspection
in optimising studies.

If one looks hard enough, it is probably possible to find some
high-aggregation optimising efforts even now (Common Market,
Comecon, OPEC etc.), although this is not quite the type of
optimisation the Bariloche people had in mind and we know
how much trouble the national boundaries are giving these

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(2) The Bariloche group suggested starting with 0.2 % in
     1980 and working up to 2 % by 1990).

aggregates!

Unfortunately national boundaries still exist, and pretty
impenetrable they are too. Just try crossing the Darien
jungle from Panama to Colombia and see if they don't catch
you! National boundaries exist, people are egoistic, we
have a thing called space discounting, another thing called
nationalism. People like to hang on to what they've got and
maybe get hold of some more if they can while they are about
it. National governments are not run by computerised philan-
thropists fortunately, but by humans with all the negative
attributes humans tend to have.

Objections to the political implications were not very strong
at the conference. When someone did remonstrate as one or
two people did, they were silenced by the answer that it was
only a *feasibility* study after all. Just trying to show what
could happen if people got together and did things the way
they should be done--properly.

But where do you draw the line between *feasibility* and *infea-
sibility* in that case? Any study is based on assumptions, but
a feasibility study should be based on *realistic* assumptions.
At least that's the way I learned it. If we don't base our
studies on realistic assumptions we are left with something
which has only academic value.

Should we not ask about the queer idea of the United States,
the Soviet Union, Western Europe, Eastern Europe, Japan,
Australia, Lebanon and Israel getting together once a year
to redistribute their wealth according to their needs and the
needs of the developing world? American capital going to
Portugal and Greece, labour from Southern Europe going to
Sweden and Norway, Israelis and Lebanese mixing freely, Japa-

nese going to Australia. And all the Governments sitting at a round table once a year over a glass of whisky and a box of cigars? Sure, it would be very nice. But the Bariloche people are implying that to save the world all this must happen *now*, not fifty years in the future! Is this realistic?

Do the Bariloche people appreciate the frightful implications of exponential growth? They seem to have forgotten how fast the world is really moving. This fast moving world has such tremendous inertia to change that a step taken today may have effect (if it has any) not next year, but maybe 10 - 30 years from now.

When population doubles as fast as it does, every 33 years[3], then we must involve all time delays which are of this order of magnitude: for example, change in mores ($\sim$30 yrs.), construction of nuclear plants ($\sim$10 yrs.), growth of new forests ($\sim$10 yrs.) etc. It would take about 30 years for mores to change sufficiently in the Kingdom of Jordan so that the average woman there will have 2 rather than the present 5 or so children. By that time the population of the Kingdom of Jordan will have doubled anyway simply because people are reproducing all the time, as a matter of course. If development growth is only just sufficient to keep up with population growth, as it now seems to be, we can't even be certain that the mores will change very much, so that 30 years is probably a low estimate.

There seems to be nothing we can do to prevent this growth over at least the next thirty years, short of shooting all excess population, because unfortunately there *is* this thing called time-lag which for some unclear reason the Bariloche people omitted from their model! Although they did mention

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(3) In 1970.

they intended to include it some day.

In the meantime the press has spread the word once again that
the world can be saved only if the developed countries hand
out at least 2 % developemnt aid. This necessity for develop-
ment aid is probably correct, but we can be certain that the
Bariloche model has not proved it is a sufficient condition.

Up to now I've said nothing about technological change. The
Bariloche group made the most pessimistic assumptions possible
about technological change. It is not clear why they did
this. If on the one hand this choice implied the most pes-
simistic development prospects for the world as a whole, on
the other it surely layed more onus on the developed countries
in the form of development aid to save the world. In this
sense the choice of no technological change was politically
biased.

Introduction of technological change in the Cobb-Douglas
production function used by the group was of course quite
trivial and I can't imagine why the Bariloche group should
not have made a trial run with this corrective! It was un-
avoidable that someone should suggest including technological
change parameters in one of the trial runs available to the
conference. This was done with the results given in Fig. 4.
The whole world was saved, even without developemnt aid in
a surprisingly short time (before 1985)!

This new fact was received with mixed feelings since it seemed
to contradict everything that had been said or implied in the
previous two days of discussion. Admittedly there was some
space for argument since the technological change coefficients
used were those for the United States and these are presumably
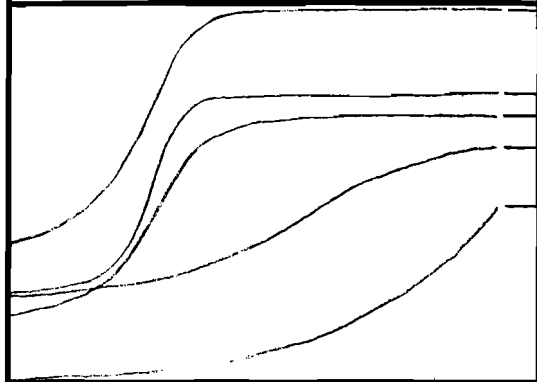higher than those for developing countries, although even this

NOT AVAILABLE

BLOCK NO. 1
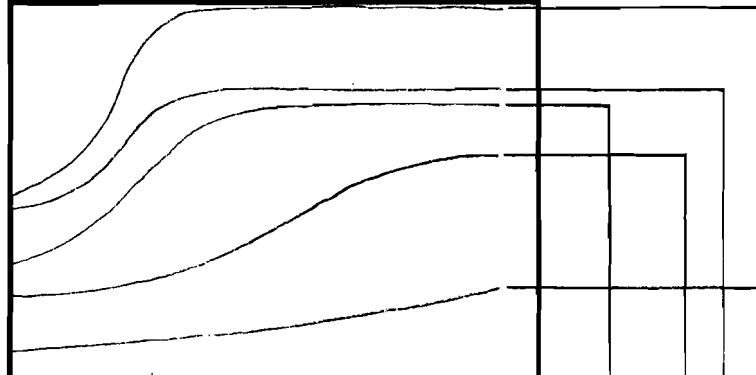
BLOCK NO. 2
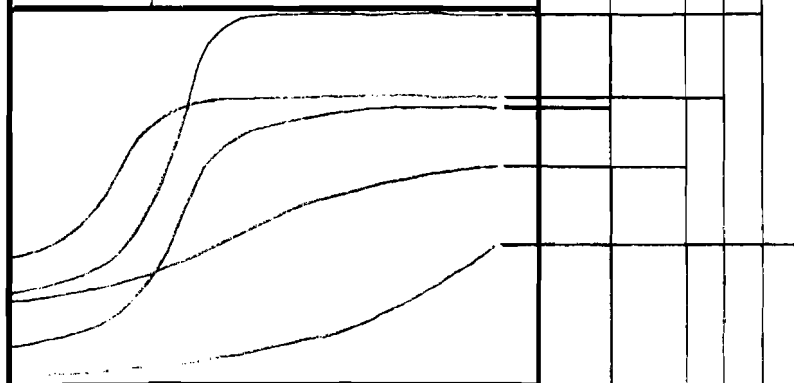
BLOCK NO. 3

BLOCK NO. 4

1970 1980 1990 2000 2010 2020

SCALE

RUNS WITHOUT ECONOMIC AID

(ASSUMING TECHNOLOGICAL CHANGE)

FIG. 4

GNP / CAPITA ($)   0 — 5×10³
ENROLLMENT (%)   0 — 100
CALORIES / CAPITA   1500 — 3500
HOUSES / FAMILY   0 — 2

LIFE EXPECTANCY AT BIRTH (YR.)   40 — 90

is debatable.

But at the time no one noticed or pointed out the full im-
plications of this demonstration. The particular test run
referred to showed that the introduction of not overly
optimistic technological change gave rise to overly optimistic
results. Who believes the world will be saved (in the sense the
Bariloche people had in mind) in 10 - 15 years and without
any development aid at that? One would have to be crazy!

This test was particularly useful however, because it picked
out the basic flaw in the Bariloche model. By relaxing the
pessimistic assumption of no technological change, the opti-
mistic attributes left in the model rose right up out of the
noise of confused pessimisms and optimisms. And what could
these be if not the fallacious political structure inherent
in the block-by-block, year-by-year optimising criterion?
The only other optimistic assumptions in the model refer to
pollution and maybe (but debatably) to natural resource
availability, but these are certainly not going to have any
preponderant effect over the next fifteen years.

Embedded in the block-by-block optimising criterion was the
other flaw: the exclusion of time-lags. The result of this
omission ceteris paribus, is to bring the saving of the
world an average weighted time-lag closer in time.

It is impossible to say which of these two flaws was most
responsible for the sudden, unaccountable saving of the world
in the next 10 - 15 years without development aid. The
Bariloche group would have to make a trial run using time-
lags where necessary, to see if we still have some residual
over-optimism to attribute to unrealistic assumptions of
socio-political nature. My guess is that we would. The

whole world would be saved in about 30 years[4] which is
still unbelievably, impossibly low if there is no develop-
ment aid whatever, by any measure of common sense.

What are we left with? The Bariloche model really doesn't
tell us very much. The basic flaws take all meaning out of
the results. If you make sufficiently favourable assumptions,
I suppose you could save the world by sending excess popula-
tion to the moon, or in orbit round the earth. Anything
becomes a feasibility study in that case.

But having made highly debatable assumptions in the beginning
people then insist on constructing, a grandiose, sophisticated
mathematical edifice around them and getting lost in all the
fascinating mathematical complexities, because mathematics
really is a fascinating tool. So we find that the Bariloche
group and many participants at the conference, were not
content with the interesting, innovative myopia of the pro-
gramming technique, which is to be acclaimed because it
really does attempt to simulate governments or market-govern-
ment mixes. Much of the discussion revolved around why the
Bariloche group had not used some optimal control solution!
They were so harassed by these attacks that the two mathemati-
cians in the group stayed up a whole night to work out an
algorithm for evaluating the optimal control path(5). Of
course they could not programme the application of the
algorithm in the short time available to them, otherwise we
might have witnessed Asia and Africa marching off to salva-
tion in a biblical seven years, without even a hint of develop-

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(4) 15 yrs. without time-lags + 15 yrs. average time-lag.

(5) The model was so highly constrained that the optimum
     path could hardly have been very different from the
     myopic programming path.

ment aid!

Would a Bariloche type model with maximum disaggregation
(into the 150 odd national blocks) be of any use? In this
case the objection of socio-political infeasibility would
possibly fall. The model would be more credible although
we would be forced to swallow the untruth that all govern-
ments allocate optimally according to Bariloche type criteria.
But at least we are getting closer to a *feasibility* study.
There is however one basic problem which maximum disaggrega-
tion does not solve and in fact aggravates. That is trade
relations. The Bariloche group entirely ignored trade rela-
tions between the four blocks. If this is not completely
satisfactory it can nevertheless be accepted as a first
order approximation at high levels of aggregation. But it
is quite inadmissible at the level of disaggregation (the
nation) for which the myopic optimisation becomes acceptable.
Any sensible model of world growth with disaggregation into
national entities finally rests on world trade.

With all its faults and fallacies the Bariloche model has
one great virtue. It has brought to the fore the necessity
of incorporating some "learning capacity" or at least "nor-
mative capacity" into models that are simply projective.
It is the first model that has done this even if only in a
rudimentary way, and it must be praised for breaking new
ground. It is quite likely that all global models from now
on will include at least a pinch of optimal allocation,
whether by market or central planning mechanisms, or at any
rate something that attempts to simulate the way nations
react to changing environments.