SYSTEMS SIMULATION FOR REGIONAL ANALYSIS. AN APPLICATION OF MATRIX INPUT-OUTPUT TO ISTMO DE TEHUANTEPEC

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ABSTRACT

This work is the application of systems simulation to regional analysis and its constains the philosophy and approach of the report dealing with economic growth in the Susquehanna River Basin prepared by Battelle Memorial Institut-Columbus Labs but a new look: the subsystem Input-Output matrix into the framework and with the demands (usually exogenous variables) like endogenous and with no necessarily fixed technical and capital coefficients over the time and its resolved by no conventional methods The application was in the Istmo De Tehuantepec, México.

INTRODUCTION

The classification of regional forecasting techniques like less sophisticated (Hamilton et al 1969, p. 55) as (1) trend extrapolation, (2) share analysis, and (3) simple economic base studies and, under the heading of sophisticated techniques has all of the kinds of mathematical models that make use tools as linear programming, input-output analysis and complex regional accounting. Models give us an overview of the campus of action. Several of the models reviewed also employ regional input-output analysis and were forced to use national coefficients at the regional level. Is possible to incorporate the matrix Input-Output of Leontieff with relative inexpensive costs of time and memory solving de subsystem of equation by no conventional methods like Gaussian Elimination, Gauss-Jordan Elimination, Method of Kaczmarz, Newton-Raphson Iteration, etc. This new method and the fact of to incorporate the matrix in the Susquehanna Model is with the finality of to have an approximation to "reality" and to reforce the make of decisions, in the regional and national level.

MATRIX INPUT-OUTPUT

In the input-ouput analysis, developed by Wassily W. Leontieff the economy is broken into sectors (or industries) and the flow of goods and services among sectors or industries is registered to indicate systematically the relations among them. These relations are called input-output relations because they tell us -

what inputs a sector needs to produce its output.

CONTRIBUTION

The final demands are endogenous variables too, and then, there are interacctions between all the relevants variables, and we can to simulate for every politic the growth or decline of the National or regional gross output, employ, etc.

The technical and capital coefficients can to change internally like hipothesis about the future variations of them, with a simple tables functions.

THE SUBMODEL

The subsystem of equations where the economy is divided into n production industries is:

$$x_i(t) - a_{i1}^t x_1(t) - a_{i2}^t x_2(t) - \dots\dots\dots a_{in}^t x_n(t) -$$

$$- b_{i1}^t \dot{x}_1(t) - b_{i2}^t \dot{x}_2(t) - \dots\dots\dots b_{in}^t \dot{x}_n(t) = y_i(t)$$

$$i = 1, 2, 3, \dots\dots n$$

where:

$x_i(t)$ = Gross output of sector i in the time t = x_i^t

$\dot{x}_i(t)$ = rate change of the gross output of the sector i in the time t = $\dot{x}_i^t$

a_{ij}^t = technical coeffcient in the time t

b_{ij}^t = capital coefficient in the time t

y_i^t = Final demand of the sector i in the time t

t = time

or, in practice form:

$$x_i^t - a_{i1}^t x_1^t - a_{i2}^t x_2^t - \dots\dots\dots - a_{in}^t x_n^t -$$

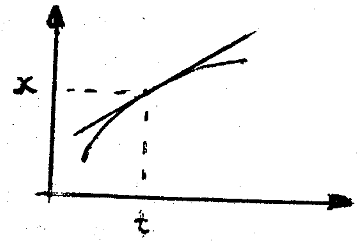
$$- b_{i1}^t (x_1^{t+1} - x_1^t) - b_{i2}^t (x_2^{t+1} - x_2^t) - \dots\dots\dots - b_{in}^t (x_n^{t+1} - x_n^t) = y_i^t$$

if we have only two sectors:

$$x_1^t = (1/(1-a_{11}^t))(a_{12}^t x_2^t + b_{11}^t(x_1^{t+1}-x_1^t) + b_{12}^t(x_2^{t+1}-x_2^t) + y_1^t)$$

and we assume:

$$\text{slope} = \frac{x_1^{t+1} - x_1^t}{dt} = \frac{x_1^t - x_1^{t-1}}{dt}$$



then:

$$x_1^t = (1/(1-a_{11}^t))(a_{12}^t x_2^t + b_{11}^t(x_1^t-x_1^{t-1}) + b_{12}^t(x_{12}^t-x_2^{t-1}) + y_1^t)$$

and with a simple example en languaje DYNAMO (observe the equations number 12 and 25)

1) PT1.K = PT1.J + (DT)((1/T)(TX1.J - PT1.J) $= x_t^t$

2) PT1 = 0

3) TX1.K = (1/(1-A11))(STOCK1.K + DSECT2.K + DTOC2.K + Y1.K)

4) DPROP1.K = (A11)(PT1.J) (if we want to know de own demand)

5) STOCK1.K = (B11)(REALS1.K)

6) REALS1.K = CLIP(IP1.K,0,IP1.K,0)

7) IP1.K = PT1.J - A1.J

8) DSECT2.K = (A12)(PT2.J)

9) DSTOC2.K = (B12)(REALS2.K)

10) A1.K = A1.J + (DT)((1/T)(TA1.J - A1.J))

11) A1 = 0

✓ 12) TA1.K = PT1.J

if the demand is fixed (for validation)

13) Y1.K = TABLE(TY1T,TIME.K,0,.5,.5)

14) TY1T = 0/55/55/55/55/55/55/55/55/55/55

15) PT2.K = PT2.J + (DT)((1/T)(TX2.J - PT2.J)) $= x_2^t$

16) PT2 = 0

17) TX2.K = (1/(1-A22))(DSECT1.K + DSTOC1.K + STOCK2.K + Y2.K)

18) DSECT1.K = (A21)(PT1.j)

19) DSTOC1.K = (B21)(REALS1.K)

20) DPROP2.K = (A22)(PT2.J)

21) STOCK2.K = (B22)(REALS2.K)

22) REALS2.K = CLIP(IP2.K,0,IP2.K,0)

23) A2.K = A2.J = (DT)(1/T)(TA2.J - A2.J)

24) A2 = 0

✓ 25) TA2.K = PT2.J

26) Y2.K = TABLE(TY2T,TIME.K,0,.5,.5)

27) TY2T = 0/30/30/30/30/30/30/30/30/30/30

Technical and Capital coefficients: A11, B11

28) A11 = 0.25

29) A12 = 0.20

30) A21 = 0.14

31) A22 = 0.12

32) B11 = 0.20

33) B12 = 0.05

34) B21 = 0.01

35) B22 = 0.07

36) T = 0.125

PRINT 1)DPROP1/2)STOCK1/3)DSECT2/4)DSTOC2/5)Y1/6)PT1

PRINT 1)DSECT1/2)DSTOC2/3)DPROP2/4)STOCK2/5)Y2/6)PT2

SPEC DT = 0.125

SPEC LENGTH = 5

SPEC PRTPER = 0.5

SPEC PLTPER = 0.125

37) IP2.K = PT2.J - A2.J

With this method proposed we have no to use the matrix inverse etc, for the solution of simultaneous equations, for Matrix I/O

In the figure No. 1 we can to see the results with both demands constants, and then, the gross output sector (1) and sector 2 are constants (for validation). In the figure No. 2 the demands change over the time, demand Y_1 growth and decline and the demand Y_2 decline and growth. Both are constants in the last period. We can to observe too, the theoric capacity of recuperation of the sector 2

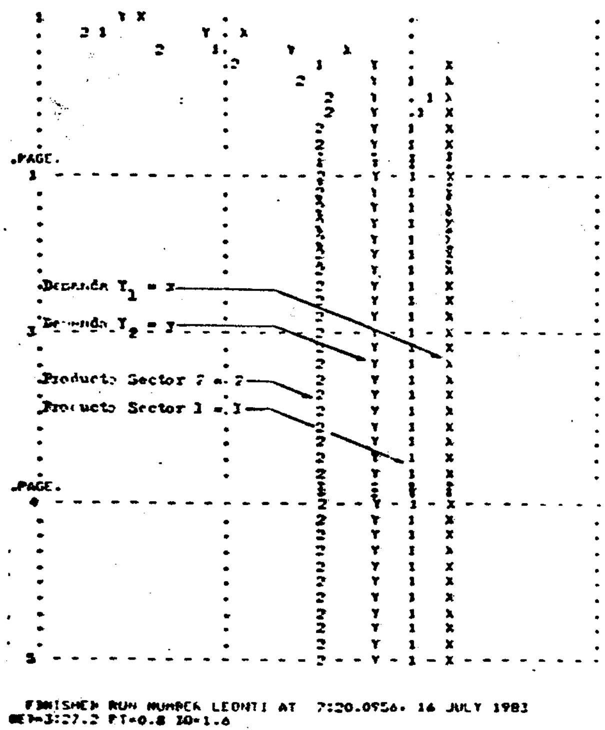


Figure No. 1

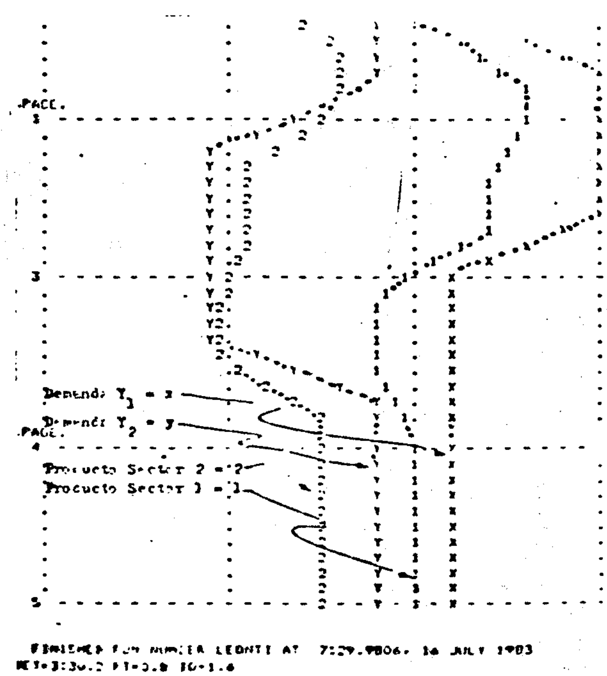
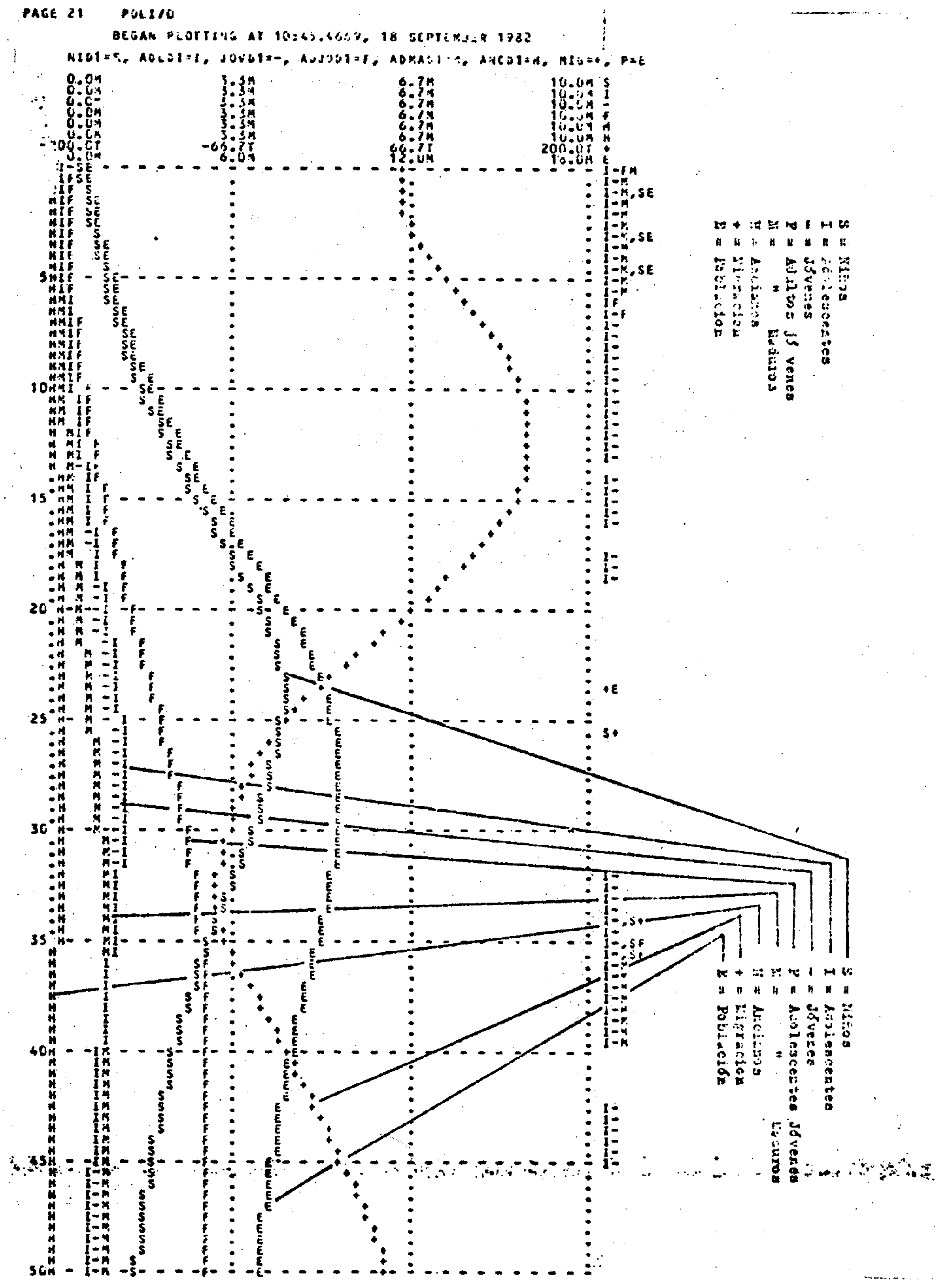


Figure No 2

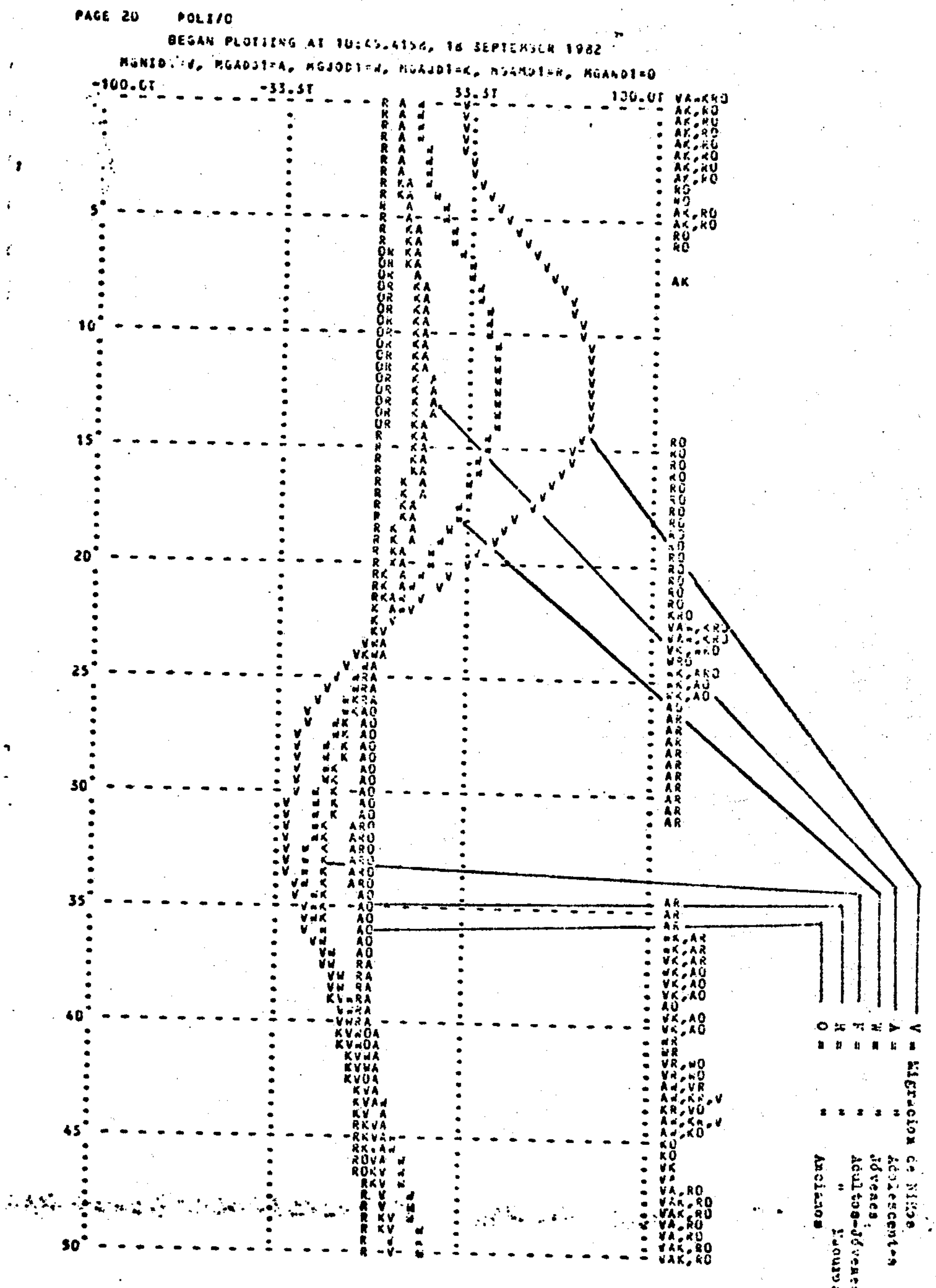
In the next figures, for the regional model in the Istmo de Tehuantepec, the results of several runs show us the dinamic of the region for several politics, with with the conception and philosophy of the model of the Susquehanna River Basin, and incorporating various submodels, by example: number of beds for hospital, contamination in the atmosphere, transportation of goods (submodel of gravity between principal - nodes), use land etc.

This work was present to Ex-Minister of Transport and Comunication, Eng. Rodolfo Félix Valdés and in the National Academy of Engineers.



<u>**Figure No. 3**</u>

Demography composition with six groups of ages (S,I,-,P,M,N), Total Migration M and Total Poblation K, over 50 years.



<u>Figure No. 4</u>

Migration by group of age: Childrens = V, Teenagers = A,.......
Old men = O over 50 years.

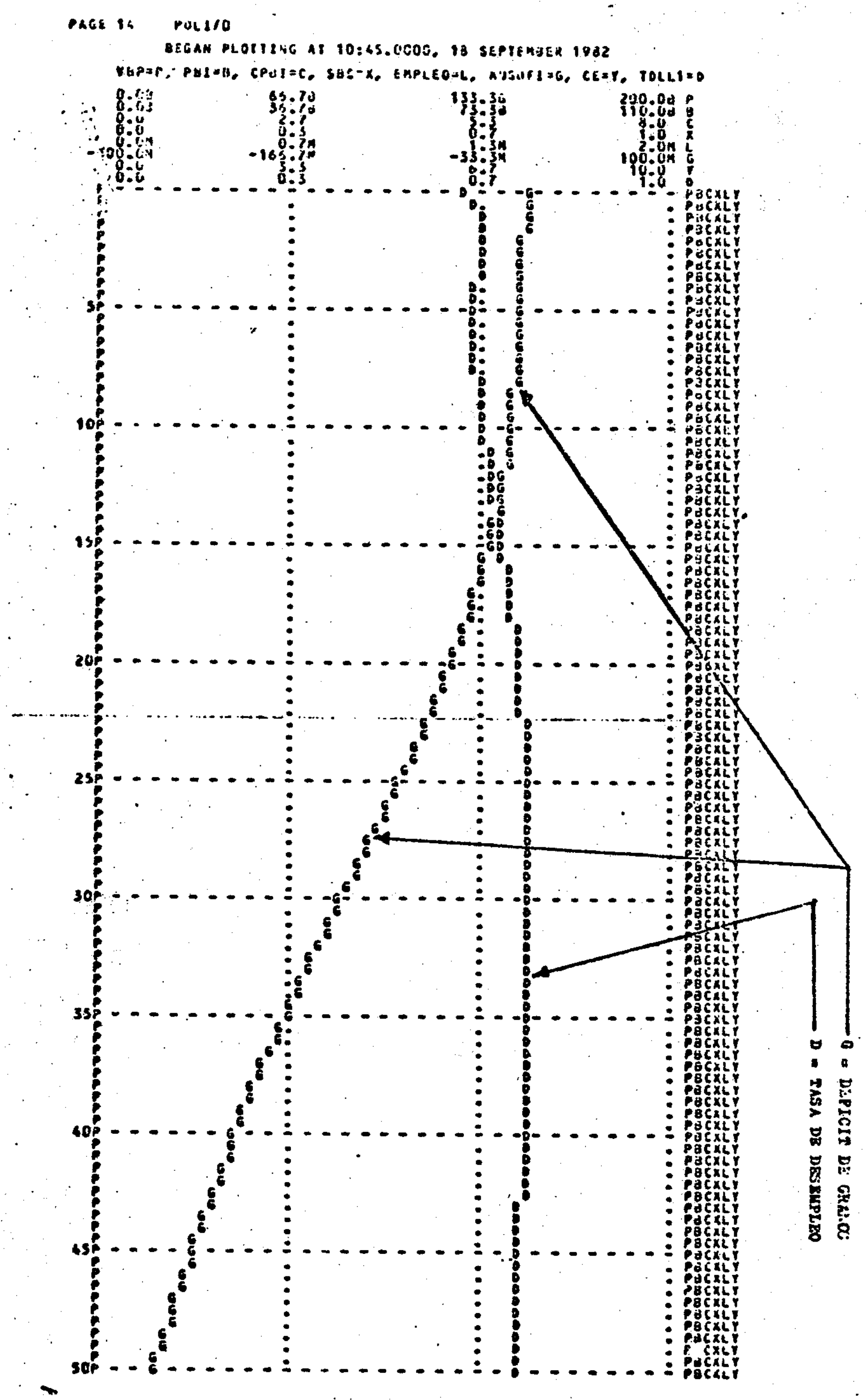
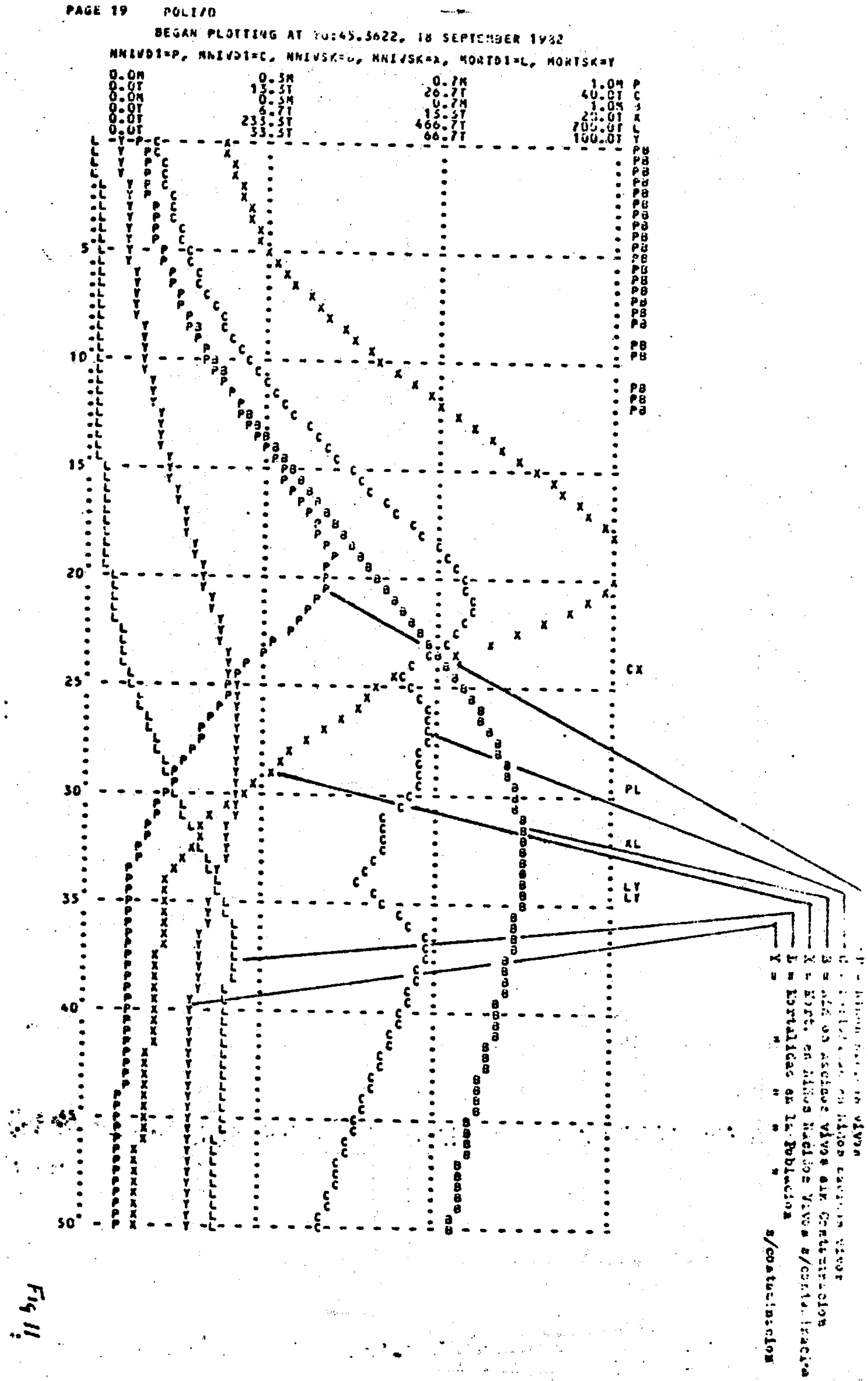


Figure No. 5

Difference of grains needed en the region and the own production = G, and the rate of unemployment = D



<u>Figure No. 6</u>

Babies born alive = <u>P</u>, mortality in babies born alive = <u>C</u>, Babies born alive WITHOUT contamination = <u>B</u>, Babies born alive WITH contamination = X, Total mortality in the population = L

Total mortality in the population without contamination.

CONCLUSIONS

We can to replaced or augmented "technical" sectors. Into the framework, is possible to incorporate the matrix Input-Output with this new method, only like approximation to "reality", in the analysis of National or Regional Level

The door is open to submodels of linear programming.

Simulation has more attention by National or Regional analysis than have many others techniques.

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