SYSTEM DYNAMICS MODEL OF INFRASTRUCTURE INDUCED DEVELOPMENT ON TAIWAN

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ABSTRACT

This paper describes a pilot model, the harbinger of a comprehensive package of interactive national, regional and sectoral models of Taiwan, to be used for long range planning. The model, called DMT (Development Model of Taiwan) is distilled from many mental and verbal models of Taiwan, each of which involved various segments of the system with considerations given to certain variables and to various policy interventions involving still other variables.

DMT is organized into seven sectors: (1) Industrial Sector, (2) Environmental Sector, (3) Infrastructure Sector, (4) Social Development Sector, (5) Demographic Sector, (6) Agriculture Sector, and (7) Employment Sector. The Industrial Sector is subdivided into manufacturing, mining, construction and business. The Infrastructure Sector is modeled to include highways, railroads, ports, airports, power and energy, water supply and distribution, telecommunications, and sewage collection and treatment. The Social Development Sector is comprised of the following elements: health, education, housing, family planning, and welfare. The Demographic Sector is made up of a rural population component and an urban population component. The Environmental Sector is organized according to the socio-economic pollution-generating sources. The Employment Sector consists of 18 categories corresponding to the Industrial, Infrastructure and Social Development Sector subdivisions.

The ultimate purpose of the examination of Taiwan's development experience, indeed any country's development experience, should be more than simply attempting to understand what happened during a certain period. It should be to distill conclusions that may be translated to policies and strategies for guiding its future development. We consequently have tried to illuminate the possibilities at various levels of aggregation and analysis through the use model generated scenarios. Seven policy experiments are described in the paper: (1) Government Support of Agriculture Policy, (2) Government Allocation to Social Services, (3) Industrial Development Policy, (4) Infrastructure Induced Development Policy, (5) Environmental Protection Policy, (6) Zoning Policy, and (7) Immigration Policy.

INTRODUCTION

Taiwan shares a number of common characteristics with many developing societies: (1) it is only modestly endowed with natural resources; (2) it is located in the tropics; (3) its economy, until recently, was based on the export of a small number of primary products; and (4) for a part of its history, it was a colony. But, as with every society, Taiwan also has its unique features: (1) several major migrations brought to Taiwan not only additional manpower but also skills and technology more advanced than those possessed by the indigenous population at the time; (2) throughout most of the twentieth century, Taiwan's government participated actively in developing the economy; and (3) from time to time in critical situations, Taiwan has been the recipient of significant amounts of external aid. Its similarities with other less developed regions and its unique features combine to make Taiwan an extremely useful and illuminating case study of socio-economic development.

Our case study is all the more interesting because Taiwan has been relatively successful in its development efforts. Its agriculture output has increased ten-fold in the twentieth century and its industrial output over twenty-fold in the past three decades. Not only does Taiwan rank among the fastest growing economies in the world but its phenomenal growth has been accomplished with equity. This is rare because accelerated growth in developing countries has most often been accomplished by a worsening of already unfavorable indices of equality. An examination of the relations between growth, equity and stability in Taiwan may help to isolate the critical elements of this performance.

PURPOSE AND APPROACH

Taiwan is committed to development and social welfare achieved through, and based on, free-market principles. It has practiced fiscal conservancy so as to maintain a balanced budget and to prevent renewed inflation. It initiated land reform without compromising agriculture production and protected infant industries without reducing productivity. The government took the difficult step of reorienting the economy to exports via trade liberalization, price reforms, and other increatives. It created a good business climate for local and foreign investment in labor intensive rather than showcase capital-intensive industry, which helped to absorb labor and distribute income more equitably. Last, but not least, the government wisely invested heavily in infrastructure which has paid-off handsomely in increasing the value-added of its industrial output. Miraculously, this socio-economic take-off was achieved in a world environment that can be described as unsympathetic, and perhaps even hostile, to Taiwan.

The key question is: can Taiwan sustain the economic growth, social equity and political stability that it has attained over the past 35 years? If the mood is optimistic and our response is affirmative, then we must ask ourselves, "how long"? Slowly and painfully we have begun to appreciate the fact that growth cannot be maintained indefinitely in a finite world; can we ignore this principle in the case of a small island?

The purpose of this study is to determine if Taiwan should, or indeed must, make a transition from growth to equilibrium and, if so, how best to achieve it. The aim is to obtain a deeper understanding of this problem which every country in the world faces to varying degrees and in assessing the possibility of Taiwan serving as a model for the rest of the world.

Recognizing that Taiwan's future will be the product of the interaction of a number of forces -- economic, political, and social; endogenous and exogenous; constructive and destructive; fortuitous and planned; ideological and pragmatic -- a comprehensive approach is needed. Until recently, there has been no way to estimate the behavior of a complex national socio-economic system such as Taiwan except by contemplation, discussion, and speculation

It is now possible to construct realistic mathematical models of nations and experiment with these models using computers. The system dynamics methodology, specifically developed for this type of analysis, is used in this study. The premise is that planning Taiwan's future should concentrate on avoiding the types of problems that typically occur in the pursuit of unrealistic, unachievable goals.

OVERVIEW

DMT (Development Model of Taiwan) is distilled from many mental and verbal models of Taiwan, each of which involves segments of the system with considerations given to certain variables and policy interventions involving still other variables. To link the goals and policy variables, the various experts have implied an understanding of the complex set of intervening relationships. However, often this understanding is implicit and subjective. In contrast, the complex set of intervening relationships between variables in DMT are expressed explicitly in two complementary forms -- causal diagrams and DYNAMO equations. The verbal descriptions of Taiwan contained in reams of pages spanning many subjects and disciplines cannot promote the type of communication and understanding leading to informed consensus and they are too fuzzy, static, incomplete, and imprecise to be used for decision-making. DMT can be represented in a single page in the form of a causal diagram displaying the intervening relationships between goal and policy variables (see Fig. 1).

The causal diagram in Fig. 1 not only facilitates writing the equations that permit one to perform the arithmetic tasks that will trace Taiwan's development through time, but portrays a gestalt-like statement of the Taiwanese social-economic development system in its own right. The significance of this graphic gestalt in the modeling paradigm is that it takes us out of a communication cul-de-sac providing a common vocabulary and structure of reasoning between individuals, professions, specialists, administrators, and cultures.

DMT is structured to accommodate three development orientations: (1) resource development, (2) regional development, and (3) sectoral development. Resource components include natural resources, land resources, water resources, and human resources (manpower). Regional development is organized on the basis of rual and urban in DMT. Economic elements represented in the model include agriculture, manufacturing, business, infrastructure and government. Obviously, the three orientations overlap. They are also tied together by two quantities most responsible for material growth: (1) population -- including the effects of all economic and environmental factors that influence human birth, death, and migration rates, and (2) capital -- including the means of producing industrial, service, and agricultural outputs. For the purpose of this report, DMT is organized as follows: Industrial Sector, Environmental Sector, Infrastructure Sector, Social Development Sector, Demographic Sector, Employment Sector, and Agriculture Sector (see Fig. 2).

INDUSTRIAL SECTOR

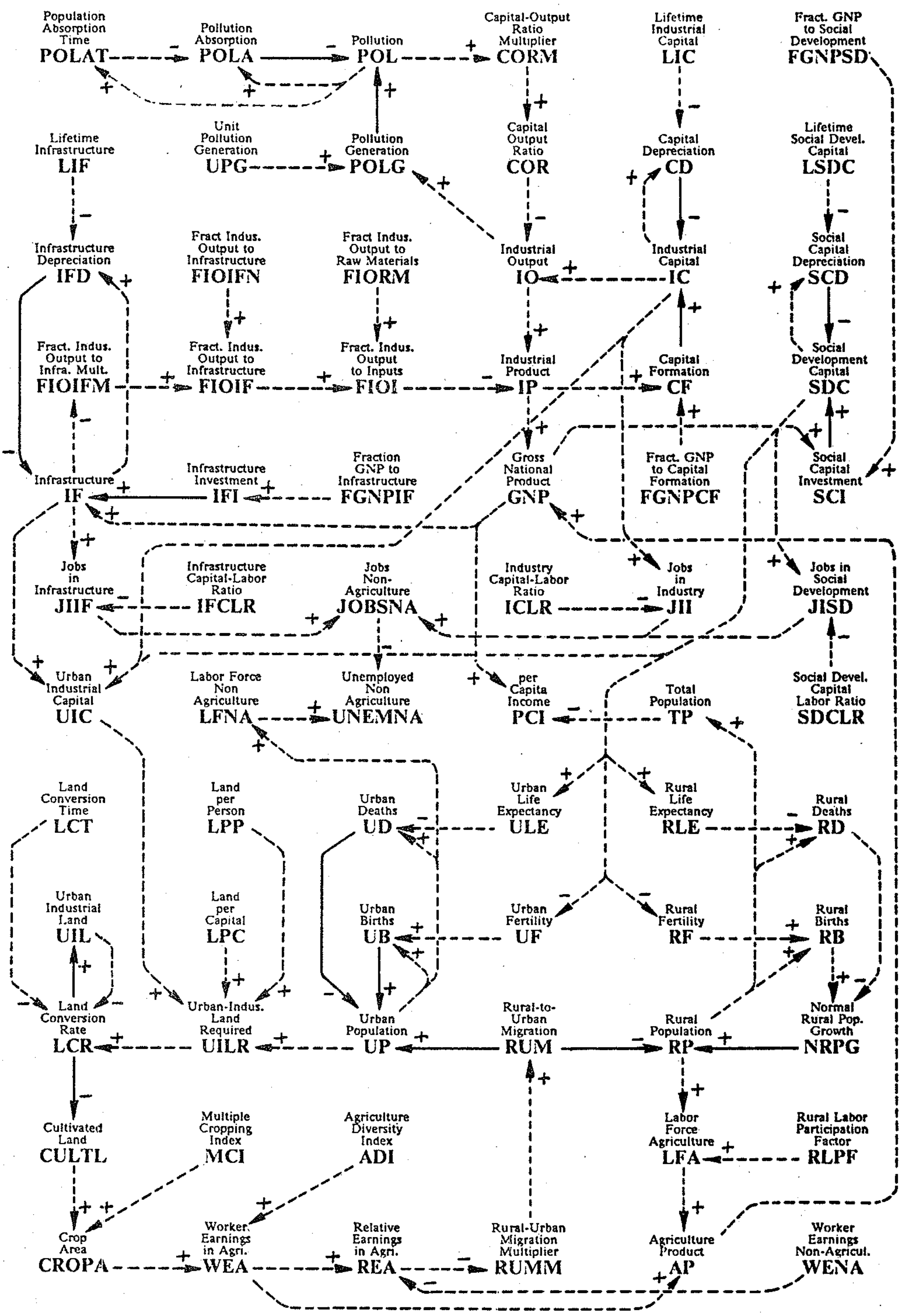
Taiwan's industrial development pattern in the past can, broadly speaking, be defined as an early primary import-substitution period followed by a principally unskilled-labor funded primary export orientation period. In modeling industrial development, many of the sectors of DMT can be thought of as elements in a national account. The national account is concerned with the measure of aggregate product originating within some geographical area, in this case Taiwan, so that a picture of economic performance can be gained.

The end result of economic activity is the production of goods and services and the distribution of those goods and services to the members of society. The most comprehensive measure of national output is the gross national product, abbreviated GNP. It is the value of all goods and services produced annually in the nation. The task of estimating the GNP, however, is not merely adding up the value of all output because that would be doubl-counting. In DMT the "value-added" method is used because in a complex society like Taiwan, there are very few final outputs produced solely by one industry. The final value of any product is created by a large number of different industries; each firm buys materials or supplies from other firms, processes or transports them, and thus adds to their value.

There are four major components of GNP, each representing a final use of GNP: consumption, investment, government purchase, and net exports. Investment refers to that portion of the final output which takes the form of additions to or replacements of capital. Government purchase of goods and services are a second component of GNP. In addition, government makes other expenditures, "transfer payments," which do not represent the purchase of output and are consequently excluded from GNP. Consumption refers to the portion of nation's output devoted to meeting consumer wants. Net exports, exports minus imports of goods and services, are a final use of GNP and must be included in our total.

For purposes of national income analysis, GNP statistics are subdivided into mutually exclusive, collectively exhaustive categories. The most commonly used scheme for subdivision is that based on the International Standard Industrial Classification (ISIC). The nine major ISIC categories are listed in Table 1.

Each of the nine ISIC economic output divisions in Table 1 is associated with a particular capital stock in DMT. In our model the agriculture provides most of the output in the first ISIC division. The "mining," "manufacturing," and "construction," capital stock in DMT provides the output in ISIC divisions 2 and 3. Business capital in the model is associated with the activities listed under ISIC divisions 6 and 8. The infrastructure sector in the model corresponds to ISIC divisions 4 and 7, and the social development sector to ISIC division 9. This disaggregated version of the



DEVELOPMENT MODEL OF TAIWAN

FIGURE 1

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NOTE *******************************************************
NOTE  FIG. 2  DEVELOPMENT MODEL OF TAIWAN (DMT-3)
NOTE *******************************************************
NOTE
NOTE INDUSTRIAL SECTOR
NOTE
FOR A=1,4=MINING,MANUF,CONSTR,BUSIN
NOTE FOR - COMPUTES SUBSCRIPTED EQUATIONS A
L     IC.K(A)=IC.J(A)+(DT)((CF.JK(A)*(1+AROI*DT))-CD.JK(A))       (1)
NOTE IC - INDUSTRIAL CAPITAL
N     IC(A)=ICN(A)                                                  (1.1)
T     ICN(*)=30E9/900E9/200E9/470E9                                 (1.2)
NOTE ICN - INITIAL VALUES OF INDUSTRIAL CAPITAL (NT$)
C     AROI=.05                                                      (1.3)
NOTE AROI - ANNUAL RATE OF INFLATION (FRAC/YR)
A     TIC.K=SUM(IC.K)                                               (1.4)
NOTE TIC - TOTAL INDUSTRIAL CAPITAL (NT$)
A     TICN.K=SUM(ICN)                                               (1.5)
NOTE TICN - TOTAL INDUSTRIAL CAPITAL INITIALLY (NT$)
R     CD.KL(A)=IC.K(A)/LIC(A)                                       (2)
NOTE CD - CAPITAL DEPRECIATION (NT$/YR)
T     LIC(*)=25/25/25/25                                            (2.1)
NOTE LIC - LIFETIME INDUSTRIAL CAPITAL (YR)
R     CF.KL(A)=GNP.K*FGNPCF(A)+HKC.K                                (3)
NOTE CF - CAPITAL FORMATION (NT$/YR)
T     FGNPCF(*)=.00375/.11250/.02500/.05875                         (3.1)
NOTE FGNPCF - FRACT GNP CAPITAL FORMATION (DIM)
A     HKC.K=CLIP(HKCI,0,TIME.K,1992)-CLIP(HKCI,0,TIME.K,1997)       (3.2)
NOTE HKC - HONG KONG CAPITAL (NT$/YR)
N     HKCI=ACPP*HKM                                                 (3.3)
NOTE HKCI - HONG KONG CAPITAL INVEST (NT$/YR)
C     ACPP=0                                                        (3.4)
NOTE ACPP - AVER CAPITAL PER PERSON (NT$/YR)
A     IP.K(A)=IO.K(A)*(1-FIOI.K(A))                                 (4)
NOTE IP - INDUSTRIAL PRODUCT (NT$/YR)
A     GNP.K=SUM(IP.K)+AP.K                                          (5)
NOTE GNP - GROSS NATIONAL PRODUCT (NT$/YR)
A     IO.K(A)=IC.K(A)/COR.K(A)                                      (6)
NOTE IO - INDUSTRIAL OUTPUT (NT$/YR)
A     FIOI.K(A)=FIORM(A)+FIOIF.K(A)                                 (7)
NOTE FIOI - FRAC INDUSTRIAL OUPUT TO INPUTS (DIM)
T     FIORM(*)=.2/.2/.2/.2                                          (7.1)
NOTE FIORM - FRAC INDUS OUTPUT TO RAW MATERIALS (DIM)
A     FIOIF.K(A)=FIOIFN(A)*FIOIFM.K(A)                              (8)
NOTE FIOIF - FRAC INDUS OUTPUT TO INFRASTRUCTURE (DIM)
T     FIOIFN(*)=.4/.4/.4/.4                                         (8.1)
NOTE FIOIFN - FRAC INDUS OUTPUT TO INFRA NORMAL (DIM)
A     FIOIFM.K(A)=TABXT(FIOIFT,(TICCI.K/TIFCI.K)/(TICN.K/TIFN.K),0,2,.5) (9)
NOTE FIOIFM - FRAC INDUS OUTPUT TO INFRA MULTIPLIER (DIM)
T     FIOIFT*.6/.75/1/1.1/1.2                                       (9.1)
NOTE FIOIFT - TABLE VALUES FOR FIOIFM (DIM)
A     TICCI.K=SUM(ICCI.K)                                           (9.2)
NOTE TICCI - TOTAL IND. CAPITAL CORRECTED FOR INFLATION (NT$)
L     ICCI.K(A)=ICCI.J(A)+(DT)(CF.JK(A)-CD.JK(A))                   (9.3)
N     ICCI(A)=ICN(A)                                                (9.4)
NOTE ICCI - INDUS. CAPITAL CORRECTED FOR INFLATION (NT$)
A     COR.K(A)=CORN(A)*CORM.K(A)                                    (10)
NOTE COR - CAPITAL OUTPUT RATIO (YR)
T     CORN(*)=1/1/1/1                                               (10.1)
NOTE CORN - CAPITAL OUTPUT RATION NORMAL (1/YR)
A     CORM.K(A)=TABXT(CORT(*,A),POLR.K,1,11.4,10.4)                 (11)
NOTE CORM - CAPITAL OUTPUT RATION MULTIPLIER (DIM)
T     CORT(*,MINING)=1/1.5                                          (11.1)
T     CORT(*,MANUF)=1/1.5                                           (11.2)
T     CORT(*,CONSTR)=1/1.5                                          (11.3)
T     CORT(*,BUSIN)=1/1.5                                           (11.4)
NOTE CORT - CORM TABLE VALUES (DIM)
A     PCI.K=GNP.K/TP.K                                              (12)
NOTE PCI - PER CAPITA INCOME (NT$/YR-PERSON)
A     PCIN.K=GNPN.K/TPN                                             (12.1)
NOTE PCIN - PER CAPITA INCOME NORMAL (NT$/YR)
A     GNPN.K=TICN.K*(1-AFIORM.K-AFIOIF.K)/ACORN.K+WEAN*RPN*RLPF     (12.2)
NOTE GNPN - GROSS NATIONAL PRODUCT NORMAL (NT$/YR)
A     AFIORM.K=SUM(FIORM)/4                                         (12.3)
NOTE AFIORM - AVER FRAC INDUS OUTPUT TO RAW MATERIALS (DIM)
A     AFIOIF.K=SUM(FIOIFN)/4                                        (12.4)
NOTE AFIOIF - AVER FRAC INDUS OUTPUT TO INFRA NORMAL (DIM)
A     ACORN.K=SUM(CORN)/4                                           (12.5)
NOTE ACORN - AVER CAPITAL OUTPUT RATIO NORMAL (YR)
N     ION=ICN(*)/CORN(*)                                            (12.6)
NOTE ION - INDUSTRIAL OUTPUT NORMAL (NT$/YR)
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NOTE
NOTE ENVIRONMENTAL SECTOR
NOTE
L     POL.K(A)=POL.J(A)+(DT)((POLG.JK(A)/(1+AROI*DT))-POLA.JK(A))   (13)
NOTE POL - POLLUTION (GRAM)
N     POL(A)=POLN(A)                                                (13.1)
N     POLN(A)=ICN(A)                                                (13.2)
NOTE POLN - POLLUTION INITIAL VALUE (GRAM)
R     POLA.KL(A)=POL.K(A)/POLAT.K(A)                                (14)
NOTE POLA - POLLUTION ABSORPTION (GRAM/YR)
A     POLAT.K(A)=(POLATN(A)*TABXT(POLATM(*,A),POLR.K,0,10,1))       (15)
NOTE POLAT - POLLUTION ABSORPTION TIME (YR)
T     POLATN(*)=5/5/5/5                                             (15.1)
NOTE POLATN - POLLUTION ABSORPTION TIME NORMAL (YR)
T     POLATM(*,MINING)=1/1/1.19/1.32/1.41/1.5/1.57/1.63/1.68/1.73/1.78 (15.2)
T     POLATM(*,MANUF)=1/1/1.19/1.32/1.41/1.5/1.57/1.63/1.68/1.73/1.78  (15.2)
T     POLATM(*,CONSTR)=1/1/1.19/1.32/1.41/1.5/1.57/1.63/1.68/1.73/1.78 (15.2)
T     POLATM(*,BUSIN)=1/1/1.19/1.32/1.41/1.5/1.57/1.63/1.68/1.73/1.78  (15.2)
NOTE POLATM - TABLE VALUES FOR POL ABSORPTION TIME MULT (DIM)
R     POLG.KL(A)=IO.K(A)*UPG(A)                                     (16)
NOTE POLG - POLLUTION GENERATION (GRAM/YR)
T     UPG(*)=.25/.25/.25/.25                                        (16.1)
NOTE UPG - UNIT POLLUTION GENERATION (GRAM/NT$)
A     POLR.K=SUM(POL.K)/SUM(POLN)                                   (17)
NOTE POLR - POLLUTION RATIO (DIM)
NOTE
NOTE INFRASTRUCTURE SECTOR
NOTE
FOR B=1,8=HIWAY,RAIL,PORTS,AIRPRT,POWER,WATER,TELCOM,SEWER
L     IF.K(B)=IF.J(B)+(DT)(IFI.JK(B)-IFD.JK(B))                     (18)
NOTE IF - INFRASTRUCTURE (NT$)
N     IF(B)=IFN(B)                                                  (18.1)
T     IFN(*)=200E9/200E9/200E9/200E9/200E9/200E9/200E9/200E9        (18.2)
NOTE IFN - INITIAL VALUES OF INFRASTRUCTURE (NT$)
A     TIF.K=SUM(IF.K)                                               (18.3)
NOTE TIF - TOTAL INFRASTRUCTURE (NT$)
A     TIFN.K=SUM(IFN)                                               (18.4)
NOTE TIFN - TOTAL INFRASTRUCTURE INITIALLY (NT$)
NOTE FOR - COMPUTES SUBSCRIPTED EQUATIONS B
R     IFD.KL(B)=IF.K(B)/LIF(B)                                      (19)
NOTE IFD - INFRASTRUCTURE DETERIORATION (NT$/YR)
T     LIF(*)=50/50/50/50/50/50/50/50                                (19.1)
NOTE LIF - LIFETIME INFRASTRUCTURE (YR)
R     IFI.KL(B)=GNP.K*FGNPIF(B)                                     (20)
NOTE IFI - INFRASTRUCTURE INVESTMENT (NT$/YR)
T     FGNPIF(*)=.0125/.0125/.0125/.0125/.0125/.0125/.0125/.0125     (20.1)
NOTE FGNPIF - FRAC GNP TO INFRASTRUCTURE (DIM)
S     IFCPCR.K=(TIFCI.K/TP.K)/(TIFN.K/TPN)                          (21)
NOTE IFCPCR - (INFRA CAPITAL PER CAPITA RATIO (DIM)
L     IFCI.K(B)=IFCI.J(B)+(DT)((IFI.JK(B)/(1+AROI*DT))-IFD.JK(B))   (21.1)
N     IFCI(B)=IFN(B)                                                (21.2)
NOTE IFCI - INFRASTRUCTURE CORRECTED FOR INFLATION (NT$)
A     TIFCI.K=SUM(IFCI.K)                                           (21.3)
NOTE TIFCI - TOTAL INFRA. CORRECTED FOR INFLATION (NT$)
NOTE
NOTE SOCIAL DEVELOPMENT SECTOR
NOTE
FOR C=1,5=HEALTH,EDUCA,HOUSING,FAMPLN,WELFRE
NOTE FOR - COMPUTES SUBSCRIPTED EQUATIONS C
L     SDC.K(C)=SDC.J(C)+(DT)(SCI.JK(C)-SCD.JK(C))                   (22)
NOTE SDC - SOCIAL DEVELOPMENT CAPITAL (NT$)
N     SDC(C)=SDCN(C)                                                (22.1)
T     SDCN(*)=160E9/160E9/160E9/160E9/160E9                         (22.2)
NOTE SDCN - SOCIAL DEVEL CAPITAL INITIAL VALUES (NT$)
A     TSDC.K=SUM(SDC.K)                                             (22.3)
NOTE TSDC - TOTAL SOCIAL DEVEL CAPITAL (NT$)
A     TSDCN.K=SUM(SDCN)                                             (22.4)
NOTE TSDCN - TOTAL SOCIAL DEVEL CAPITAL INITIALLY (NT$)
R     SCD.KL(C)=SDC.K(C)/LSDC(C)                                    (23)
NOTE SCD - SOCIAL DEVEL CAPITAL DEPRECIATION (NT$/YR)
T     LSDC(*)=50/50/50/50/50                                        (23.1
NOTE LSDC - LIFETIME SOCIAL DEVEL CAPITAL (YR)
R     SCI.KL(C)=GNP.K*FGNPSD(C)                                     (24)
NOTE SCI - SOCIAL DEVEL CAPITAL INVESTMENT (NT$/YR)
T     FGNPSD(*)=.015/.015/.015/.015/.015                            (24.1)
NOTE FGNPSD - FRAC GNP TO SOCIAL DEVELOPMENT (DIM)
A     SDCPCR.K=(TSDCCI.K/TP.K)/(TSDCN.K/TPN)                        (25)
NOTE SDCPCR - SOCIAL DEVEL CAPITAL PER CAPITA RATIO (DIM)
L     SDCCI.K(C)=SDCCI.J(C)+(DT)((SCI.JK(C)/(1+AROI*DT))-SCD.JK(C)) (25.1)
N     SDCCI(C)=SDCN(C)                                              (25.2)
NOTE SDCCI - SOCIAL DEVEL. CAPITAL CORRECTED FOR INFLATION (NT$)
A     TSDCCI.K=SUM(SDCCI.K)                                         (25.3)
NOTE TSDCCI - TOTAL SOCIAL DEVEL. CAPITAL CORRECTED FOR INFLATION (NT$)
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NOTE
NOTE DEMOGRAPHIC SECTOR
NOTE
A    TP.K=UP.K+RP.K                                              (26)
NOTE TP - TOTAL POPULATION (PERSONS)
N    TPN=UPN+RPN                                                 (26.1)
NOTE TPN - TOTAL POPULATION NORMAL (PERSONS)
L    UP.K=UP.J+(DT)(UB.JK-UD.JK-ER.JK+IM.JK+RUM.JK)              (27)
N    UP=UPN                                                      (27.1)
NOTE UP - URBAN POPULATION (PERSONS)
C    UPN=12.8E6                                                  (27.2)
NOTE UPN - URBAN POPULATION INITIAL VALUE (PERSONS)
R    UB.KL=UP.K*UF.K                                             (28)
NOTE UB - URBAN BIRTHS (PERSONS/YR)
A    UF.K=UFN*UFM.K                                              (29)
NOTE UF - URBAN FERTILITY (FRACT/YR)
C    UFN=.03                                                     (29.1)
NOTE UFN - URBAN FERTILITY NORMAL (FRACT/YR)
A    UFM.K=TABXT(UFMT,SDCPCR.K,.5,6,.5)                          (30)
NOTE UFM - URBAN FERTILITY MULTIPLIER (DIM)
T    UFMT=1.1/1/.92/.85/.79/.74/.70/.67/.65/.64/.634/.63         (30.1)
NOTE UFMT - URBAN FERTILITY MULT TABLE VALUES
R    UD.KL=UP.K*UM.K                                             (31)
NOTE UD - URBAN DEATHS (PERSONS/YR)
A    UM.K=PMM.K*ULEM.K/ULEN                                      (32)
NOTE UM - URBAN MORTALITY (FRACT/YR)
C    ULEN=67                                                     (32.1)
NOTE ULEN - URBAN LIFE EXPECTANCY NORMAL (YR)
A    ULEM.K=TABXT(ULEMT,SDCPCR.K,.5,6,.5)                        (33)
NOTE ULEM - URBAN LIFE EXPECTANCY MULTIPLIER (DIM)
T    ULEMT=1/1/.98/.964/.95/.937/.925/.913/.901/.89/.88/.87      (33.1)
NOTE ULEMT - URBAN LIFE EXPECTANCY MULT TABLE VALUES
A    PMM.K=TABXT(PMMT,POLR.K,0,10,1)                             (34)
NOTE PMM - POLLUTION MORTALITY MULTIPLIER (DIM)
T    PMMT=1/1/1.005/1.013/1.025/1.043/1.07/1.11/1.16/1.22/1.29   (34.1)
NOTE PMMT - POLLUTION MORTALITY MULT TABLE VALUES (DIM)
R    ER.KL=UP.K*EF*EM.K                                          (35)
NOTE ER - EMIGRATION RATE (PERSONS/YR)
C    EF=.001                                                     (35.1)
NOTE EF - EMIGRATION FACTOR (FRACT/YR)
A    EM.K=TABXT(EMT,PCI.K/PCIN,0,2,.25)                          (36)
NOTE EM - EMIGRATION MULTIPLIER (DIM)
T    EMT=20/8/4/2/1/.85/.8/.8/.8                                 (36.1)
NOTE EMT - EMIGRATION MULTIPLIER TABLE VALUES
R    IM.KL=CLIP(HKM,0,TIME.K,1992)-CLIP(HKM,0,TIME.K,1997)+NIM   (37)
NOTE IM - IMMIGRATION (PERSONS/YR)
C    HKM=0                                                       (37.1)
NOTE HKM - HONG KONG MIGRATION (PERSONS/YR)
C    NIM=10000                                                   (37.2)
NOTE NIM - NORMAL IMMIGRATION (PERSONS/YR)
L    RP.K=RP.J+(DT)(RB.JK-RD.JK-RUM.JK)                          (38)
N    RP=RPN                                                      (38.1)
NOTE RP - RURAL POPULATION (PERSONS)
C    RPN=5E6                                                     (38.2)
NOTE RPN - RURAL POPULATION INITIAL VALUE (PERSONS)
R    RB.KL=RP.K*RF.K                                             (39)
NOTE RB - RURAL BIRTHS (PERSONS/YR)
A    RF.K=RFN*RFM.K                                              (40)
NOTE RF - RURAL FERTILITY (FRACT/YR)
C    RFN=.036                                                    (40.1)
NOTE RFN - RURAL FERTILITY NORMAL (FRACT/YR)
A    RFM.K=TABXT(RFMT,SDCPCR.K,.5,6,.5)                          (41)
NOTE RFM - RURAL FERTILITY MULTIPLIER (DIM)
T    RFMT=1/1/.9/.769/.667/.588/.526/.475/.435/.406/.382/.372    (41.1)
NOTE RFMT - RURAL FERTILITY MULT TABLE VALUES
R    RD.KL=RP.K*RM.K                                             (42)
NOTE RD - RURAL DEATHS (PERSONS/YR)
A    RM.K=RLEM.K/RLEN                                            (43)
NOTE RM - URBAN MORTALITY (FRACT/YR)
C    RLEN=65                                                     (43.1)
NOTE RLEN - RURAL LIFE EXPECTANCY NORMAL (YR)
A    RLEM.K=TABXT(RLEMT,SDCPCR.K,.5,6,.5)                        (44)
NOTE RLEM - RURAL LIFE EXPECTANCY MULTIPLIER (DIM)
T    RLEMT=1/1/.98/.95/.901/.88/.87/.865/.862/.86/.86/.86        (44.1)
NOTE RLEMT - RURAL LIFE EXPECTANCY MULT TABLE VALUES
S    FPU.K=UP.K/TP.K                                             (45)
NOTE FPU - FRACT POPULATION URBAN (DIM)
S    PD.K=TP.K/AREA                                              (46)
NOTE PD - POPULATION DENSITY (PERSONS/SQ KM)
C    AREA=36000                                                  (46.1)
NOTE AREA - AREA OF TAIWAN (SQ KM)
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NOTE
NOTE AGRICULTURE SECTOR
NOTE
R    RUM.KL=NRPG.K*RUMM.K                                        (47)
NOTE RUM - RURAL-URBAN MIGRATION (PERSONS/YR)
A    NRPG.K=RB.JK-RD.JK                                          (48)
NOTE NRPG - NATURAL RURAL POPULATION GROWTH (PERSONS/YR)
A    RUMM.K=TABXT(RUMMT,REA.K/REAN.K,0,2,.5)                     (49)
NOTE RUMM - RURAL-URBAN MIGRATION MULTIPLIER (DIM)
T    RUMMT=2/1.4/1/.75/.6                                        (49.1)
NOTE RUMMT - TABLE VALUES FOR RUMM
A    REAN.K=WEAN/WENAN.K                                         (50)
NOTE REAN - RELATIVE EARNINGS AGRICULTURE NORMAL (DIM)
A    WENAN.K=(GNPN.K-WEAN*RPN*RLPF)/LFNAN                        (50.1)
NOTE WENAN - WORKER EARNINGS NON-AGRICULTURE NORMAL (NT$/WORKER-YR)
N    LFNAN=UPN*ULPF                                              (50.2)
NOTE LFNAN - LABOR FORCE NON-AGRICULTURE NORMAL (WORKERS)
A    REA.K=WEA.K/WENA.K                                          (51)
NOTE REA - RELATIVE EARNING IN AGRICULTURE (DIM)
A    WENA.K=SUM(IP.K)/JOBSNA.K                                   (52)
NOTE WENA - WORKER EARNINGS NON-AGRICULTURAL (NT$/WORKER-YR)
A    WEA.K=WEAN*(CROPA.K/CROPAN)*(ADI.K/ADIN)                    (53)
X         *((1+AROI*DT)**(TIME.K-1980))
NOTE WEA - WORKER EARNINGS AGRICULTURE (NT$/WORKER)
C    WEAN=80000                                                  (53.1)
NOTE WEAN - WORKER EARNINGS AGRICULTURE NORMAL (NT$/WORKER-YR)
C    ADIN=10                                                     (53.2)
NOTE ADIN - AGRICULTURAL DIVERSITY INDEX NORMAL (DIM)
A    ADI.K=TABXT(ADIT,TIME.K,1980,2050,10)                       (54)
NOTE ADI - AGRICULTURAL DIVERSITY INDEX (DIM)
T    ADIT=10/11/11.8/12.5/13.1/13.6/14/14.3                      (54.1)
NOTE ADIT - TABLE VALUES FOR ADI
A    CROPA.K=CULTL.K*MCI.K                                       (55)
NOTE CROPA - CROP AREA (HA)
N    CROPAN=CULTLN*MCIN                                          (55.1)
NOTE CROPAN - CROP AREA NORMAL (HA)
C    MCIN=2.0                                                    (55.2)
NOTE MCIN - MULTIPLE CROPPING INDEX NORMAL (DIM)
A    MCI.K=TABXT(MCIMT,FGNPA/FGNPAN,0,4,1)
X         *TABXT(MCIT,TIME.K,1980,2050,10)                       (56)
NOTE MCI - MULTIPLE CROPING INDEX (DIM)
T    MCIT=2/2.5/2.9/3.2/3.4/3.5/3.5/3.5                          (56.1)
T    MCIMT=1/1/1.3/1.5/1.6                                       (56.2)
NOTE MCIT - TABLE VALUES FOR MCI
S    PCCPR.K=(CROPA.K/TP.K)/(CROPAN/TPN)                         (57)
NOTE PCCPR - PER CAPITA CROP PRODUCTION RATIO (DIM)
A    LFA.K=RP.K*RLPF                                             (58)
NOTE LFA - LABOR FORCE AGRICULTURE (WORKERS)
C    RLPF=.3                                                     (58.1)
NOTE RLPF - RURAL LABOR PARTICIPATION FACTOR (DIM)
L    CULTL.K=CULTL.J-(DT)(LCR.JK)                                (59)
N    CULTL=CULTLN                                                (59.1)
NOTE CULTL - CULTIVATED LAND (HA)
C    CULTLN=900000                                               (59.2)
NOTE CULTLN - CULTIVATED LAND INITIALLY
L    UIL.K=UIL.J+(DT)(LCR.JK)                                    (60)
N    UIL=UILN                                                    (60.1)
NOTE UIL - URBAN INDUSTRIAL LAND (HA)
N    UILN=((ICN(1)+ICN(2)+ICN(3)+ICN(4))
X         +(IFN(1)+IFN(2)+IFN(3)+IFN(4)+IFN(5)+IFN(6)+IFN(7)+IFN(8))
X         +(SDCN(1)+SDCN(2)+SDCN(3)+SDCN(4)+SDCN(5)))*LPCN
X         +UP.K*LPPN                                             (60.2)
NOTE UILN - URBAN INDUSTRIAL LAND INITIALLY (HA)
C    LPCN=1.2E-8                                                 (60.3)
NOTE LPCN - LAND PER CAPITAL NORMAL (HA/NT$)
C    LPPN=.004                                                   (60.4)
NOTE LPPN - LAND PER PERSON NORMAL (HA/PERSON)
A    LPC.K=LPCN*LPCM.K                                           (61)
NOTE LPC - LAND PER CAPITAL (HA/NT$)
A    LPP.K=LPPN*LPPM.K                                           (62)
NOTE LPP - LAND PER PERSON (HA/PERSON)
A    LPCM.K=TABXT(LPCMT,UIL.K/UILN,0,5,1)                        (63)
T    LPCMT=1.2/1/.9/.85/.82/.8                                   (63.1)
NOTE LPCM - LAND PER CAPITAL MULTIPLIER (DIM)
A    LPPM.K=TABXT(LPPMT,UIL.K/UILN,0,5,1)                        (64)
T    LPPMT=1.2/1/.9/.85/.82/.8                                   (64.1)
NOTE LPPM - LAND PER PERSON MULTIPLIER (DIM)
R    LCR.KL=(UILR.K-UIL.K)/LCT                                   (65)
NOTE LCR - LAND CONVERSION TIME (YR)
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C    LCT=5                                                              (65.1)
NOTE LCT - LAND CONVERSION TIME (YR)
A    UILR.K=(TIC.K+TIF.K+TSDC.K)*LPC.K+UP.K*LPP.K                       (66)
NOTE UILR - URBAN INDUSTRIAL LAND REQUIRED (HA)
A    AP.K=WEA.K*LFA.K                                                   (67)
NOTE AP - AGRICULTURE PRODUCT (NT$/YR)
C    FGNPA=.025                                                         (67.1)
NOTE FGNPA - FRACT GNP TO AGRICULTURE (DIM)
C    FGNPAN=.025                                                        (67.2)
NOTE FGNPAN - FRACT GNP TO AGRICULTURE NORMAL (DIM)
S    AFS.K=(CULTL.K/CULTLN)*(RPN/RP.K)*AFSN                             (68)
NOTE AFS - AVERAGE FARM SIZE (HA)
C    AFSN=1.1                                                           (68.1)
NOTE AFSN - AVERAGE FARM SIZE IN 1980 (HA)
S    PPF.K=TP.K/LFA.K                                                   (69)
NOTE PPF - POPULATION PER FARMER (DIM)
NOTE
NOTE EMPLOYMENT SECTOR
NOTE
A    JII.K(A)=ICCI.K(A)/ICLR.K(A)                                       (70)
NOTE JII - JOBS IN INDUSTRY (PERSONS)
A    ICLR.K(A)=ICLRN(A)*ICLRM.K(A)                                      (71)
NOTE ICLR - INDUS CAPITAL-LABOR RATIO (NT$/PERSON)
T    ICLRN(*)=.425E6/.425E6/.425E6/.425E6                               (71.1)
NOTE ICLRN - INDUS CAPITAL-LABOR RATIO NORMAL (NT$/PERSON)
A    ICLRM.K(A)=TABXT(ICLRT(*,A),ICCI.K(A)/ICN(A),1,8,1)                (72)
NOTE ICLRM - INDUS CAPITAL-LABOR RATIO MULTIPLIER (DIM)
T    ICLRT(*,1)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66                    (72.1)
T    ICLRT(*,2)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66                    (72.2)
T    ICLRT(*,3)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66                    (72.3)
T    ICLRT(*,4)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66                    (72.4)
NOTE ICLRT - TABLE VALUES FOR ICLRM
A    JIIF.K(B)=IFCI.K(B)/IFCLR.K(B)                                     (73)
NOTE JIIF - JOBS IN INFRASTRUCTURE (PERSONS)
A    IFCLR.K(B)=IFCLRN(B)*IFCLRM.K(B)                                   (74)
NOTE IFCLR - INFRASTRUCTURE CAPITAL-LABOR RATIO (NT$/PERSON)
T    IFCLRN(*)=1.56E6/1.56E6/1.56E6/1.56E6/1.56E6/1.56E6/1.56E6/1.56E6 (74.1)
NOTE IFCLRN - INFR CAPITAL-LABOR RATIO NORMAL (NT$/PERSON)
A    IFCLRM.K(B)=TABXT(IFCLRT(*,B),IFCI.K(B)/IFN(B),1,8,1)              (75)
NOTE IFCLRM - INFRA CAPITAL-LABOR RATIO MULTIPLIER (DIM)
T    IFCLRT(*,1)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66                   (75.1)
T    IFCLRT(*,2)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66                   (75.2)
T    IFCLRT(*,3)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66                   (75.3)
T    IFCLRT(*,4)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66                   (75.4)
T    IFCLRT(*,5)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66                   (75.5)
T    IFCLRT(*,6)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66                   (75.6)
T    IFCLRT(*,7)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66                   (75.7)
T    IFCLRT(*,8)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66                   (75.8)
NOTE IFCLRT - TABLE VALUES FOR IFCLRM
A    JISD.K(C)=SDCCI.K(C)/SDCLR.K(C)                                    (76)
NOTE JISD - JOBS IN SOCIAL DEVELOPMENT (PERSONS)
A    SDCLR.K(C)=SDCLRN(C)*SDCLRM.K(C)                                   (77)
NOTE SDCLR - SOCIAL DEVEL CAPITAL-LABOR RATIO (NT$/PERSON)
T    SDCLRN(*)=1.56E6/1.56E6/1.56E6/1.56E6/1.56E6                       (77.1)
NOTE SDCLRN - SOCIAL DEVEL CAPITAL-LABOR RATIO NORMAL (NT$/PERSON)
A    SDCLRM.K(C)=TABXT(SDCLRT(*,C),SDCCL.K(C)/SDCN(C),1,8,1)            (78)
NOTE SDCLRM - SOCIAL DEVEL CAPITAL-LABOR RATIO MULTIPLIER (DIM)
T    SDCLRT(*,1)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66                   (78.1)
T    SDCLRT(*,2)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66                   (78.2)
T    SDCLRT(*,3)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66                   (78.3)
T    SDCLRT(*,4)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66                   (78.4)
T    SDCLRT(*,5)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66                   (78.5)
NOTE SDCLRT - TABLE VALUES FOR SDCLRT
S    LF.K=LFNA.K+LFA.K                                                  (79)
NOTE LF - LABOR FORCE (PERSONS)
A    LFNA.K=UP.K*ULPF                                                   (80)
NOTE LFNA - LABOR FORCE NON-AGRICULTURE (PERSONS)
C    ULPF=.4                                                            (80.1)
NOTE ULPF - URBAN LABOR PARTICIPATION FRACTION (DIM)
A    JOBSNA.K=TJII.K+TJIIF.K+TJISD.K                                    (81)
NOTE JOBSNA - JOBS NON-AGRICULTURE (PERSONS)
A    TJII.K=SUM(JII.K)                                                  (81.1)
NOTE TJII - TOTAL JOBS IN INDUSTRY (PERSONS)
A    TJIIF.K=SUM(JIIF.K)                                                (81.2)
NOTE TJIIF - TOTAL JOBS IN INFRASTRUCTURE (PERSONS)
A    TJISD.K=SUM(JISD.K)                                                (81.3)
NOTE TJISD - TOTAL JOBS IN SOCIAL DEVELOPMENT (PERSONS)
S    UNEMNA.K=(LFNA.K-JOBSNA.K)/LFNA.K                                  (82)
NOTE UNEMNA - UNEMPLOYMENT NON-AGRICULTURE (DIM)
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NOTE
NOTE CONTROL STATEMENTS
NOTE
C    DT=.5
N    TIME=1980
C    LENGTH=2030
C    PLTPER=1
C    PRTPER=10
PLOT UP=U,RP=R,TP=T
PLOT IC(1)=N,IC(2)=M,IC(3)=C,IC(4)=B,TIC=T
PLOT IP(1)=N,IP(2)=M,IP(3)=C,IP(4)=B,AP=A,GNP=G
PLOT IF(1)=H,IF(2)=R,IF(3)=P,IF(4)=A,IF(5)=F,IF(6)=W,IF(7)=T,IF(8)=S
PLOT SDC(1)=H,SDC(2)=E,SDC(3)=D,SDC(4)=F,SDC(5)=W
PLOT TIC=I,TIF=F,TSDC=S
PLOT UIL=U,CULTL=C
PLOT TJII=I,TJIIF=F,TJISD=S,JOBSNA=J
PLOT JII(1)=N,JII(2)=M,JII(3)=C,JII(4)=B,TJII=I
PLOT WENA=N,WEA=A,PCI=I
PLOT UNEMNA=U
PLOT LFNA=L,JOBSNA=J
PLOT IFCPCR=I,SDCPCR=S,POLR=P
PLOT FPU=U,PCCPR=C
PLOT AFS=F
PLOT PD=D/PPF=F
SAVE UP,RP,TP,GNP,AP,TIC,TIF,TSDC,UIL,CULTL,TJII,TJIIF,TJISD,JOBSNA
SAVE WENA,WEA,PCI,UNEMNA,LFNA,IFCPCR,SDCPCR,POLR,FPU,PCCPR,AFS,PD,PPF
A    CMPPER.K=STEP(CMPR,LONG)
C    CMPR=0
N    SAVPER=LONG
SPEC LONG=1
NOTE BASELINE -----------------------------------------------+
RUN B
T    FGNPCF(*)=.0035625/.106875/.02375/.0558125
T    FGNPIF(*)=.012/.012/.012/.012/.012/.012/.012/.011
T    FGNPSD(*)=.015/.015/.015/.015/.015
C    FGNPA=.040
CPLOT UP.B=1,RP.B=2,TP.B=3,UP=U,RP=R,TP=T
CPLOT AP.B=1,GNP.B=2,AP=A,GNP=G
CPLOT TIC.B=1,TIF.B=2,TSDC.B=3,TIC=I,TIF=F,TSDC=S
CPLOT UIL.B=1,CULTL.B=2,UIL=U,CULTL=C
CPLOT TJII.B=1,TJIIF.B=2,TJISD.B=3,TJII=I,TJIIF=F,TJISD=S
CPLOT JOBSNA.B=B,JOBSNA=J
CPLOT WENA.B=1,WEA.B=2,PCI.B=3,WENA=N,WEA=A,PCI=I
CPLOT UNEMNA.B=B,UNEMNA=U
CPLOT LFNA.B=1,JOBSNA.B=2,LFNA=L,JOBSNA=J
CPLOT IFCPCR.B=1,SDCPCR.B=2,POLR.B=3,IFCPCR=I,SDCPCR=S,POLR=P
CPLOT FPU.B=1,PCCPR.B=2,FPU=U,PCCPR=C
CPLOT AFS.B=A,AFS=F
CPLOT PD.B=1,PD=D/PPF=F,PPF.B=2
NOTE AGRICULTURE DEVELOPMENT POLICY ---------------------+
RUN A
T    FGNPCF(*)=.0035625/.106875/.02375/.0558125
T    FGNPIF(*)=.012/.012/.012/.012/.012/.012/.012/.011
T    FGNPSD(*)=.018/.018/.018/.018/.018
C    FGNPA=.025
NOTE SOCIAL DEVELOPMENT POLICY --------------------------+
RUN S
T    FGNPCF(*)=.0045/.135/.030/.0705
T    FGNPIF(*)=.01/.01/.01/.01/.01/.01/.01/.01
T    FGNPSD(*)=.012/.012/.012/.012/.012
C    FGNPA=.020
NOTE INDUSTRIAL DEVELOPMENT POLICY ----------------------+
RUN I
T    FGNPCF(*)=.0035625/.106875/.02375/.0558125
T    FGNPIF(*)=.015/.015/.015/.016/.016/.016/.016/.016
T    FGNPSD(*)=.013/.013/.013/.013/.013
C    FGNPA=.020
NOTE INFRASTRUCTURE DEVELOPMENT POLICY ------------------+
RUN F
C    CORN(*)=1.10/1.10/1.10/1.10
T    UPG(*)/.27/.27/.23/.18
NOTE ENVIRONMENTAL PROTECTION POLICY -------------------+
RUN E
C    LPCN=1.0E-8
C    LPPN=.0037
C    FIOIFN=.44
NOTE ZONING POLICY -------------------------------------+
RUN Z
C    HKM=200000
C    ACPP=10000
NOTE IMMIGRATION POLICY --------------------------------+
RUN M
```

model, written in DYNAMO III, is called DMT-3.

Referring to Fig. 2, we see that the Industrial Sector of DMT is comprised of Mining, Manufacturing, Construction and Business as described above. Of particular interest is Taiwan's manufacturing sector which has undergone substantial structural changes over the last 30 years. In the 1950's when the economy was centered on the farm sector, agricultural based operations such as sugar refining and fruit and vegetable processing were the mainstay of the manufacturing sector. In addition import substituting manufactures were expanded, namely cement, fertilizer, textile and paper processing, mostly for domestic consumption. By 1960, manufacturing accounted for 22% of the GNP. Government policies and the creation of export processing zones greatly aided manufacturing. In the 1970's second phase import substitution in capital goods and industrial intermediates used in the production of existing export goods (so-called "upstream industries") was promoted.

Table 1. International Standard Industrial Classification

Code	Classification and Description
1	Agriculture, hunting, forestry, and fishing
2	Mining and quarrying
3	Manufacturing
4	Electricity, gas, and water
5	Construction
6	Wholesale and retail trade, restaurants, and hotels
7	Transport, storage, and communication
8	Financing, insurance, real estate, and business services
9	Community, social, and personal services

Each of the nine ISIC economic output divisions in Table 1 is associated with a particular capital stock in DMT. In our model the agriculture provides most of the output in the first ISIC division. The "mining", "manufacturing", and "construction" capital stock in DMT provides the output in ISIC divisions 2 and 3. Business capital in the model is associated with the activities listed under ISIC divisions 6 and 8. The infrastructure sector in the model corresponds to ISIC divisions 4 and 7, and the social development sector to ISIC division 9. This disaggregated version of the model, written in DYNAMO III, is called DMT-3.

Taiwan's comparative advantage for exports has traditionally been its large and relatively inexpensive labor. However, since the 1970's, the trend has been towards rising real wages and this will eventually erode Taiwan's comparative edge. In order to counterbalance this trend, the government's strategy in the long run is to replace labor intensive production.

INFRASTRUCTURE SECTOR

Where the people go, public works follow--and vice versa. A ready supply of fresh, clean water must be available along with a sanitary sewer system to handle the wastes. A transportation network of highways, bridges, airports, and railroads make cities accessible to each other, while streets and public transit systems allow movement within the cities. Public works, however, are not limited to urban areas; they stretch far beyond to include rural highways, dams, power plants, irrigation systems, electric utility lines and others. This underlying foundation of public capital facilities, the basic framework which permits a nation to function is "infrastructure."

For almost a hundred years, public works have provided the physical infrastructure essential to the social and economic development of Taiwanese civilization. They make human settlements possible and are indispensable to commerce and industry. Effective public works facilities and services are of utmost importance in every community and, in Taiwan, they account for expenditures of more than NT$40 billion annually. Additional billions are also invested in similar privately developed and operated facilities such as utilities.

It is not money that ultimately determines the effectiveness of public works systems, however--it is people. The planning, design, construction, operation, and maintenance of public works facilities have always demanded a high level of training and proficiency in a variety of disciplines. Skyrocketing costs of government, rapid advances in science and technology, and the pressing need for public works to serve an increasingly urbanized populace have made it imperative that public works practitioners be able to respond to the gamut of social, economic, environmental, and political factors inherent in program planning, policy resolution, and project management.

In the 1970's major infrastructure work was carried on under the government's Ten Major Construction Projects costing over NT$250 billion. Six of these projects were addressed to Taiwan's major transportation infrastructure, which, though already extensive was becoming saturated. The North-South Freeway, running from the port of Keelung in the north to the port of Kaoshiung in the south relieved chronic traffic tie-ups on existing highways as well as easing the railroad's passenger and freight burden. Electrification of the mainline West Coast railroad cut fuel imports and increased the carrying capacity of the railroad. Two new ports, at Suao and Taichung, greatly relieved overcrowding at Keelung and Kaoshiung and further encouraged regional growth. The Suao-Hualien railroad spur ended the relative isolation of Taiwan's East Coast, which still lays far behind in development. Other infrastructure projects in this package included a new international airport at Taoyuan, several nuclear power plants, an integrated steel mill, a large shipyard, and several petrochemical plants.

Following on the Ten Major Construction Projects of the 1970's are the 14 Key Investment Projects of the 1980's, scheduled for completion in 1990. These include the expansion of the China Steel Corporation's facilities, the Taiwan Power Company's fourth nuclear power plant, thermal and hydroelectric power plant facilities, a naphtha cracking plant and storage transport facilities for liquified natural gas, modernization of the telecommunication system to include the introduction of a digital switching network, railway expansion to include a southern link from the west to east coast lines, highway expansion to include a second highway in the north, a mass transit system for Taipei, water and drainage systems, new reservoirs for drinking water, new national parks, garbage treatment plants, and improvements to the rural infrastructure.

In DMT the Infrastructure Sector is modeled to include the following components: highways, railroads, ports, airports, power and energy, water supply and distribution, telecommunication and sewage treatment (see Fig. 2).

The Ministry of Communication reports that in 1983 there were 18,891 km of roadways of which 15,885 were paved. The total length of railway track was 4,900 km. Most domestic traffic is carried by these two modes with the split about 3 to 1 in favor of vehicle traffic. International air services now operate out of Kaoshiung airport in the south as well as Taoyuan airport outside of Taipei in the north. Kaoshiung, now the world's tenth largest port and fifth largest container port, accounts for 62 percent of Taiwan's shipping with the remainder split between the ports of Keelung, Hualien, Taichung and Suao. During the 1970's, Taiwan's telecommunications expanded at a rapid rate with the number of telephone subscribers increasing at an average rate of 120 percent a year between 1974-1983, to reach 3.6 million.

Regarding energy, Taiwan is heavily dependent on imported energy with 88 percent of the supply of primary commercial energy coming from this source. Taiwan's modest resources in coal, natural gas and petroleum are commercially exploitable on a limited scale. The Taiwan Power Company is government owned and operated and has a monopoly on power generation. In 1983, "Taipower" generated 45.52 billion KWH of electricity. Coal and oil fired thermal power accounted for 49.2 percent of this, nuclear power accounted for 39.9 percent and hydro-power for 10.9 percent. A comparison of the annual growth rates of real GNP and power consumption between 1974-83 illustrates the success of conservation measures taken in wake of the 1973-74 oil crisis. While real GNP grew by an average 10 percent per year, power consumption grew by 8 percent on average over the same period.

DEMOGRAPHIC SECTOR

In 1985, when the Japanese annexation began, Taiwan's population is thought to have exceeded 2.5 millions, 95 percent Chinese in-migrants and their descendents. By the end of the occupation period in 1945 the Taiwanese population was close to 6 million.

The 1980 census put the population of Taiwan at 17,805,067 and it was estimated at 19 million at the end of 1984. The rate of natural increase has declined fairly steadily from 3.7 percent in 1956 to 1.6 percent in 1983. The birth rate has fallen to 23 per 1000 in the last decade from 39 per 1000 in the late 1960's. The death rate fell rapidly in the 1950's and 1960's and more slowly after; nevertheless, mortality is now at a level that is low compared with many countries in the region. In 1982 about one-third of the population was under 15 years of age. Immigration is a minor factor, at present, in the population increase. The population is is almost entirely Chinese in origin including 2 million mainlanders who came to the island in 1947-49. The population density is high, at 528 persons per sq. km in 1984, and is concentrated in the western and northern coastal fringes. Government encouragement of migration to the eastern coast has met with limited success. Over 90 percent of the population is literate with nine years of school being compulsory. Urban population, 42 percent of the total in 1978, has been steadily increasing.

Family planning has not received the emphasis it has in a comparable state of development in many parts of the world. For example, the issue of legalizing abortions--already numbering 300,000 to 400,000 annually--brought on a debate in 1984 when the population reached 19 million. Population control has long been a controversial subject on Taiwan since it implied that the mainland would not be recovered and Taiwan's surplus would have nowhere to go.

EMPLOYMENT SECTOR

Wherever there is very low marginal productivity in agriculture and many people scratch out a bare living in peripheral urban activities, conditions that existed in Taiwan in the 1950's as in most developing countries today, the human benefits of a highly labor-demanding development are obvious. This sort of development is probably the only way in which the benefits of growth can be widely spread. From the production point of view, a highly labor-demanding development is also efficient. The real cost to the economy of supplying labor is low, and there is an advantage in making things which are made in relatively labor-intensive ways.

In 1983 around 7 million civilians were employed and there was about one-half million in the military. The official minimum working age is 15; based on this Taiwan has had virtually full employment for over a decade. One of the most important trends in employment has been the concentration of the labor force in the productive sector of the economy, the manufacturing sector.

In the 1950's and early 1960's the economy was based on agriculture, with some light industry directed toward import substitution. Since then there has been a major structural change so that the emphasis now is on manufacturing and export oriented industry. This has meant a substantial redistribution of the labor force with workers leaving the land to take up the increasing job opportunities in industry as exports of manufacturers have grown and agriculture became more efficient. At the beginning of the 1960's half the workforce was engaged in agriculture, and only 15 percent in manufacturing; a decade later the proportion were 33 percent and 25 percent, while in the early 1980's less than 20 percent worked on the land and almost a third were employed in manufacturing. Taiwan's labor force is also becoming more educated, in part the result of the need for skilled workers as production becomes export oriented, which is more technology interactive.

SOCIAL DEVELOPMENT SECTOR

Rapid economic growth in Taiwan has not only raised income but has also been accompanied by a steady improvement in its distribution. While the 1952 income of the top 20 percent is estimated to have been some 15 times that of the bottom 20 percent; by 1964 the gap had narrowed to 5.33 to 1 and by 1976 further to 4.18 to 1. Indeed, this favorable development has drawn the attention of many an international economist and has often been rated as a successful example of rapid economic growth with equity.

The phenomenal economic growth in recent years has brought an unprecedented degree of material well-being to the people of Taiwan. In the 25 years up to 1977, the level of consumption tripled and was accelerating. Economic prosperity has also brought significant changes in consumption patterns. In 1952, 55 percent of a family's expenditure was for food; in 1977 the figure had dropped to 40 percent. However the quality of food improved substantially over the same period, with the daily calorie and protein intake per person among the highest in Asia. It will also be noted that as people spend relatively less on food, they are enjoying better housing and education with more leisure for recreation.

The literary rate of 90 percent is twice what it was in 1946. The crude death rate and life expectancy, two typical indications of the level of sanitation have improved dramatically over the period from 1952 to 1980: the death rate from 9.9 per thousand to 4.8 and the life expectancy from 58.6 years to 70.8 years. Housing construction during the past three decades has been quite successful. About 90% of the houses in Taipei and 80% of the houses in Taiwan were built after World War II. Living space per head has increased from 4.6 square meters in 1949 to 17.9 square meters in 1980. The share of dwelling investment in the GNP increased from one percent in 1952 to 4.5 percent in 1980. One particular welfare item, the wide-scale diffusion of public utilities, increased in scope far more than can be measured in terms of monetary income. For example, the percentage of houses equipped with electric lighting grew from 33 percent in 1944 to 99.7 percent in 1980.

In sum, it is obvious that industrialization and urbanization have brought in their wake significant social welfare benefits. However, Taiwan has not yet moved very far toward becoming a welfare state. In this area the Chinese worker lags furthest behind his Western counterpart. There is currently much discussion in Taiwan about improving the social insurance system. At present about one-fourth of the national budget goes to social development, over half of which is allocated to education. To place this figure in perspective, 40 percent of the budget goes to general administration and defense, a higher percentage than in the U.S. for example.

ENVIRONMENTAL SECTOR

Many benefits and costs of economic growth are not reflected in national product and consumption measurements discussed in the previous section. Examples of excluded items are readily available which significantly affect the quality of life -- especially pollution. Statistics released by the Taiwan Provincial Institute of Environmental Sanitation show that the average fallout in Taipei increased from 39 tons/square mile/month in 1959 to 56 in 1966. In Taipei's residential areas, the increase was from 30 tons/square mile/month in 1959 to 61 in 1965. Clearly, for those living in Taipei and its vicinity the quality of life has been adversely affected by this development -- a change not taken into account by the usual social development indicators such as per capita consumptions.

AGRICULTURE SECTOR

Agriculture's share in GNP has declined significantly since the 1950's when Taiwan's economy began to be transformed from one based predominantly on agriculture to one which has a fairly diversified industrial base. In 1963, agriculture accounted for 26 percent of real GNP whereas in 1984, this proportion had declined to 6.7 percent. The decline in agriculture's relative importance has been due to the rapid development of the industrial sector and to the limited land resources in Taiwan. Only about a quarter of the island is cultivated, about 900,000 ha. After a slow annual average rise of 0.2 percent in area of cultivated land during 1955-77, a slight decline began in 1978, mainly due to increased industrialization and urbanization.

Taiwan's agriculture is largely based on family farms with the average land holdings per farm being around 1.1 ha. In 1984, agriculture labor accounted for 17.6 percent of the total labor force and the agriculture population was 23 percent of the total population in 1983. Both of these ratios have declined since the 1952-64 period when agriculture provided all of the principal export products and was the backbone of government's development plan. At the end of 1983, 83.3 percent of the total 816,000 farm families were farmers who owned all of the land they cultivated, 10.7 percent were past owners, and 6.0 percent were full tenant farmers. The high ratio of owner farmers is attributable to the land reform program carried out by the government in 1953.

Agricultural production rose sharply during 1952-64 at 5 percent a year on the average and more slowly from 1965-83 at 2.4 percent a year. Increases in output were brought about by the introduction of mechanization, the use of high yield varieties of crops, multiple cropping, agricultural diversification with increased emphasis on higher value crops, improvement to the agricultural infrastructure including irrigation, and the expansion of livestock and fisheries production.

DESIGN OF EXPERIMENTS

In Taiwan, as in many places in the world, a growing number of scientists, business leaders, government officials, and other individuals from all professions are making a concerted effort to understand and forecast future social, economic and technological developments. An important function of decision-aiding models such as DMT is the estimation of uncontrolled development variables over time.

Forecasting techniques tend to fit into six categories: extrapolation, trend correlation, analogies, intuitive forecasting, dynamic forecasting and scenario analysis. Extrapolative techniques are the most common. They base forecasts of future behavior on "hard" data usually obtained from past performance and include regression, exponential smoothing and time-series models. Trend correlation analysis, the second technique, makes use of one or more trends to determine another. An example is forecasting energy demand by correlating it to the Gross National Product, or to population, or to both. Analogies, the third technique, have conceptual appeal and have been extensively applied to technological forecasting because of the apparent similarities between technological and biological growth.

In cases where statistical or pseudo-mathematical estimation may be impossible because either there is no historical precedent or the relevant attributes of the system are inherently difficult to quantify and to measure, it may be possible to generate "soft" data obtained from a panel of experts or from opinion polls and make use of intuitive forecasting. In explaining this category forecasting is often paraphrased into a tautology involving prediction. Any of the above categories of procedures results in a forecast. There may be causal factors at work, however, that will not be exhibited in the data. For example, the demand for petroleum will be strongly influenced by improved solar energy technologies or by the onset of a recession. Inclusion of such possible events results in a prediction based on an intuitive revision of the forecast. In such instances the Delphi method, based on a revised group consensus arrived at by an iterative process which collates, summarizes and communicates to the group individual predictions of experts, has proven useful.

If there is a difference between forecast and prediction in ordinary communication, it is a subtle one. Both are based on observation, experience, or scientific reasoning. Both differ from an opinion in that they rest upon quantitative relationships, stated assumptions, and a logic that yields relatively consistent results. Only in the relatively new and prolific field of forecasting called technological forecasting is the distinction explicit. A technological forecast is defined as a prediction with an indicated level of confidence of a technical achievement in a given time frame with a specified level of support. The specification of level of confidence has proved to be unrealistic in the application of forecasting to such practical questions as the timing of new scientific knowledge, technical capability, and socio-economic consequences. When misguided, statistical estimation and forecasting can only give the illusion of accuracy by providing detail.

We prefer a far less ambitious interpretation of a forecast as a statement-giving advance warning in sufficient time for beneficial action to be taken. This simply says that to predict is to declare in advance, to forecast is to plan ahead. A forecast ought to be directed toward the consequences of a system which means concentrating on variables that are useful indicators of system performance rather than on variables that may be convenient to predict -- the difference between information as a means to an end and information as an end in itself. In this context the remaining two categories of forecasting techniques -- dynamic forecasting and scenario analysis -- will be discussed in the next section.

SCENARIO ANALYSIS

A mathematical model is a set of equations that characterizes a real-world system to the extent that the excitation-response relationships of the system are correctly represented. By expressing the exogenous inputs mathematically, they can serve as the excitation of the model; the solutions of the model equations then constitute mathematical representation of system responses. In general, the closer the correspondence to the real-world system, the more reliable the model as a tool for predicting responses to excitations other than those used in constructing the model. At the same time, the realization that constructing the model is an inverse problem makes it clear that there can never be a unique solution -- a unique model.

To be useful to policy makers, a model must be capable of performing some information-producing tasks regarding the future. In the physical sciences, absolute precise predictions such as the times and places of next ten solar eclipses are possible. In the social sciences the information producing use of models are limited to unconditional forecasting, conditional forecasting, and descriptive clarification. Unconditional forecasts indicate circumstances that policy and decision makers are likely to face -- unemployment rates, interest rates, travel patterns, energy demand, etc. Conditional forecasts are contingent on the actions that policymakers are likely or at least capable of taking -- increasing taxes, land zoning, low-income housing programs, etc. A third more indirect and elusive use of models is simply in refining the intuition of policy makers as instruments for exploring reality as well as portraying it.

The capacity of DMT for conditional forecasting is demonstrated in the next section in the form of computer plots of selected variables from the various sectors for a period covering the next one hundred years. However, unlike forecasting techniques described in the previous section -- regression, exponential smoothing, time-series, and trend correlation -- DMT is built up from the internal nonlinear structure of Taiwan's socio-economic system and is therefore capable of generating modes of behavior that have never been observed in the island's history. This emphasis on capturing intrinsic structure and interdependences between sectors in the construction of DMT is in keeping with the purpose of the model -- to make conditional forecasts so as to provide useful inputs to future policy decisions that will have a significant impact on Chinese society for many generations to come.

Policymakers require information, not only about the effectiveness of existing programs but about the kinds of programs that ought to be brought into existence, and the present state-of-the-art of policy evaluation leaves this need ummet. The problem is that program data are nonexistent, and implementing a hypothetical program and observing its effects is not only costly but defeats the purpose of policy analysis in the first place. However through simulation, policy analysts can produce the conditional forecasts essential for estimating the effects of alternative policy proposals, external repercussions, untried ideas, and innovative administrative arrangements.

The information-producing functions of DMT which make it such a powerful tool for policy research in conjunction with development planning involve two aspects of analysis: objective and subjective. The objective aspects are those based on the relationships describing a system's functioning which are established through experience, scientific analysis, and available data. For example viewed as an economic system we can relate Taiwan's industrial ouput to its supply of infrastructure capital. As a population system, migration from one region to another can be explained by quantifiable measures of relative attractiveness. The subjective aspects are those which refer to the uncertainty that is always present when looking into the future and when dealing with human beings. The objective aspects of Taiwan's development are represented in the equations of DMT which are presented in the Fig. 2.

The subjective aspects of national development will be dealt with in this section in the way the computer model is used to analyze possible future patterns. The method is called scenario analysis with a scenario being a sequence of possible events and socio-political choices. The likelihood of any future evolution depends on the likelihood of events which constitute a given scenario taking place in reality. A great deal of understanding of the future can be gained. For example, if the set of alternative scenarios is broad enough, and the system (national development) shows a certain pattern persistently in all scenarios, it can be considered as inevitable that this pattern will occur in the future.

A scenario is a forecast of the future states of a system based on the likely interactions between system variables and the external constraints to, and forces for, change. As a forecasting technique, scenario analysis has been widely applied to international political system, to regional development planning, and to national defense planning. Scenario analysis helps to illuminate the interaction of psychological, social, economic, technical, cultural and political dimensions in a form that permits understanding many such interactions at once, making it an ideal tool for policy research.

DEVELOPMENT INDICATORS

Development requires change, but change with direction is required. Development must be planned, analyzed and managed which requires that we be able to describe where we are going and where we are. The output of scenario analysis is a description of future states, in this case Taiwan's development over the next 100 years. This raises the questions: "What elements are necessary to describe Taiwan's future development profile?"

The development indicators selected for aiding in scenario analysis are summarized in Table 2. In the table the indicators are grouped into arbitrary socio-economic categories and will be discussed briefly in this section on that basis.

Table 2. Development Indicators

Category	Indicator	Variable
Human Resources	Total Population	TP
	Fraction of Population Urban	FPU
Wealth	Gross National Product	GNP
	Per Capita Income	PCI
Distribution of Wealth	Unemployment Non Agriculture	UNEMNA
	Relative Earnings in Agriculture	REA
Land Resources	Population Density	PD
	Average Farm Size	AFS
Agriculture/Food	Per Capita Crop Production Ratio	PCCPR
	Population Per Farmer	PPF
Environment	Infrastructure Capital Per Capita Ratio	IFCPCR
	Social Devel. Capital Per Capita Ratio	SDCPCR
	Pollution Ratio	POLR

Indicators in the Human Resources category include Total Population, TP, and the Fraction of Population Urban, FPU. In addition to these indicators, such variables as birth and death rates in both urban and rural areas are of interest. Of particular concern will be the effect of various development policies on these variables because, even today with a density of over 500 persons per square kilometer, Taiwan is one of the most densely populated areas in the world. Urbanization provides a good measure of the relative proportion of the population exposed to modernity. Cities are important in introducing a money economy, new social patterns, and the possibility of developing intellectual centers -- windows to the outside world.

Gross National Product and national per capita income as measured by GNP per capita are traditionally used as indicators of many different values. Most often, total GNP is employed as a measure of production of total wealth or resources of a country. Not uncommonly GNP is also used as a measure of power, of the resources available to a country to control its own destiny. National per capita income is a better measure of comfort or wellbeing. The combination of these two items -- GNP and per capita income -- is quite useful.

Taiwan's recent development achievement over the past few decades is unique because it has been accomplished with distribution of wealth. In the model rural to urban migration is assumed to depend on Relative Earnings in Agriculture, REA, an indicator of the distribution of wealth. A second indicator in the Distribution of Wealth category is Unemployment Non-Agriculture, UNEMNA.

Population density is a measure of land resource utilization. A nation with limited territory may be blessed with other resources of a material or human nature. Many of the economically most advanced states are among the most densely populated. A second indicator of land resource utilization used in the model is Average Farm Size, AFS. The two indicators selected for the Agriculture and Food category are Per Capita Crop Production Ratio, PCCPR, and Population Per Farmer, PPF.

Indicators of the quality of life and of the environment are Infrastructure Per Capita Ratio, IFCPCR, Social Development Capital Per Capita, SDCPCR, and Pollution Ratio, POLR. In the base year, 1980, these indicators have a value of 1.0 and change over time -- increasing if the infrastructure capital, for example, increases faster than population size. Since infrastructure capital in the model includes highways, rail, ports, airports, power, water, telecommunications and sanitary engineering services, and social development capital includes health, education, housing, family planning and welfare, the two indicators combine to provide surrogate measures of a very wide spectrum of personal services. With respect to the third indicator, "pollution" denotes any material or energy stream that either disrupts the natural processes of the ecosystem or impairs the aesthetic qualities of the environment. Materials will inevitably be released to Taiwan's environment through the output of industrial activities.

THE POLICY MENU

Development strategies are combinations of projects, programs and policies for inducing desired socio-economic impacts. An intervention or impact strategy is an attempt to translate theories regarding the regulation, modification, and control of national conditions into policies on which decisions can be based. Intervention strategies are predicted on some notion of cause and effect. A fully developed national policy should try to examine the cogency of the hypothesized causal explanation.

In this report all the assumptions regarding illustrative intervention strategies are implicit for obvious reasons -- all are hypothetical. In the implementation of DMT, there would be the resources and time available to make them explicit. The importance of this cannot be underestimated. The absence of an explicitly stated intervention model prevents replication of the policy, program or project and severely limits the opportunities for controlling its quality, and evaluating its effectiveness.

In identifying policy alternatives it is useful to review the functions of government. There are five major areas in which government units, on the national and local levels, are involved in the economy:

1. Protection of the rights and freedoms of individuals -- economic, political, and religious -- through courts and the administration of laws.

2. Providing goods and services in the interest of all citizens -- such as highways, national defense, and education.

3. Regulation -- the promotion of fair economic competition and the protection of public health and safety.

4. Promotion of economic growth through various economic policies and programs.

5. Direct support to individuals such as programs to reduce hardships for those who can not meet their minimum needs because of special circumstances or lack of employment.

In countries pursuing economic development, the formation of policy is made especially difficult by two factors: first, by the conflict that may exist between the immediate impact and the longer range effects of any action and, second, by the degree of which policies aimed at one set of economic phenomena may have unintended side effects on other aspects of the economy. Ideally, it is desirable to be able to estimate the effects of economic interventions on noneconomic goals such as social development and political stability. Using DMT this can be done to the extent of estimating the comparative effects of alternative policies. The difficulty here lies in value judgements for policy research -- the judgement of "facts" but also the debate over value judgements or the implications of those facts.

For pursuit of various national goals a variety of instruments is available. The principal instruments traditionally used are the allocation of financial resources achieved through fiscal policies. However, in addition to financial resources, there are other resources at governments disposal. They include human resources, raw materials, land, energy, information, and technology, if we use an ecosystem image, rather than a purely economic one, to define the dimensions of policy impact.

IDENTIFICATION OF SCENARIOS

Seven policy experiments were identified which will be referred to as follows:

1. Government Support of Agriculture Policy.
2. Government Allocation to Social Services.
3. Industrial Development Policy.
4. Infrastructure-Induced Development.
5. Environmental Protection Policy.
6. Zoning Policy.
7. Immigration Policy.

Considering the first policy experiment, agriculture production must be increased in order to satisfy future needs. This can be accomplished by using more intensive agriculture, by bringing more land under cultivation, and by increasing on-farm efficiency. This policy control variable is Fraction GNP to Agriculture, FGNPA.

In the second policy experiment, the strategy to be investigated is increasing Government's allocation to social development programs. The policy variable is Fraction GNP to Social Development, FGNPSD.

Many developing countries tie their futures to industrial development. In DMT the policy variable for simulating this approach is Fraction GNP to Industrial Capital Formation, FGNPCF.

Taiwan has generally pursued a policy of infrastructure-induced development. The effect of accelerating this policy in the future is investigated in an experiment by increasing the value of the policy variable, Fraction of GNP to Infrastructure, FGNPIF.

The fifth policy experiment can be thought of as investigating developmental-environmental trade-offs. Environmental achieves a reduction in Pollution Generation (a reduction in UPG) by increasing industrial capital-out ratios (an increase in CORN).

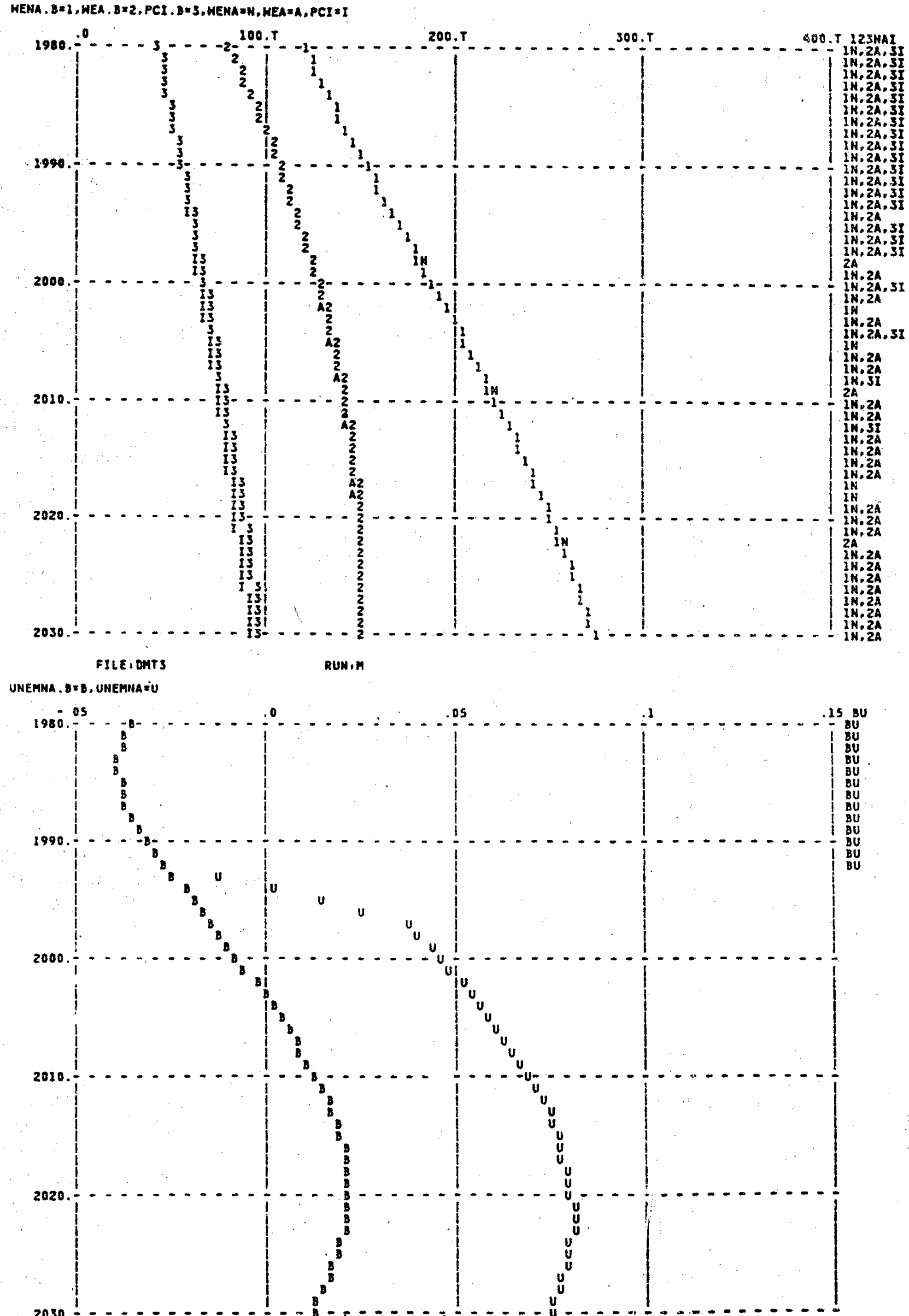
Referring to the sixth scenario, zoning decisions determine the supply of land available for various socio-economic activities. In Taiwan, zoning is a viable policy instrument. The amount of land and its use influence such things as the present and future housing market, population mix, economic growth, employment conditions, and environmental quality. Since a country must live with its zoning decisions for decades, local decisions affecting land use should be made in the context of the total national system. Land zoning policy tests afford a basis for accomplishing this. Specifically, Land Per Capital Normal, LPCN, Land Per Person Normal, LPPN, and Fraction Industrial Output to Raw Materials, FIORM, are the variables used to generate this scenario.

The last policy experiment seeks to determine the socio-economic implications of a policy encouraging disaffected Hong Kong Chinese to move to Taiwan, promoted by the recent Sino-British declaration returning Hong Kong to China's control after 1997. Policy measures that have been proposed include "priority consideration" in the processing of investment applications, low interest loans for home purchase and favorable school admissions. This scenario describes an immigration of 200,000 persons a year from Hong Kong for a five year period from 1992 to 1997 (HKM=200000), with an inflow of capital averaging 10,000 NT$ per person (ACPP=10000). Fig. 3 depicts the effects of this policy on selected development indicators.

CONCLUSIONS

Simulation of a socio-economic system like a region involves building and operating a model designed to represent those features of the system which are deemed to be significant in view of the objectives behind the simulation. Some of the more obvious benefits of simulation include: (1) forecasting of macro behavior; (2) predicting consequences of government actions and refusal to act; (3) conducting sensitivity analysis to establish research and data gathering priorities, and (4) providing aids to communication among specialists and in the achievement of understanding.

It is known that the construction of computer simulation models help free


HENA.B=1,WEA.B=2,PCI.B=3,HENA=H,WEA=A,PCI=I
.0
100.T
200.T
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1980.
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2000.
2010.
2020.
2030.
FILE:DMT3
RUN:M
UNEMNA.B=B,UNEMNA=U
-.05
.0
.05
.1
.15 BU
1980.
1990.
2000.
2010.
2020.
2030.

FIGURE 3

development planners from a mechanistic, deterministic view of a region, and provide them with a more dynamic and comprehensive tool for influencing change. Specific potential uses of DMT include: (1) providing a means for implementing a systems capability, (2) monitoring progress during policy implementation, (3) comparing strategic alternatives, and (4) as a pedagogical tool aiding in developing a cadre of development analysts. Each of these will be reviewed briefly.

Implementation of a Systems Perspective. Faced with the wide range of multidisciplinary expertise required for regional analysis, DMT can be viewed as a mechanism for extending the user's perception of problems and as an organizational framework for ordering disparate, specialized insights. One potential use of DMT is to systemize regional analysis and planning. The importance of this cannot be underestimated since the major obstacle to designing regional development is the organization of local capability to initiate, sustain, and implement the effort.

A crucial question in a large scale development effort such as Taiwan is how systems engineering--systems planning and systems analysis--can be made an effective tool in the management of a total program and individual projects. Methods of initiation include the following: (1) retaining short-term consultants, (2) hiring specialists, (3) training people in the organization, (4) entering into cooperative research programs with university centers, and (5) some combination of these.

Monitoring Progress. DMT can become a device for monitoring progress during reconstruction and post-reconstruction. From the model much insight will be gained toward the eventual development of a computer-based management information system. Such a system would provide for a comprehensive data base for the region and would support the staff in developing individual project models, as well as in the monitoring of these individual projects.

The importance of the model in the final design of an MIS can not be overemphasized. Comprehensive surveys associated with regional analysis, such as land-use surveys, economic surveys, demographic surveys, industrial surveys, resource surveys, transportation surveys, etc., are expensive and time consuming. This is not an argument against the accumulation of a large, high quality regional data base, it is stated for two reasons. First of all, decisions can not be differed indefinitely while the ultimate in regional data is collected and analyzed. The pressure for development is real. Secondly, experience tells us to beware of massive data gathering programs which can be expansionist in their natural and obsessive in their demands until it becomes an end in itself. The advantage of using pilot sampling schemes, defined and designed through the modeling effort, before embarking on any large scale data program is important.

Policy and Sensitivity Experiments. We take it to be that one of the main functions of regional analysis to provide decision makers with knowledge about the consequence of alternative courses of action or inaction. Rational decisions are based on forecasts. The regional analyst should be able to predict the direction of impact as an instrument of adjustment on the variables to be controlled and the approximate time lag between application and impact. It is also highly desirable to know something of the order of magnitude of the impact.

The forecasts obtained from DMT are based on knowledge about relationships between hundreds of variables gained from past and present experience, formulating hypotheses about relationships between variables, and then confronting this hypotheses with new experience (testing).

Pedagogical Uses. The use of simulation in both teaching and training is quite extensive. Simulation is more than a means of solving mathematical models that cannot be solved analytically, or a modeling technique in its own right; simulation is also a pedagogical tool. Regarding the latter, there can be no doubt that simulation is a growth point in education. Simulation provides the user an intuitive feel for the structure of the system being simulated, taking them out of the role of the spectator and moving them into the role of player, where simulation can take on a highly competitive element.

The process of building the simulation model is itself a valuable educational tool since it lays bare the principals involved in the system under scrutiny. Similarily the simplification of a complex model may also reveal what is basic to a particular process. In order that links can be securely made with regional situations and subsystems, briefing workshops should be made an integral part of future extensions of the models.

Simulation is perhaps the only way in which a systematic view of a region like Taiwan can be conveyed economically, which explains why an increasing number of regional simulational models have been developed recently. Few of these, however, have been designed with instructional purposes in mind. The idea here is to reproduce the essential features of Taiwan in a manageable package. Maps are not enough. Just as years had to be compressed into minutes, the number of actors has to be reduced to those who carry on the research in Taiwan. In a matter of speaking Taiwan has to be compressed to table-top size and relevant historical background synopsized so that it can be assimilated in a few months.

As difficult as the day-to-day operations of government are, those of orderly long range development are even more demanding because the answers to these problems must be found in a new setting. Taiwan's future will not be found by a simple extrapolation of the past. To cope with Taiwan's problems, one needs to comprehend enough of the socio-economic system from which they originate to distinguish modes of behavior and examine the implications of alternative actions. It comes as no surprise that government officials should look to formal tools for representing development interactions in a form in which they can be probed and projected by a computer in a process of policy modeling. DMT is such a tool -- an instrument for not only coping with the immense numerical and descriptive material inherent in national development planning but for extending government's logic by permitting it to

FIGURE 4

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00000 *
00001 NOTE 台灣總體經濟發展模型          工業,農業,基本設施,社會發展,環境,都市
00001 NOTE                              農村,人口,教育等部門之交互作用
00002 NOTE 工業部門
00003 L 工業資本.K=工業資本.J+(DT)(資本形成量.JK-資本形成量.JK*DT*通貨膨脹率    (1)
00004 X 資本消耗量.JK)
00005 N 工業資本= 1600E9                                                    (1.1)
00006 C 通貨膨脹率=0.05                                                     (1.2)
00007 R 資本消耗量.KL=工業資本.K/資本耐用年限                                   (2)
00008 C 資本耐用年限=25                                                     (2.1)
00010 R 資本形成量.KL=國民生產毛額.K*資本形成比率+香港流入資本.K                     (3)
00020 C 資本形成比率=0.2                                                    (3.1)
00030 A 香港流入資本.K=CLIP(港僑投資量.K,0,TIME,1992)-CLIP(港僑投資量.K,0,TIME     (3.2)
00040 X ,1997)
00050 A 港僑投資量.K=港僑每人資本*港僑遷台人數                                   (3.3)
00060 C 港僑每人資本=0                                                      (3.4)
00070 A 工業產出.K=工業可能產出.K*(1-工業產出比率.K)                              (4)
00080 A 國民生產毛額.K=工業產出.K+農業產出.K                                     (5)
00090 A 工業可能產出.K=工業資本.K/資本產出比率.K                                  (6)
00100 A 工業產出比率.K=原料產出+基本設施產出.K                                    (7)
00110 C 原料產出=0.2                                                        (7.1)
00120 A 基本設施產出.K=基設常態產出*基設產出乘數.K                                 (8)
00130 C 基設常態產出=0.4                                                    (8.1)
00140 A 基設產出乘數.K=TABHL(基設乘數表,資本平減比.K,0.2,2.2,0.5)                 (9)
00150 T 基設乘數表=0.6/0.75/1/1.1/1.2                                       (9.1)
00160 A 資本平減比.K=(平減工業資本.K/平減基設資本.K)/基期平減基準                     (9.2)
00170 C 基期平減基準=1                                                      (9.3)
00180 L 平減工業資本.K=平減工業資本.J+(DT)(資本形成量.JK  資本消耗量.JK)            (9.4)
00190 N 平減工業資本=1600E9                                                 (9.5)
00200 A 資本產出比率.K=常態產出比率*產出比率乘數.K                                (10)
00210 C 常態產出比率=1.0                                                    (10.1)
00220 A 產出比率乘數.K=TABHL(產出比乘數表,污染比值.K,1,11,4,10,4)                 (11)
00230 T 產出比乘數表=1/1.5                                                  (11.1)
00240 A 每人所得.K=國民生產毛額.K/總人口.K                                      (12)
00250 C 常態每人所得=760E9/17.8E6                                          (12.1)
00260 NOTE  常態工業產出*(1-原料產出-基設產出)+常態農業所得*常態農村人口
00270 NOTE *農業產出率
00280 C 常態GNP=760E9                                                     (12.2)
00290 C 常態工業產出=1600E9                                                 (12.3)
00300 NOTE
00310 NOTE 環境部門
00320 L 污染量.K=污染量.J+DT*(污染產生量.JK-污染產生量.JK*通貨膨脹率*DT            (13)
00330 X 污染吸收量.JK)
00340 NOTE 期初污染量=期初工業資本
00350 N 污染量=1600E9                                                     (13.1)
00360 R 污染吸收量.KL=污染量.K/污染吸收時間.K                                   (14)
00370 A 污染吸收時間.K=常態吸收時間*TABHL(時間乘數表,污染比值.K,0,10,1)             (15)
00380 C 常態吸收時間=5                                                      (15.1)
00390 T 時間乘數表=0/1/1.19/1.32/1.41/1.5/1.57/1.63/1.68/1.73/1.78            (15.2)
00400 R 污染產生量.KL=工業可能產出.K*單位產出污染                                (16)
00410 C 單位產出污染=0.25                                                   (16.1)
00420 A 污染比值.K=污染量.K/1600E9                                          (17)
00430 NOTE
00440 NOTE 基本設施部門
00450 NOTE
00460 L 基本設施量.K=基本設施量.J+DT*(基本設施投資.JK-基本設施損壞.JK)              (18)
00470 N 基本設施量=1600E9                                                  (18.1)
00480 R 基本設施損壞.KL=基本設施量.K/基本設施壽命                                (19)
00490 C 基本設施壽命=50                                                     (19.1)
00500 R 基本設施投資.KL=國民生產毛額.K*基設投資比率                              (20)
00510 C 基設投資比率=0.1                                                    (20.1)
00520 A 每人基設比值.K=(平減基設資本.K/總人口.K)/常態每人基設                      (21)
00530 C 常態每人基設=1600E9/17.8E6                                         (21.1)
00540 L 平減基設資本.K=平減基設資本.J+DT*基本設施投資.JK/(1+通貨膨脹率*DT)          (21.2)
00550 X 基本設施損壞.JK
00560 N 平減基設資本=1600E9                                                (21.3)
00570 NOTE
00580 NOTE 社會發展部門
00590 NOTE
00600 L 社會發展資本.K=社會發展資本.J+DT*(社會資本投資.JK-社會資本消耗.JK)          (22)
00610 N 社會發展資本=800E9                                                 (22.1)
00620 R 社會資本消耗.KL=社會發展資本.K/社資耐用年限                              (23)
00630 C 社資耐用年限=50                                                     (23.1)
00640 R 社會資本投資.KL=國民生產毛額.K*社資投資比率                              (24)
00650 C 社資投資比率=0.075                                                  (24.1)
00660 A 每人社資比值.K=(平減社會資本.K/總人口.K)/常態每人社資                      (25)
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00670 C 常態每人社資=800E9/17.8E6                                              (25.1)
00680 L 平減社會資本.K=平減社會資本.J+DT*社會資本投資.JK/(1+通貨膨脹率*DT)      (25.2)
00690 X DT*社會資本消耗.JK
00700 N 平減社會資本=800E9                                                    (25.3)
00710 NOTE
00720 NOTE 人口部門
00730 NOTE
00740 A 總人口.K=都市人口.K+農村人口.K                                        (26)
00750 C 期初總人口=17.8E6                                                     (26.1)
00760 L 都市人口.K=都市人口.J+DT*(都市新生人口.JK-都市死亡人口.  -都市移出人口   (27)
00770 X .JK+國外移入人口.JK+農村移出人口.JK)
00780 N 都市人口=12.8E6                                                       (27.1)
00790 R 都市新生人口.KL=都市人口.K*都市生育率.K                               (28)
00800 A 都市生育率.K=常態生育率*生育率乘數.K                                  (29)
00810 C 常態生育率=0.03                                                       (29.1)
00820 A 生育率乘數.K=TABHL(生育率乘數表,每人社資比值.K,0.5,6,0.5)              (30)
00830 T 生育率乘數表=1.1/1/0.92/0.85/0.79/0.74/0.70/0.67/0.65/0.64/0.634/0.63  (30.1)
00840 R 都市死亡人口.KL=都市人口.K*都市死亡率.K                               (31)
00850 A 都市死亡率.K=污染影響乘數.K*期望壽齡乘數.K/都市期望壽齡                (32)
00860 C 都市期望壽齡=67                                                       (32.1)
00870 A 期望壽齡乘數.K=TABHL(壽齡乘數表,每人社資比值.K,0.5,6,0.5)              (33)
00880 T 壽齡乘數表=1/1/0.98/0.964/0.95/0.937/0.925/0.913/0.901/0.89/0.88/0.87  (33.1)
00890 A 污染影響乘數.K=TABHL(污染乘數表,污染比值.K,0,10,1)                     (34)
00900 T 污染乘數表=1/1/1.105/1.013/1.025/1.043/1.07/1.11/1.16/1.22/1.29        (34.1)
00910 R 都市移出人口.KL=都市人口.K*移民因子*移民乘數.K                         (35)
00920 C 移民因子=0.001                                                        (35.1)
00930 A 移民乘數.K=TABHL(移民乘數表,每人所得.K/常態每人所得,0,2,0.25)          (36)
00940 T 移民乘數表=20/8/4/2/1/0.85/0.8/0.8/0.8                                 (36.1)
00950 R 國外移入人口.KL=CLIP(港僑臺台人數,0,TIME,1992)+CLIP(港僑臺台人數,0,    (37)
00960 X TIME,1997)+常態移入人口
00970 C 港僑臺台人數=0                                                        (37.1)
00980 C 常態移入人口=10000                                                    (37.2)
00990 L 農村人口.K=農村人口.J+DT*(農村新生人口.JK-農村死亡人口.JK-農村移出人口   (38)
01000 X .JK)
01010 N 農村人口=5E6                                                          (38.1)
01020 R 農村新生人口.KL=農村人口.K*農村生育率.K                               (39)
01030 A 農村生育率.K=農常態生育率*農生育率乘數.K                              (40)
01040 C 農常態生育率=0.036                                                    (40.1)
01050 A 農生育率乘數.K=TABHL(農生育乘數表,每人社資比值.K,0.5,6,0.5)            (41)
01060 T 農生育乘數表=1/1/0.9/0.769/0.667/0.588/0.526/0.475/0.435/0.406/0.382/  (41.1)
01070 X 0.372
01080 R 農村死亡人口.KL=農村人口.K*農村死亡率.K                               (42)
01090 A 農村死亡率.K=農期望壽乘數.K/農村期望壽齡                              (43)
01100 C 農村期望壽齡=65                                                       (43.1)
01110 A 農期望壽乘數.K=TABHL(農壽齡乘數表,每人社資比值.K,0.5,6,0.5)            (44)
01120 T 農壽齡乘數表=1/1/0.98/0.95/0.901/0.88/0.87/0.865/0.862/0.86/0.86/0.86  (44.1)
01130 A 都市人口比率.K=都市人口.K/總人口.K                                    (45)
01140 A 人口密度.K=總人口.K/土地面積                                          (46)
01150 C 土地面積=36000                                                        (46.1)
01160 NOTE
01170 NOTE
01180 NOTE
01190 NOTE 農業部門
01200 NOTE
01210 R 農村移出人口.KL=農村自然成長.K*農村移出乘數.K                         (47)
01220 A 農村自然成長.K=農村新生人口.JK-農村死亡人口.JK                        (48)
01230 A 農村移出乘數.K=TABHL(農移出乘數表,相對農村所得.K/相對農常所得,0,2,0.5) (49)
01240 T 農移出乘數表=2/1.4/1/0.75/0.6                                         (49.1)
01250 NOTE
01260 NOTE
01270 NOTE
01280 NOTE
01290 C 相對農常所得=0.4267                                                   (50)
01300 A 相對農村所得.K=農業勞動所得.K/非農勞動所得.K                          (51)
01310 A 非農勞動所得.K=工業產出.K/非農業就業量.K                              (52)
01320 A 農業勞動所得.K=常態農業所得*(可耕地面積.K/常態耕地面積)*(耕作指標.K/   (53)
01330 X 常態耕作指標)*(1+DT*通貨膨脹率)(TIME-1980)
01340 C 常態農業所得=80000                                                    (53.1)
01350 C 常態耕作指標=10                                                       (53.2)
01360 A 耕作指標.K=TABHL(耕作指標表,TIME,1980,2050,10)                         (54)
01370 T 耕作指標表=10/11/11.8/12.5/13.1/13.6/14/14.3                           (54.1)
01380 A 糧食生產面積.K=可耕地面積.K*收穫次數.K                                (55)
01390 C 常態耕地面積=1800000                                                  (55.1)
01400 C 常態收穫次數=2                                                        (55.2)
01410 A 收穫次數.K=TABHL(收穫次數表甲,農業GNP比,0,4,1)*TABHL(收穫次數表乙,TIME  (56)
01420 X ,1980,2050,10)
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01430 T 收穫次數表甲=1/1/1.3/1.5/1.6                                   (56.1)
01440 T 收穫次數表乙=2/2.5/2.9/3.2/3.4/3.5/3.5/3.5                     (56.2)
01450 C 農業GNP比=1                                                   (56.3)
01460 A 每人糧食比.K=(糧食生產面積.K/總人口.K)/期初比                   (57)
01470 C 期初比=0.101                                                  (57.1)
01480 A 農業勞動力.K=農村人口.K÷農勞參與率                             (58)
01490 C 農勞參與率=0.3                                                (58.1)
01500 L 可耕地面積.K=可耕地面積.J-DT÷耕地移轉使用.JK                    (59)
01510 N 可耕地面積=900000                                             (59.1)
01520 L 都市工業用地.K=都市工業用地.J+DT÷耕地移轉使用.JK                (60)
01530 NOTE
01540 N 都市工業用地=99200                                            (60.1)
01550 C 常態資本用地=1.2E-8                                           (60.2)
01560 C 常態每人用地=0.004                                            (60.3)
01570 A 單位資本用地.K=常態資本用地÷資本用地乘數.K                      (61)
01580 A 每人用地.K=常態每人用地÷每人用地乘數.K                          (62)
01590 A 資本用地乘數.K=TABHL(資用地乘數表,都工用地指數.K,0,5,1)         (63)
01600 T 資用地乘數表=1.2/1/0.9/0.85/0.82/0.8                          (63.1)
01610 A 都工用地指數.K=都市工業用地.K/99200                            (63.2)
01620 A 每人用地乘數.K=TABHL(人用地乘數表,都工用地指數.K,0,5,1)         (64)
01630 T 人用地乘數表=1.2/1/0.9/0.85/0.82/0.8                          (64.1)
01640 R 耕地移轉使用.KL=(都工用地需求.K-都市工業用地.K)/使用移轉時間     (65)
01650 C 使用移轉時間=5                                                (65.1)
01660 A 都工用地需求.K=(工業資本.K+基本設施量.K+社會發展資本.K)÷單位資本用地.K   (66)
01670 X +都市人口.K÷每人用地.K
01680 A 農業產出.K=農業勞動所得.K÷農業勞動力.K                          (67)
01690 A 平均農作規模.K=可耕地面積.K/900000÷(5E6/農村人口.K)÷期初農作規模  (68)
01700 C 期初農作規模=1.1                                              (68.1)
01710 A 農業人口比.K=總人口.K/農業勞動力.K                              (69)
01720 NOTE
01730 NOTE 就業部門
01740 NOTE
01750 A 工業就業.K=平滑工業資本.K/工資本勞動比.K                        (70)
01760 A 工資本勞動比.K=工常態資勞比÷工資勞比乘數.K                      (71)
01770 C 工常態資勞比=0.425E6                                          (71.1)
01780 A 工資勞比乘數.K=TABHL(勞資比乘數表,平滑工業資本.K/1600E9,1,8,1)  (72)
01790 T 勞資比乘數表=1/1.5/1.96/2.38/2.76/3.10/3.4/3.66               (72.1)
01800 A 基本設施就業.K=平滑基設資本.K/基設資勞比.K                      (73)
01810 A 基設資勞比.K=常基設資勞比÷基資勞比乘數.K                        (74)
01820 C 常基設資勞比=1.56E6                                           (74.1)
02000 A 基資勞比乘數.K=TABHL(基資勞乘數表,平滑基設資本.K/1600E9,1,8,1)  (75)
02010 T 基資勞乘數表=1/1.5/1.96/2.38/2.76/3.10/3.40/3.66              (75.1)
02020 A 社會部門就業.K=平滑社會資本.K/社會資勞比.K                      (76)
02030 A 社會資勞比.K=常態社資勞比÷社資勞比乘數.K                        (77)
02040 C 常態社資勞比=1.56E6                                           (77.1)
02050 A 社資勞比乘數.K=TABHL(社資勞乘數表,平滑社會資本.K/800E9,1,8,1)   (78)
02060 T 社資勞乘數表=1/1.5/1.96/2.38/2.76/3.1/3.4/3.66                (78.1)
02070 A 勞動力.K=非農業勞動力.K+農業勞動力.K                            (79)
02080 A 非農業勞動力.K=都市人口.K÷都勞動參與率                          (80)
02090 C 都勞動參與率=0.4                                              (80.1)
02100 A 非農業就業量.K=工業就業.K+基本設施就業.K+社會部門就業.K          (81)
02110 A 非農失業率.K=(非農業勞動力.K-非農業就業量.K)/非農業勞動力.K      (82)
02120 SPEC DT=0.5/TIMESTART=1980/LENGTH=2030/PLTPER=1/PRTPER=10
02125 NOTE 都工用地指數=I,耕地移轉使用=K,都工用地需求=L,單位資本用地=F
02130 PLOT 都市人口=U,農村人口=R,總人口=T
02140 PLOT 工業資本=I,基本設施量=F,社會發展資本=S
02150 NOTE PLOT 工業可能產出=I,污染量=P,都市工業用地=L,可耕地面積=C
02160 PLOT 工業就業=I,基本設施就業=F,社會部門就業=S,非農業就業量=J
02170 NOTE PLOT 非農勞動所得=N,農業勞動所得=A,每人所得=P
02180 NOTE PLOT 非農失業率=U,非農業勞動力=L,非農就業量=J
02190 NOTE PLOT 每人基設比值=I,每人社資比值=S,污染比值=P,平均農作規模=F
02200 NOTE PLOT 都市人口比率=U,每人糧食比=C,人口密度=D,農業人口比=F
02205 PRINT 工業資本,基本設施量,社會發展資本
02210 ÷
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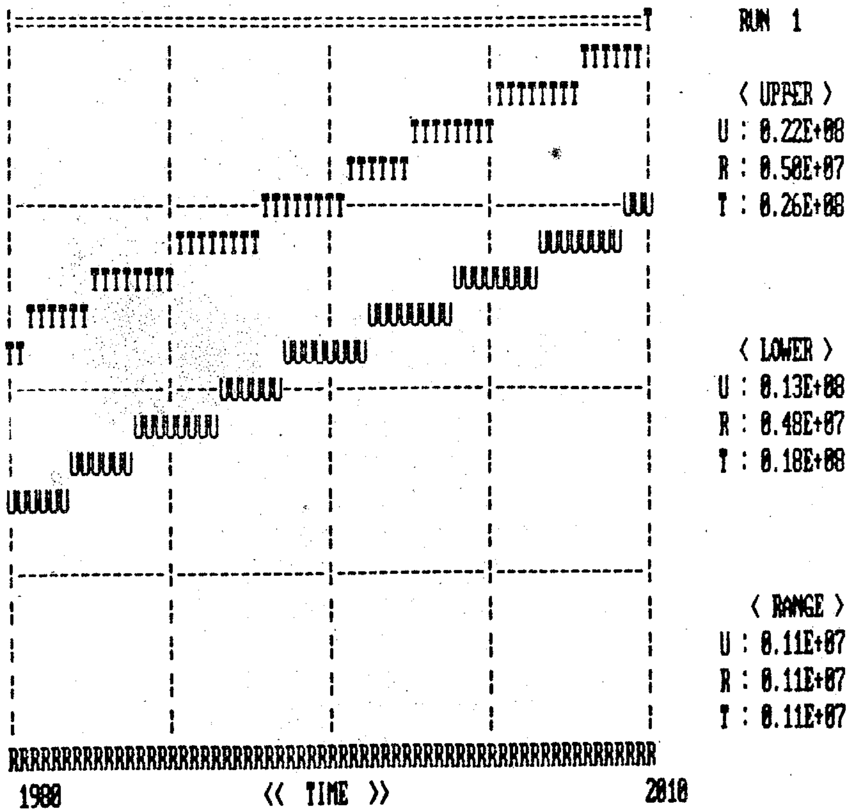
FIG 5

TTIME	工業資本	基本設施量	社會發展資本
1980.00	1600.00E+09	1600.00E+09	8000.00E+08
1981.00	1705.45E+09	1650.92E+09	8461.49E+08
1982.00	1813.43E+09	1704.11E+09	8938.43E+08
1983.00	1923.57E+09	1759.40E+09	9429.57E+08
1984.00	2035.51E+09	1816.61E+09	9933.58E+08
1985.00	2119.26E+09	1861.04E+09	1034.02E+09
1986.00	2204.34E+09	1906.86E+09	1075.59E+09
1987.00	2290.65E+09	1954.02E+09	1118.01E+09
1988.00	2378.09E+09	2002.47E+09	1161.27E+09
1989.00	2466.54E+09	2052.15E+09	1205.31E+09
1990.00	2555.90E+09	2103.01E+09	1250.09E+09
1991.00	2646.05E+09	2154.97E+09	1295.58E+09
1992.00	2757.12E+09	2217.92E+09	1349.17E+09
1993.00	2869.87E+09	2282.58E+09	1403.92E+09
1994.00	2984.13E+09	2348.89E+09	1459.78E+09
1995.00	3099.74E+09	2416.76E+09	1516.69E+09
1996.00	3204.83E+09	2480.39E+09	1570.30E+09
1997.00	3298.34E+09	2539.10E+09	1620.10E+09
1998.00	3391.57E+09	2598.31E+09	1670.17E+09
1999.00	3484.38E+09	2657.95E+09	1720.44E+09
2000.00	3576.64E+09	2717.93E+09	1770.86E+09
2001.00	3668.18E+09	2778.17E+09	1821.36E+09
2002.00	3758.86E+09	2838.55E+09	1871.87E+09
2003.00	3862.21E+09	2905.68E+09	1927.33E+09
2004.00	3978.96E+09	2980.07E+09	1988.14E+09
2005.00	4095.46E+09	3055.13E+09	2049.35E+09
2006.00	4211.51E+09	3130.74E+09	2110.87E+09
2007.00	4316.61E+09	3201.75E+09	2168.85E+09
2008.00	4385.56E+09	3255.67E+09	2213.91E+09
2009.00	4417.31E+09	3291.61E+09	2245.40E+09
2010.00	4407.83E+09	3307.25E+09	2261.57E+09



1 都市人口=U,農村人口=R,總人口=T

assess the consequences of implementing alternative strategies.

This paper describes a pilot model, the harbinger of what could become a comprehensive package of interactive regional and sectoral models of Taiwan, to be used for long range planning. To fulfill its purpose, many versions and many extensions of DMT will be needed such as the PC DYNAMO II version appearing in Fig. 4 with sample output shown in Fig. 5 (Hsieh 1987).

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