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IPASS Technical Manual

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by

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IPASS Technical Manual

This manual is intended to lead the user through the algorithmic logic of IPASS[1]. An understanding of the logic and assumptions of IPASS permits the user to take full advantage of IPASS's flexibility and power as well as leads to better interpretation of an impact analysis.

We are assuming that the user has read the IPASS user manual[2] and has knowledge of input-output models and an appropriate technical background for interpreting the organization and terminology of IPASS.

For those interested in the source code of IPASS, it can be obtained from Doug Olson or Con Schallau at the PNW Forest and Range Experimental Station, 3200 Jefferson Way, Corvallis, Oregon 97331.

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[1]The Interactive Policy Analysis Simulation System is currently written in Fortran V and is available only on Oregon State University's CDC Cyber 170 model 720 computer. A similar model, "SIMLAB", is also available at the University of Minnesota.

[2]Olson, Doug; Schallau, Con; Maki, Wilbur. IPASS: an interactive policy analysis simulation system. Gen. Tech. Rep. PNW-170. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Statio; 1984. 70 p.

Organization of IPASS and this Manual

The IPASS source code is segmented (by overlays) so that each segment is an identifiable collection of algorithms --i.e., set of computer instructions. This "modular" format allows greater ease in adding or replacing parts of the IPASS model. It can also be more readily taught and understood. Figure 1, which is similar to figure 1 (page 1) in the IPASS user manual, shows the modular flow of the IPASS simulation.

Currently IPASS has 52 overlays (modules). Of these, seven contain the logic shown in Figure 1. Another 32 overlays display data -- half in 80 column format and the other half in 132 column format. Nine overlays and one subroutine deal with user modification of data. One overlay allows the user opportunity to alter programming instructions. Two overlays read in a data base from a permanent file and save a data base onto a permanent file. Eight overlays and a subroutine allow the user to modify any of 120 IPASS parameters and variables. The remaining one is the Main or Control overlay, which acts as the director, calling up each of the various overlays to perform their functions. There is also a "bullet proofing" routine which, in the interactive mode, allows the user to retype illegal characters without bringing the program to an ignominious stop.

Figure 2 shows the relationship of the Control overlay to other overlays. Note that any of the overlays called into action by the Control module may, in turn, call into action a secondary overlay.

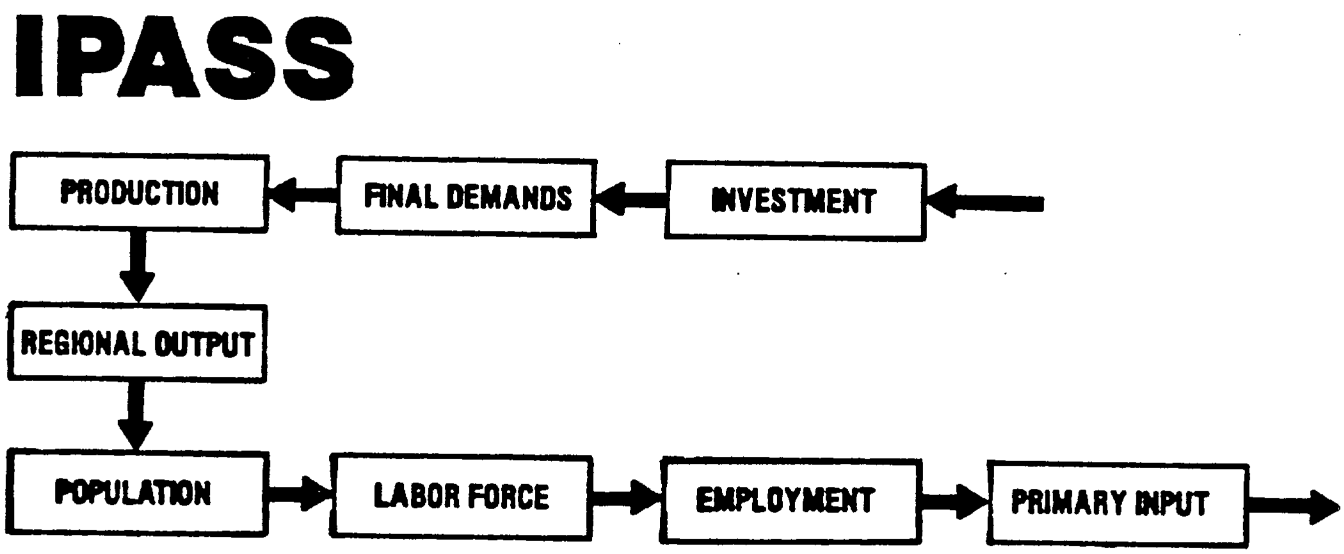

Figure 1. Modular flow of the IPASS model. (Population calculations are now performed before labor force and employment, allowing population estimates to be calculated in a more straightforward manner.)

All modules shown in Figure 2 are described in the following sections. For each module, a brief description of what the module does is followed by a table showing, step by step, the logic within the module. On the facing page is a flow chart summarizing those steps. Many of those flowcharts are broken up by this format. A complete flowchart is provided in Appendix B for those modules which have fragmented flowcharts. Each flow chart is kept as simple as possible while maintaining a faithful representation of the model. Despite this simplicity we believe adequate documentation is provided to enable the user to master the fine points of IPASS.

Appendix C is a combination glossary and index to variables and parameters. It provides a definition and the locations of each occurence of parameters and variables throughout the manual. A few of the entries in the glossary, however, show up only in the IPASS Database Manual and IPASS source code and not in this technical manual.

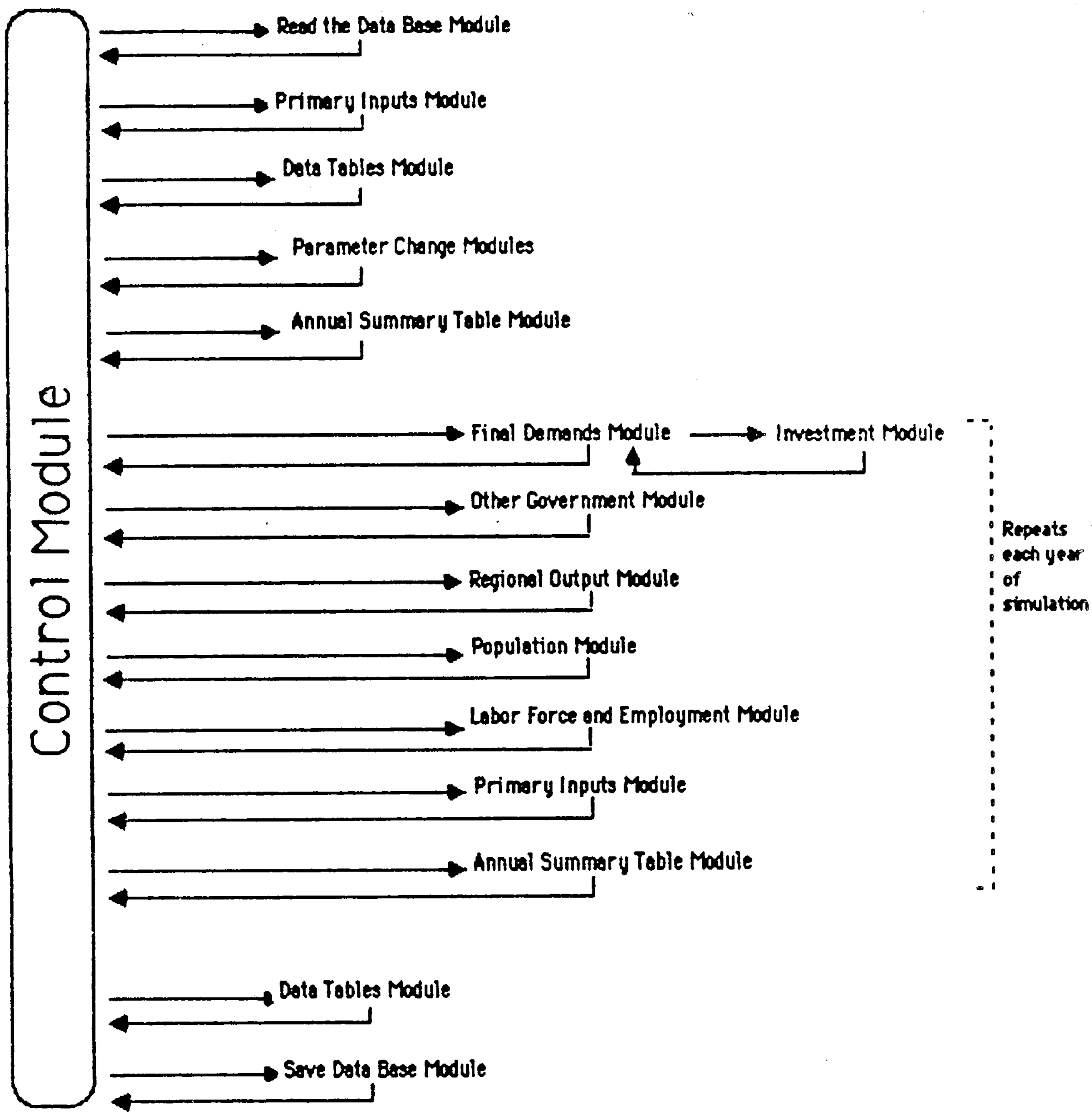

Figure 2. Relationship between the Control, Primary and Secondary Overlays used in the IPASS model to interact with the user and manipulate the data base

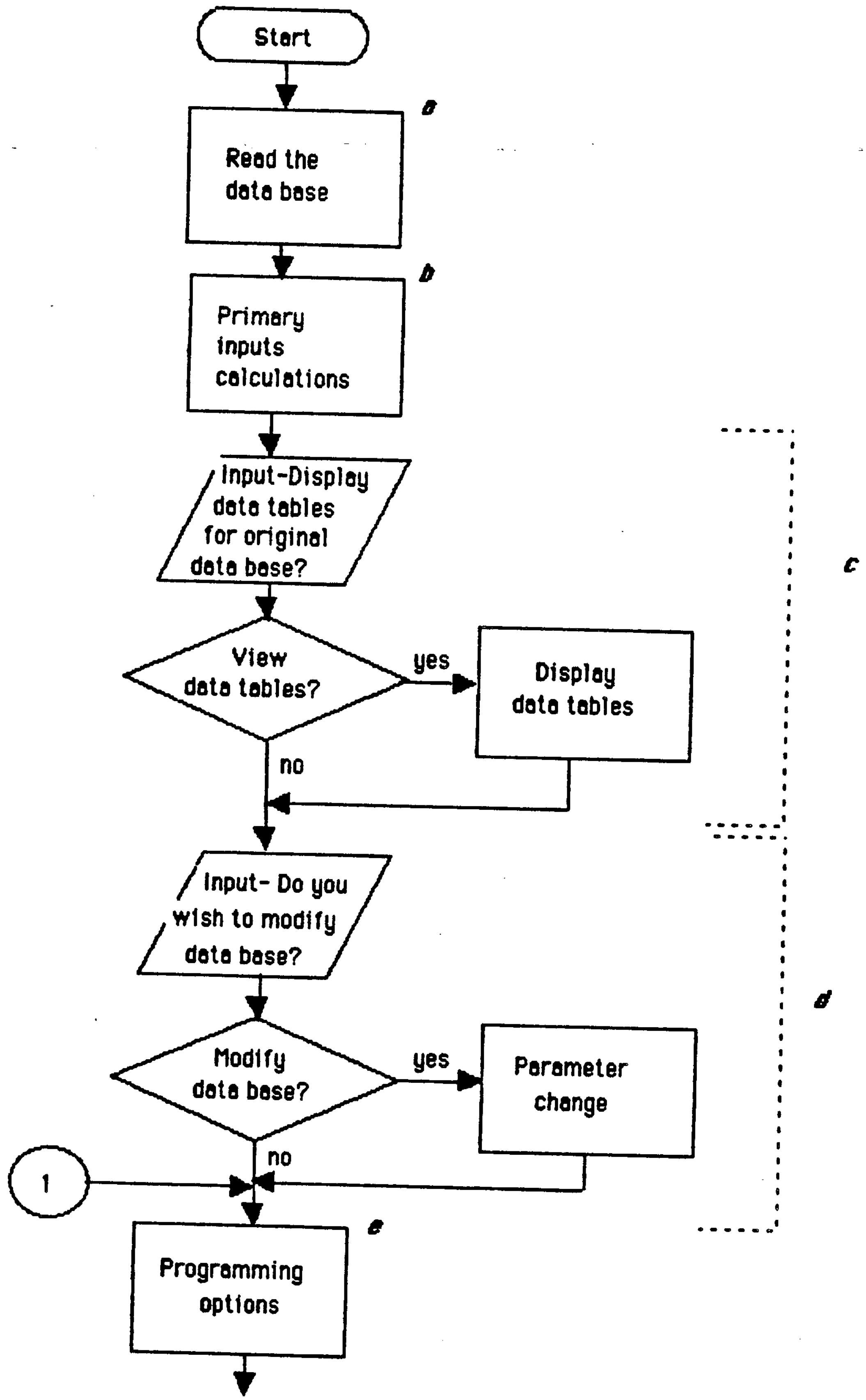

Figure 3. Main Control Module

Main Control Module [Overlay(0,0)]

The Control module (i.e., overlay) directs the sequence of action in an IPASS simulation to a primary module which may in turn pass control to secondary overlays. Control is eventually passed back to the Control module which will then move to the next step in its sequence. The Control module starts the IPASS program. It also ends the IPASS program. For this and each subsequent overlay, the individual steps are described. Each step is summarized in a flowchart on the facing page.

Table 1. Main Control Module [Overlay(0,0)]

Step	Description
a.	Data for each individual region is stored in separate disk storage files on the Cyber computer. The Read in Data module asks the user to specify a region for simulation and then read in the data for that region. [See page 15 - overlay (1,0)]
b.	The Primary Inputs module calculates value added, imports, depreciation, business income and personal income in dollar values based on the "historical" values and ratios from the from the original data base. [See page 69 - overlay (7,0)]
c.	The user may have current data displayed in table form. Examples can be found in the IPASS user manual in Appendix A section 1. [See page 79 - overlays (11,0) to (11,11) and (12,0) to (12,11)] (Note: the parallelogram in the flow chart represents the need for input from the user. The following block usually tests the response given by the user.)
d.	The Parameter Change module allows the user to externally change current IPASS ratios and variables for "fine tuning" of data base or impact analysis. [See page 83 - overlays (14,0) to (14,10), subroutine FETCH, and part of overlays (2,0) and (2,1)]
e.	A number of programming "options" are available to the IPASS user. These options allow changes in assumptions, such as allowing output capacity to be non-constraining. The user may also request that certain variables and parameters be displayed automatically each year. The Options module currently allows the user to select from 13 options. [See page 17 - overlay (20,0)]

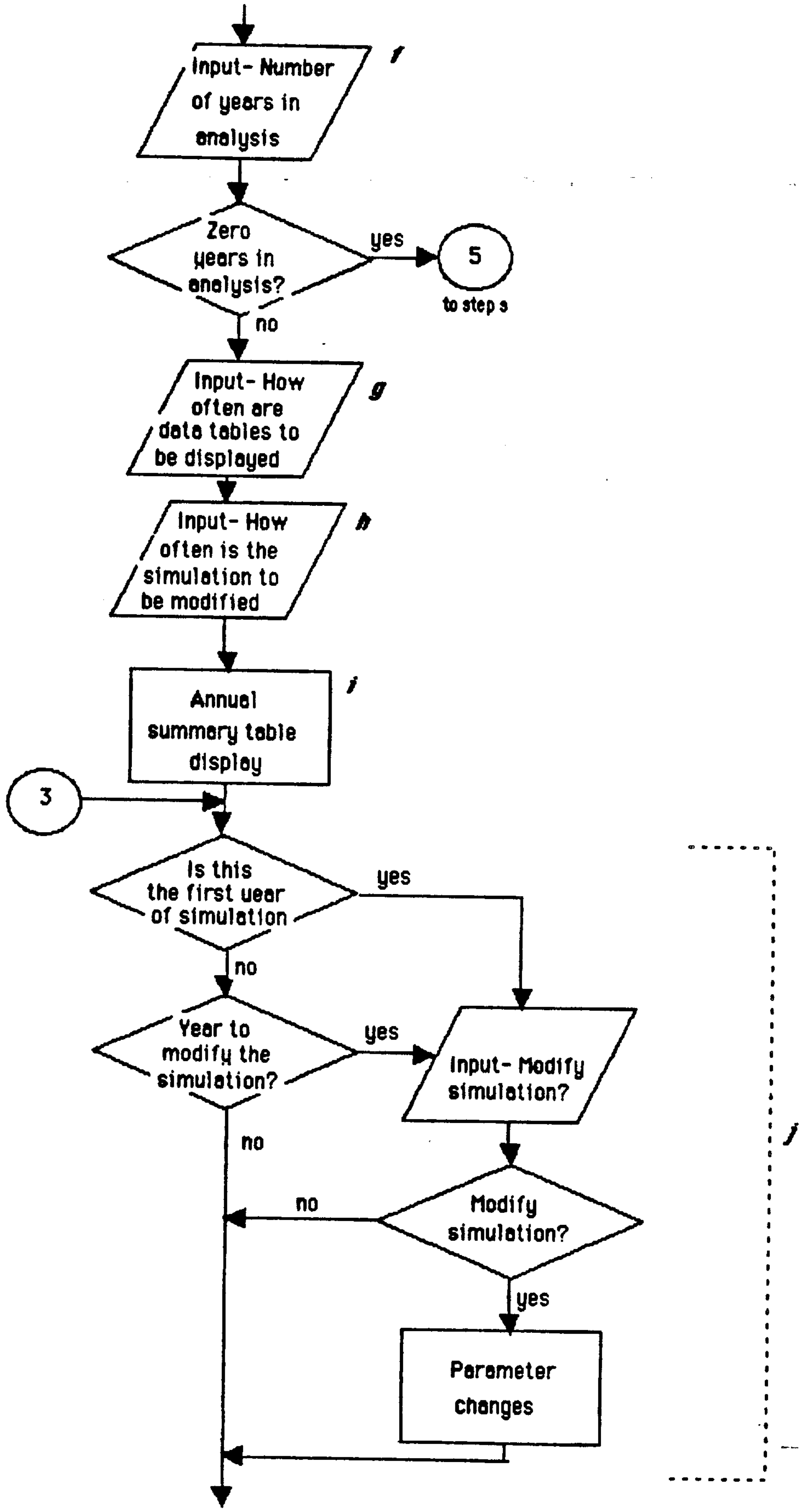

Figure 3.(Cont'd) Main Control Module

Table 1.(Cont'd) Main Control Module [Overlay(0,0)]

Step	Description
f.	The user sets the number of simulation years. The response is added to variable IYB (base year of data) to form IYE (ending year of simulation). Variable IYEAR is the current year, which is at this point in the simulation is equal to IYB.
g.	The user sets the interval in which data tables may be displayed. Variable MFREQ1 is set equal to the user response. If "0" then MFREQ1 is set to 9999 -- i.e., IPASS will offer the user the opportunity to view tables every 9999 years.
h.	The user sets the interval in which parameters may be modified. Variable MFREQ2 is set equal to the user response. If "0" then MFREQ2 is set to 9999.
i.	The annual summary table displays a topical summary of socio-economic indicators as represented in the "historical" regional data base as altered (if altered) by the user in step d. [See page 81 - overlays(21,0) to (21,6) and (10,0) to (10,6)]
(Step j marks the beginning of each annual iteration of the simulation. Variable IYEAR is updated to represent the year currently being simulated -- i.e., IYEAR = IYEAR + 1. Variables ICOUNT1 and ICOUNT2 track the number of years since the user's last opportunity to view data tables and to modify parameters, respectively.)	
j.	Even when the user specifies that the simulation is not to be modified (i.e., MFREQ2 = 9999) the user may modify the simulation during the first year (i.e., when IYEAR = IYB (base year) + 1). The user also may modify the simulation when MFREQ2 = ICOUNT2 -i.e., when specified by the user in step h. (When "yes", ICOUNT2 is reset to zero to track the next occurrence).

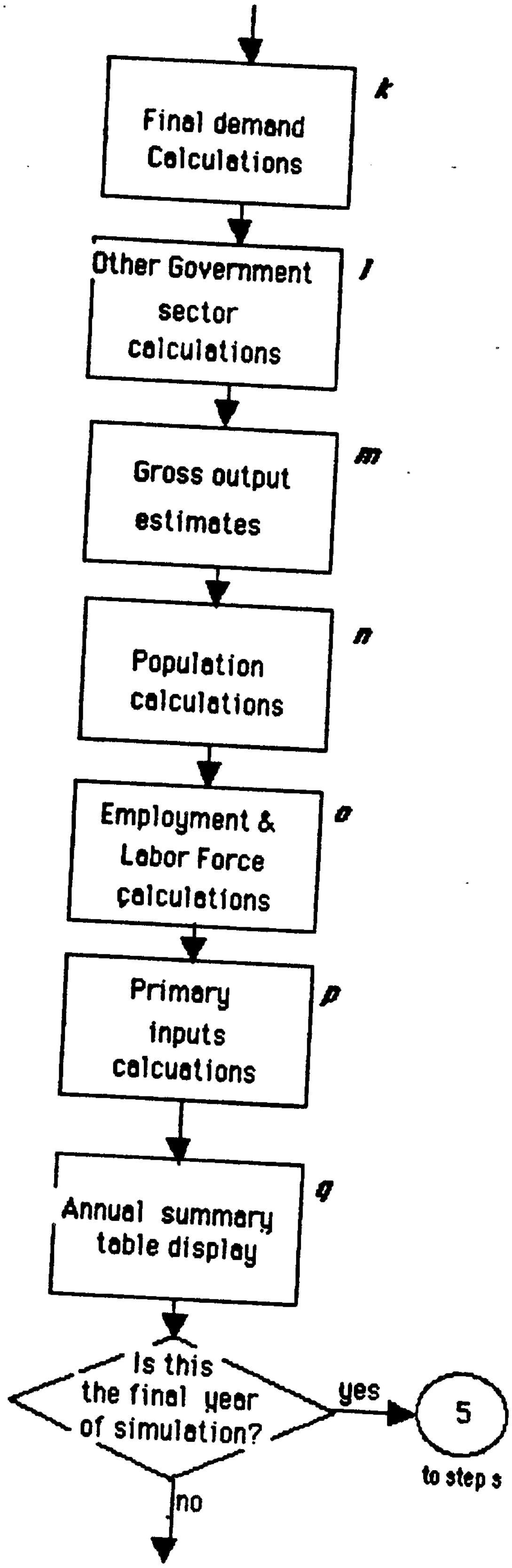

Figure 3.(Cont'd) Main Control Module

Table 1.(Cont'd) Main Control Module [Overlay(0,0)]

Step	Description
k.	Control is passed to the Final Demands module. This module estimates the level of seven components of final demand. It also passes control to the Investment routine [overlay(2,1)] which calculates investment by industrial sector for use in determining the gross private capital formation component of final demand. [See page 19 - overlay(2,0)]
l.	Control is passed to Other Government module. The IPASS model requires that the last sector -- i.e., sector number NIS (number of industrial sectors), be "other government". Since the level of output of this sector is not affected by industry interaction (i.e., it is exogenous to the I/O model) its output is estimated separately by this module. [See page 39- overlay(3,0)]
m.	Control is passed to Regional Output module. The demand for sector output based on final demands is calculated using the Leontief inverse matrix. This output is then constrained by IPASS to conform to output capacity of each industrial sector. [See page 43 - overlay (4,0)]
n.	Control is passed to the Population module. This module estimates population by one year age classes. [See page 49 - overlay (5,0)]
o.	Control is passed to the Labor Force and Employment module. This routine calculates labor force, occupational, and industry employment characteristics. Output is again constrained by IPASS (if necessary) to conform to labor force constraints. [See page 57 - overlay(6,0)]
p.	Control is passed to the Primary Inputs module. This module estimates value added and imports based on estimated output per sector. Also estimated is total personal income. [See page 69 - overlay(7,0)]

(Step p completes the calculations for the current simulation year IYEAR.)

(If this iteration is the last year to be simulated (i.e., IYEAR = IYE) then skip to step s, otherwise we will continue to step r which will, in turn, cycle back to step k.)

q.	The annual summary table for the current year is displayed. See Appendix A of the IPASS user manual for an example of all tables.

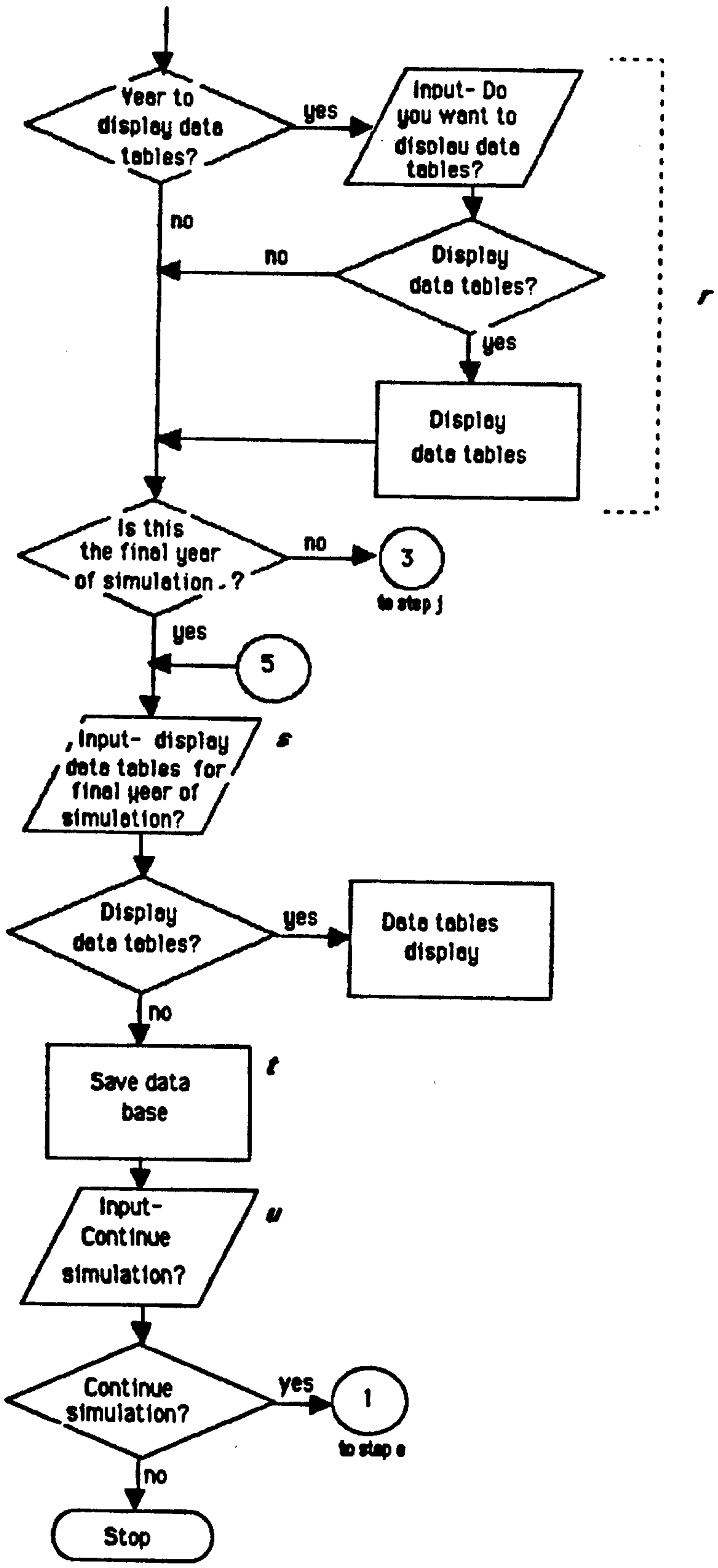

Figure 3.(Cont'd) Main Control Module

Table 1.(Cont'd) Main Control Module [Overlay(0,0)]

Step	Description
r.	If it is time to view data tables as specified in step g (i.e., ICOUNT1=MFREQ1) then the user is provided that opportunity and ICOUNT1 is reset to zero to track for the next occurrence.

(A year of simulation is completed. The counter IYEAR is increased by one year and the program returns to step j to continue the simulation for the next year.)

Step	Description
s.	After the final year of simulation the user is given the opportunity to look at the final data tables.
t.	Control is passed to the Data Base Save module. This routine can create a permanent file using the IPASS derived data for the current year of data. This "saved" data base can be used in another IPASS simulation. [See page 77 - overlay(13,0)]
u.	The user may now request that IPASS continue simulation using the current year data as the beginning data base.

(IPASS will return to step e if the user wishes to continue the simulation.)

(The program terminates.)

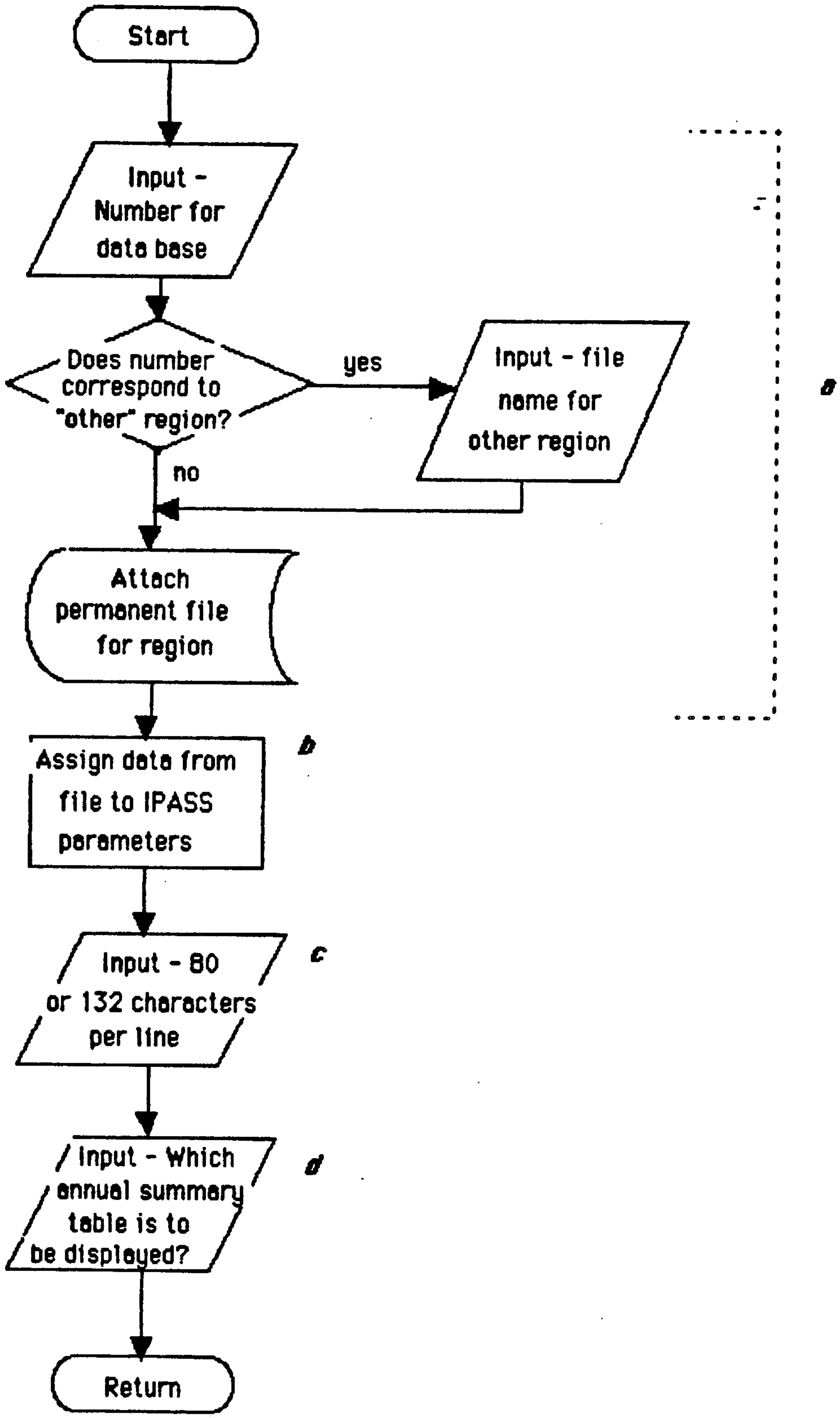

Figure 4. Read in Data Module [Overlay(1,0)]

Read in Data Module [Overlay(1,0)]

IPASS is designed to work with any set of data (data base) which has been prepared for use with IPASS. The user must specify which data base is to be used in the current simulation. The IPASS Database Manual is available for use in creation of a data base.

Table 2. Read in Data Module [Overlay(1,0)]

Step	Description
a.	The user must select one of the models offered in a list displayed by IPASS or select number 25, "other". If other, then the user must type in the name of the file in which the data base is stored on the computer. In any case the file chosen must be available in the computer's memory as a permanent file. The computer will then attach the chosen file.
b.	All data from the file is assigned to the appropriate parameters and variables.
c.	The user must specify if all output is to displayed in 132 columns or 80 columns.
d.	The user must also specify which annual summary table is to be displayed throughout the simulation. An example of all tables can be found in Appendix A of the IPASS user manual.

(Control is returned to the Control module.)

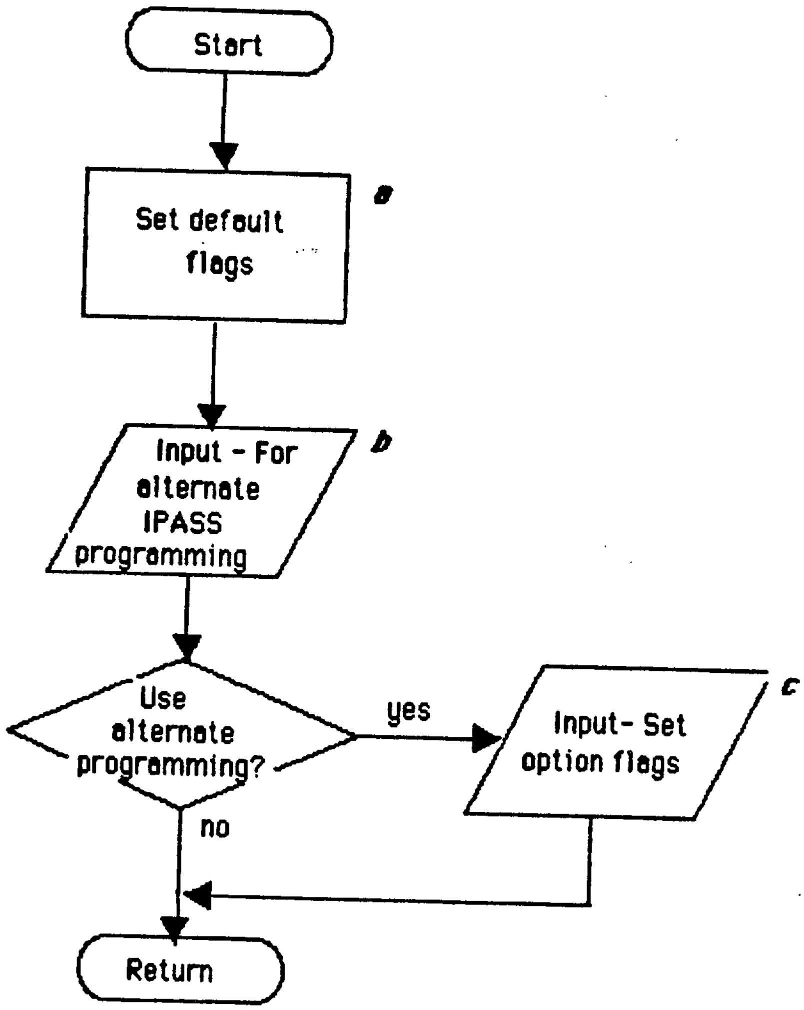

Figure 5. Options Module [Overlay(20,0)]

Options Module [Overlay(20,0)]

When a user has a special need, alterations or additions are made to IPASS. A flag can then be set by the user which IPASS recognizes as a signal to perform the customized programming. Customized programming that may be useful to other users is offered as an option. Most options display data that is not otherwise available. There are currently four options, however, that change basic assumptions.

There are thirteen options:

a. Do you want to ignore capital constraints?
b. Do you want to ignore output per worker?
c. Do you want to freeze wages in borrowing sectors?
d. Do you want pollution abatement capacity constraining?
e. Do you want to see calculations for the conversion of investment to GPCF?
f. Do you want to print out components of the PCE calculations?
g. Do you want to view the the change in gross output resulting from "user-specified" final demands?
h. Do you want to see the Leontief inverse calculations that determine gross output demanded?
i. Do you want to see a comparison of actual output and output demanded by sector?
j. Do you want to see the occupational employment data?
k. Do you want to see population and migration data by one-year age classes?
l. Do you want to print out components of business income calculations?
m. Do you want to see which sectors needed to borrow or freeze earnings to remain viable?

Table 3. Options Module [Overlay(20,0)]

Step	Description
a.	Set all options flags to "no". "No", therefore, becomes the default value.
b.	The user must respond to the question: Do you want to use optional IPASS programming?
	(If "no" then all default values are accepted and control is returned to the Control Module)
c.	If "yes" the user must respond to each of the thirteen options, a to m, as listed above before control is returned to the Control module.

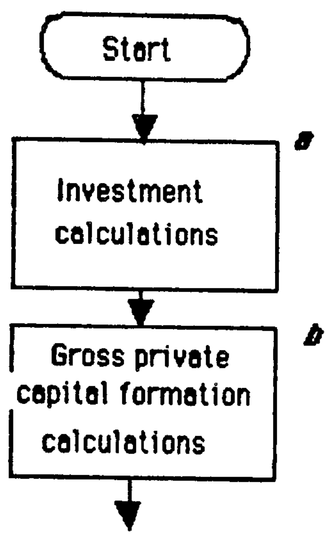

Figure 6. Final Demands Module [Overlay(2,0)]

Final Demands Module [Overlay (2,0)]

The final demands module drives the model because the total final demand determines the potential economic activity of the region.

This module projects the values for each of six final demands:

1. Personal Consumption Expenditures (PCE)
2. Gross Private Capital Formation (GPCF)
3. Change in Business Inventories (BINCH)
4. Exports (EXPORT)
5. State and Local Government Expenditures (SGOVE)
6. Federal Government Expenditures (FGOVE)

It also allows the user to specify the level of:

7. User Specified Final Demand (USERFD)

The sequence of steps for calculating final demands are described in table 4. Each step is summarized in a flowchart on the facing page.

Table 4. Final Demands Module [Overlay(2,0)]

Step	Description
a.	Control is passed to the investment module [Overlay (2,1)] which estimates the level of investment for calculating GPCF. The four kinds of investment estimated are: 1. Expansion investment in productive capital stock (EINVPR) 2. Expansion investment in pollution abatement equipment (EINVPA) 3. Replacement investment of productive capital stock (RINVPR) 4. Replacement investment in pollution abatement stock (RINVPA)
b.	The final demand "gross private capital formation" (GPCF) can now be calculated. But first the sum of all investment for each industry (AINV) is calculated: 1. $AINV_j = EINVPR_j + EINVPA_j + RINVPR_j + RINVPA_j$

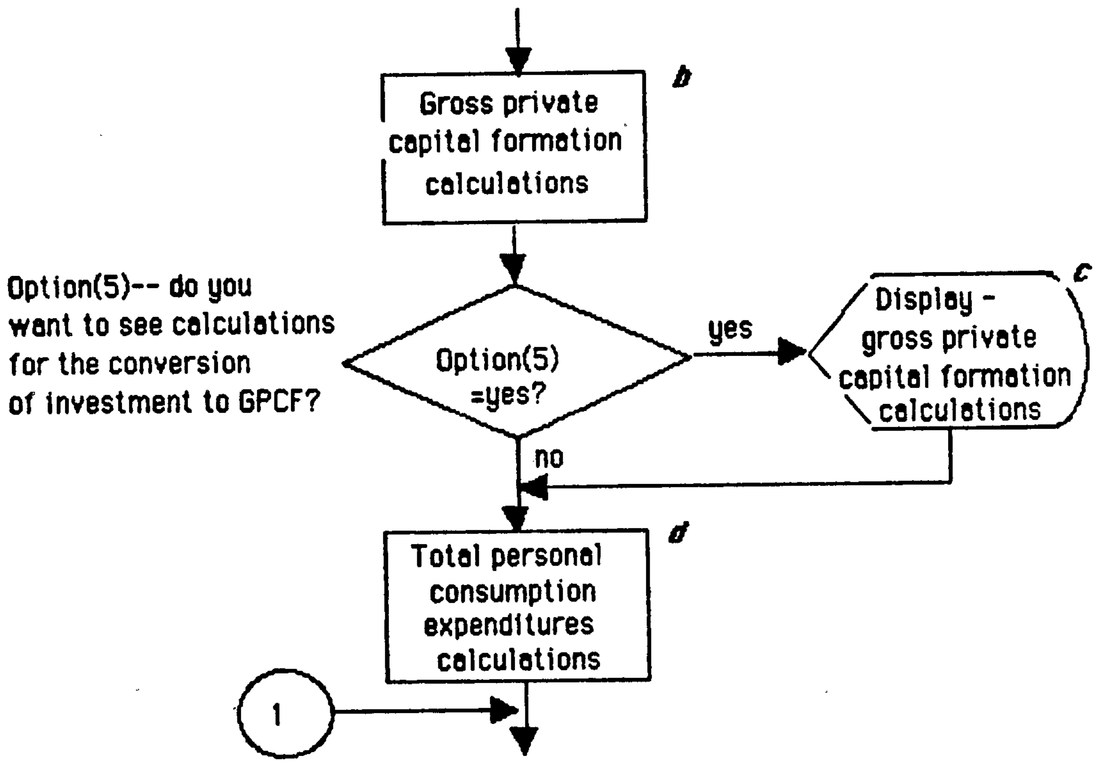

Figure 6.(Cont'd) Final Demands Module [Overlay(2,0)]

Table 4. (Cont'd) Final Demands Module [Overlay(2,0)]

Step	Description
b.	(Cont'd) Total GPCF final demand purchases from each industry i is the sum of the individual GPCF purchases by industry j from industry i. The investment matrix ($INVMAT_{i,j}$) stores the distribution of purchases by j from i for each dollar of investment: 2. $GPCF_i = \sum_{j=1}^{nis} INVMAT_{j,i} * AINV_j$
c.	Example calculations of GPCF can be displayed if asked for by the user in the Options module. An example of this output can be found in Appendix A (page 40) of the IPASS user manual
d.	Total personal consumption expenditures (PCET) is now calculated. First, calculate rate of change in total population (PT) from IYEAR-2 to IYEAR-1: 3. PT = POPT/POPTM1 where: POPT is total population in IYEAR-1 POPTM1 is total population in IYEAR-2 Calculate total disposable income from IYEAR-2 (DITM1) and IYEAR-1 (DIT): 4. DITM1 = PIDITR * PITM1 5. DIT = PIDITR * PIT where: PIDITR is the personal to disposable income ratio PIT is total personal income from IYEAR-1 PITM1 is total personal income from IYEAR-2 Total PCE (PCET) is set equal to total PCE from IYEAR-1 (PCETM1) plus the portion of the change in total disposable income not placed in savings: 6. PCET = PCETM1 + PCER * (DIT - DITM1) where: PCER is (1. - the national savings to earnings ratio) Calculate the approximate rate of change in PCET per wage earner from IYEAR-1 (the previous year) to IYEAR (the current year): 7. PI = (PCET/EMPLOYT) / (PCETM1/EMPM1T) where: EMPLOYT is total employment in IYEAR-1 EMPM1T is total employment from IYEAR-2

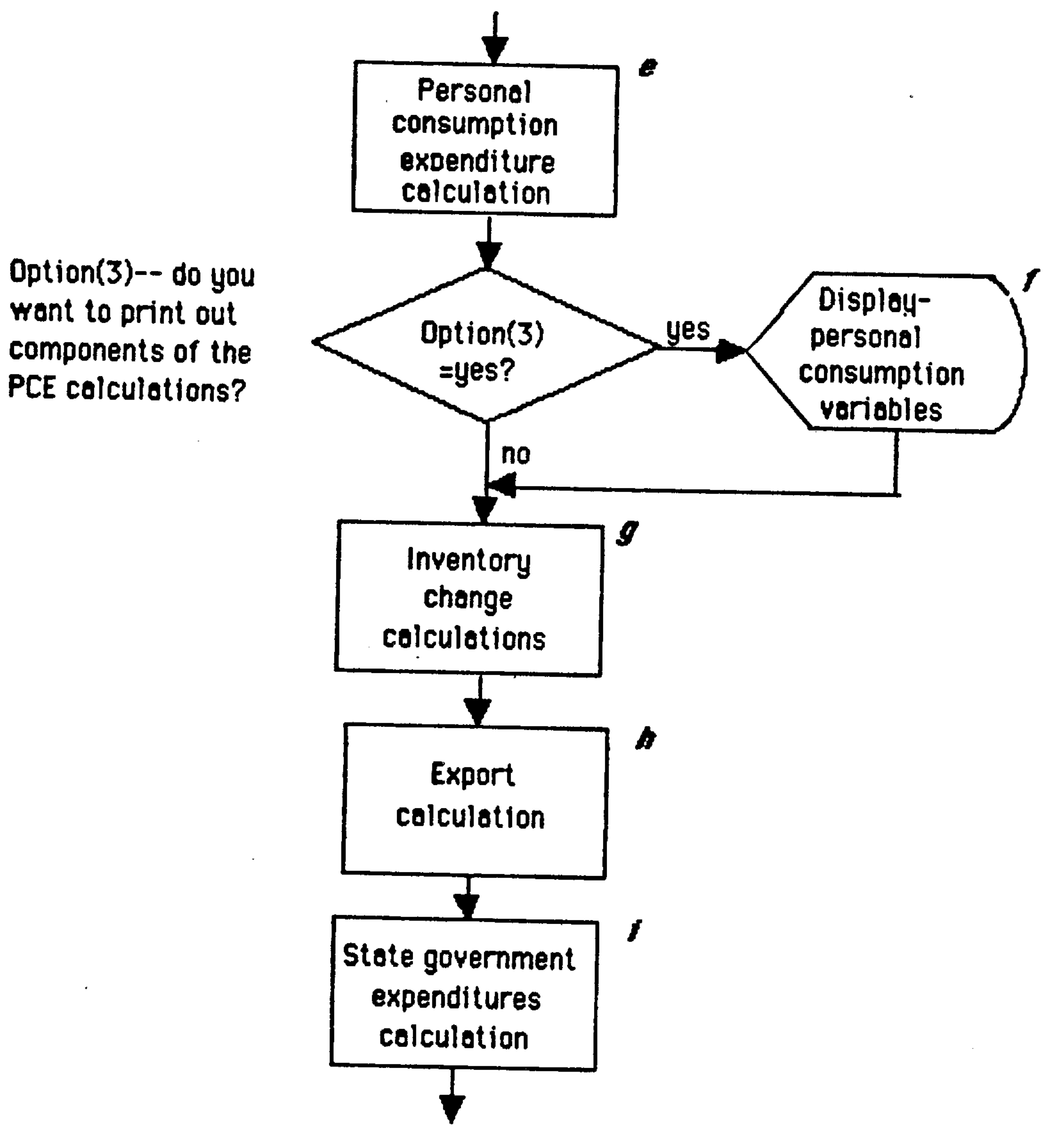

Figure 6.(Cont'd) Final Demands Module [Overlay(2,0)]

Table 4.(Cont'd) Final Demands Module [Overlay(2,0)]

Step	Description
e.	The final demand "personal consumption expenditures" (PCE_i) is equal to PCE_i from IYEAR-1 ($PCEM1_i$) altered by the ratio of change in population (PT) and the change in PCET per wage earner (PI) times the income elasticity for goods of sector i ($ELASIN_i$): 8. $PCE_i = PCEM1_i * (1 + (PT-1) + (ELASIN_i * (PI-1)))$
f.	Variables and parameters of PCE can be displayed if asked for by the user in the Options module. An example of this table can be found in Appendix A (page 41) of the IPASS user manual.
g.	Change in business inventory for industry i ($BINCH_i$) is set equal to the change in industry i's output from IYEAR-2 to IYEAR-1 times industry i's change in business inventory ratio ($BINCHR_i$): 9. $BINCH_i = BINCHR_i * (X_i - XM1_i)$ where: X_i is the output for IYEAR-1 $XM1_i$ is output for IYEAR-2
h.	Exports for industry i ($EXPORT_i$) are calculated as the region's market share of the U.S. gross output. First, update U.S. gross output of sector i ($USGO_i$) and the regional market share of sector i ($REGMKS_i$): 10. $USGO_i = USGO_i * (1 + GROWTHR_{i,j})$ 11. $REGMKS_i = REGMKS_i * (1 + REGMKSR_i)$ where: $GROWTHR_{i,j}$ is the annual growth rate of U.S. gross output of sector i during time period j $REGMKSR_i$ is the annual growth rate of the regional market share for industry i Then calculate exports: 12. $EXPORT_i = REGMKS_i * USGO_i$
i.	State and local government expenditures ($SGOVE_i$) increase proportionately with the rate of change in population (PT) and total personal income (PI). RSGEMP is the rate of change of state and local government expenditures not related to population and income: [current year] [IYEAR-1] 13. $SGOVE_i = SGOVE_i * (1 + RSGEMP + (PT-1) + (PI-1))$

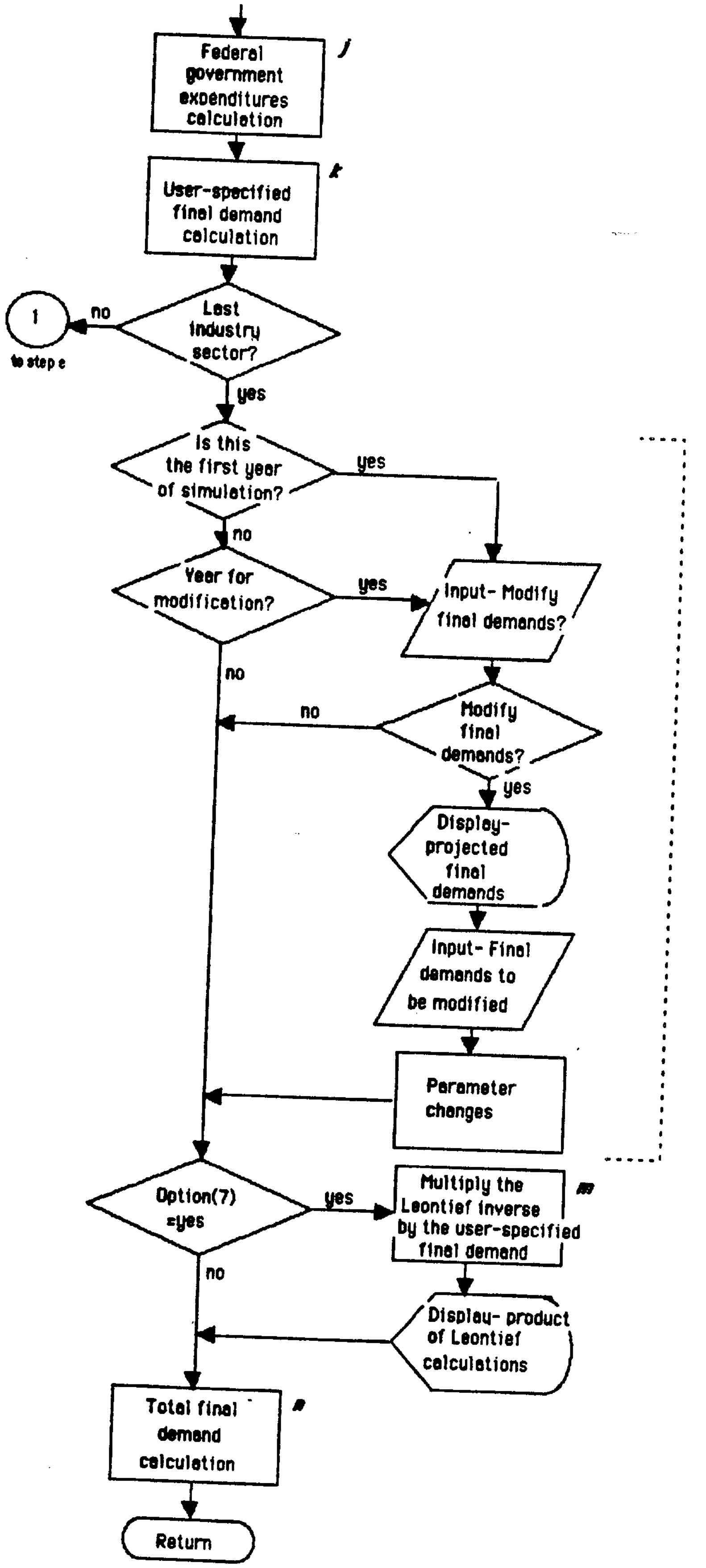

Figure 6.(Cont'd) Final Demands Module [Overlay(2,0)]

Table 4.(Cont'd) Final Demands Module [Overlay(2,0)]

Step	Description
j.	Federal government expenditures ($FGOVE_i$), is similar to state and local expenditures except that Federal expenditures are assumed to be unaffected by local income. RFCEMP is the annual rate of change for Federal government expenditures not related to population. 14. $FGOVE_i = FGOVE_i * (1+ RFCEMP + (PT-1))$
k.	User-specified final demands ($USERFD_i$) are also be subjected to an annual rate of change ($USERFDR_i$): 15. $USERFD_i = USERFD_i * (1 + USERFDR_i)$

(Final demands are determined for each of the NIS-minus-one endogenous sectors. Final demands for the last sector (Other Government) do not directly affect output of the endogenous sectors.)

l.	The user may modify final demands whenever specified in step h of the Control module [overlay(0,0)]. Attempts to modify these "special" variables when the opportunity arose at step j in the Control module would have been nullified by the calculations in this module.
m.	The user-specified final demand component of final demand is multiplied by the Leontief inverse, enabling users to observe the unconstrained impact of the exogenously introduced change. An example of this table can be found in Appendix A (page 42) of the IPASS user manual.
n.	Total final demands for each sector i (FD_i) are the sum of each of the seven final demand components: 16. $FD_i = PCE_i + GPCF_i + EXPORT_i + BINCH_i + SGOVE_i + FGOVE_i + USERFD_i$

(Control is returned to the Control module [overlay(0,0)].)

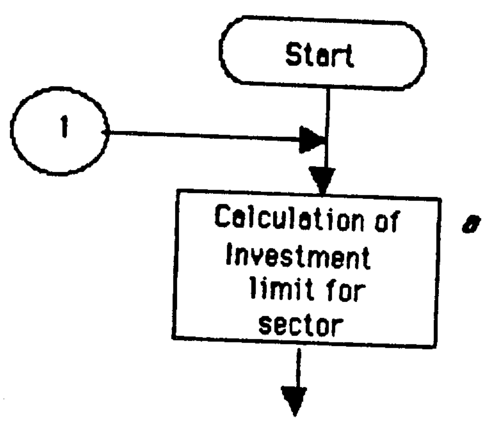

Figure 7. Investment Module [Overlay(2,1)]

Investment Module [Overlay(2,1)]

The investment module comprises some of the most sensitive components of the model. This module determines whether to replace and/or increase the capital stock of each specified industry. This choice, in turn, has a direct effect upon the economic activity within the region, since a constraint on output keeps the region from attaining a greater gross regional product.

The investment module estimates the level of investment for each industrial sector. Expansion investment is triggered by demand which is greater than capacity. Replacement investment is used to replace worn out and obsolete equipment. Four kinds of investments are calculated:

1. Expansion investment in productive capital stock (i.e., to increase capacity) -- EINVPR.
2. Expansion investment in pollution abatement equipment -- EINVPA.
3. Replacement investment of productive capital stock -- RINVPR
4. Replacement investment in pollution abatement stock -- RINVPA

Table 5. Investment Module [Overlay(2,1)]

Step	Description
a.	Calculate the investment limit for each sector ($TMAX_i$). $TMAX_i$ is the amount of capital available to be used for all types of investment: 1. $TMAX_i = INVLMC_i * NBUSINC_i + INVLMA_i * ACNETBI_i$ where: $INVLMC_i$ is the leverage ratio for sector i--i.e., the multiple of net annual income (NBUSINC) that a sector can borrow. This is similar to the price/earnings ratio of stocks, because a firm raises capital by issuing stock at some multiple of its earnings.

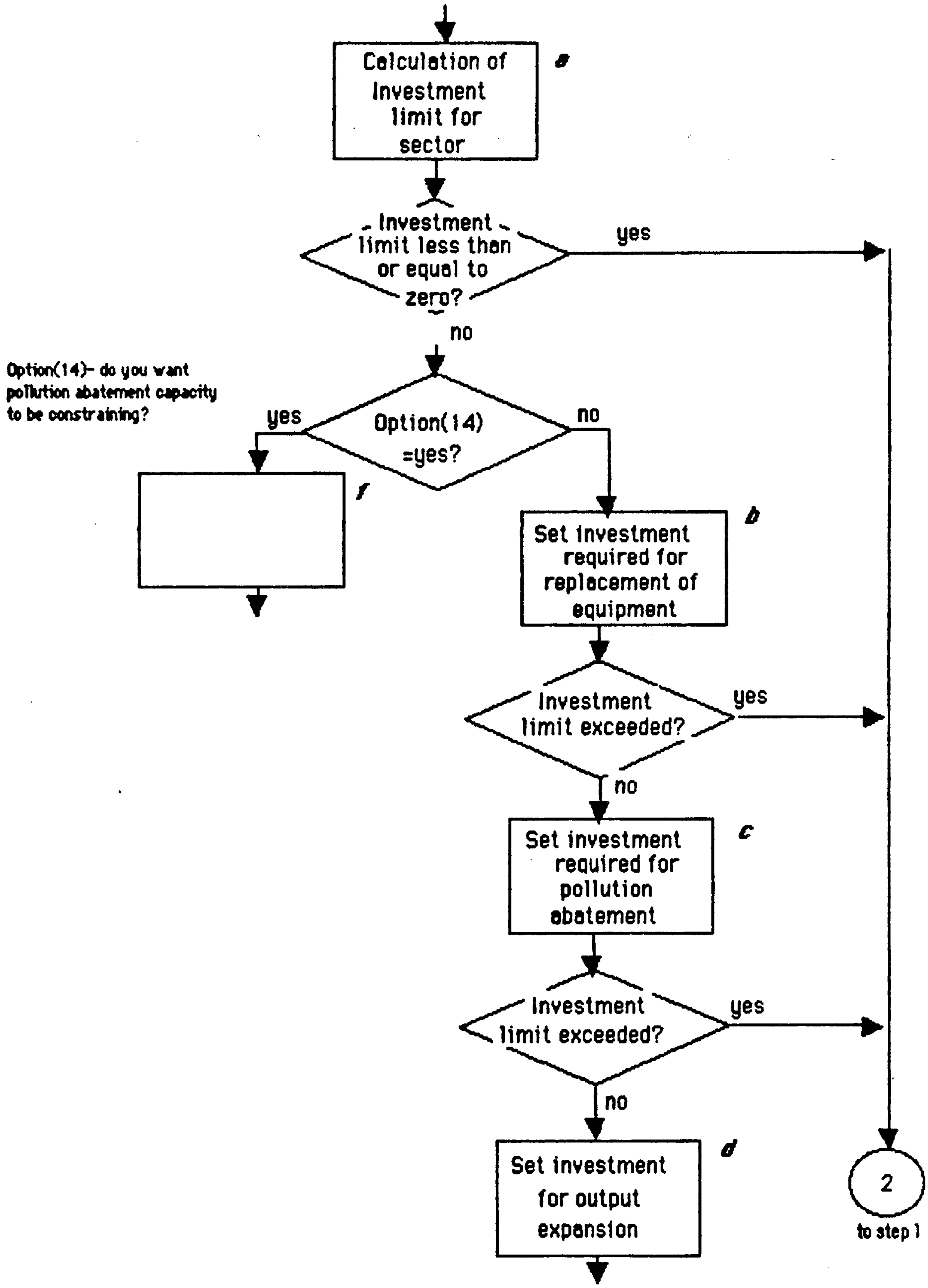

Figure 7.(Cont'd) Investment Module [Overlay(2,1)]

Table 5.(Cont'd) Investment Module [Overlay(2,1)]

Step	Description
a.	(Cont'd) $NBUSINC_i$ is net business income (Value added net of wages and salary and indirect business taxes) for the previous year for sector i. It is calculated at step f of the Primary Inputs module. $INVLMA_i$ is the liquidity preference ratio for sector i--i.e., it is the proportion of total retained earnings (ACNETBI) which a sector is willing to spend on investment. $ACNETBI_i$ is the accumulated net business income which is calculated at step m.

(If $TMAX_i$ is less than or equal to zero then there is no money for investment. In this case skip to step l.)

(The user may specify in the Options module that IPASS treat pollution abatement equipment as a constraint. If the user invokes this option then IPASS skips from here to step f. If not IPASS continues to step b and skips steps f through k.)

Step	Description
b.	$RINVPR_i$ is set to the value of depreciated production equipment from the previous year ($CADEPR_i$). $CADEPR_i$ is calculated in step e of the Primary Inputs module [overlay(7,0)]. $TMAX_i$ is then reduced by $RINVPR_i$ and the remainder is available for the remaining kinds of investment. If, however, $RINVPR_i$ is greater than or equal to $TMAX_i$ then $RINVPR_i$ is set equal to $TMAX_i$ (i.e., all available capital is used, and there will be no further investment for this simulation year) and the program skips to step l.
c.	$RINVPA_i$ is set to the value of depreciated pollution abatement equipment from the previous year ($CADEPA_i$). $CADEPA_i$ is calculated in step e of the Primary Inputs overlay. $TMAX_i$ (as modified at step b) is then reduced by $RINVPA_i$ and the remainder is available for the remaining kinds of investment. If, however, $RINVPA_i$ is greater than or equal to $TMAX_i$ then $RINVPA_i$ is set equal to $TMAX_i$ (i.e., all remaining capital is used, and there will be no further investment for this simulation year) and the program skips to step l.
d.	$EINVPR_i$ is set to zero when capacity exceeds output demanded. If, however, output demanded (XD_i) is greater than capacity (XS_i) then $EINVPR_i$ is calculated as follows: 2. $EINVPR_i = CAPPRR_i * (XD_i - XS_i)$ where: $CAPPRR_i$ is the production capital stock to output ratio--i.e., the amount of machinery and equipment required for each dollar of gross output

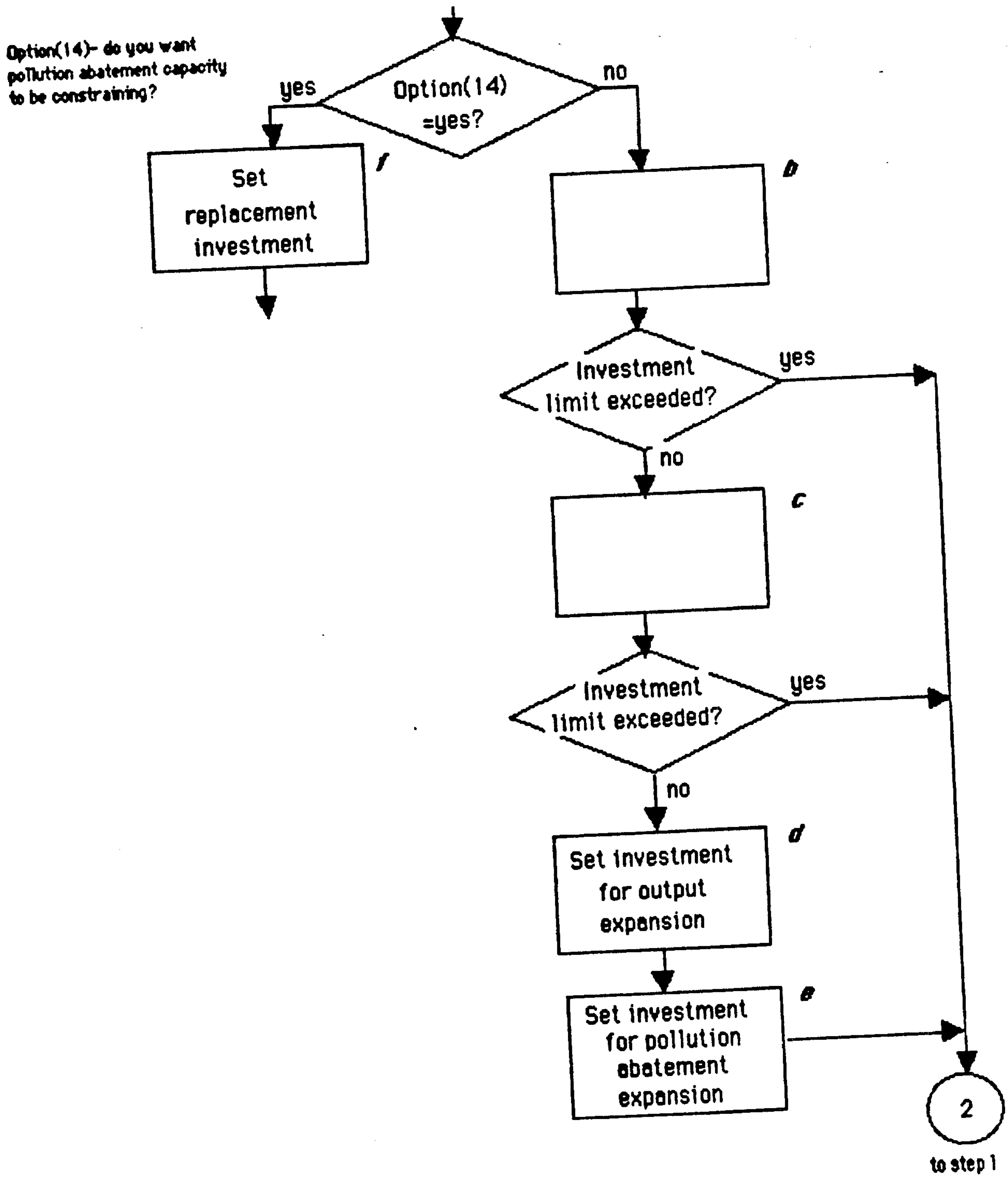

Figure 7.(cont'd) Investment Module [Overlay(2,1)]

Table 5. (Cont'd) Investment Module [Overlay(2,1)]

Step	Description
d.	(Cont'd) $TMAX_i$ (as modified in step c) is reduced by $EINVPR_i$ and the remainder is available for the remaining kinds of investment. If, however, $EINVPR_i$ is greater than or equal to $TMAX_i$, then $EINVPR_i$ is set equal to $TMAX_i$ (i.e., all remaining capital is used, and there will be no further investment for this simulation year) and the program skips to step 1.
e.	$EINVPA_i$ is set to zero when capacity exceeds output demanded. If, however, output demanded (XD_i) is greater than capacity (XS_i) then $EINVPA_i$ is calculated as follows: 3. $EINVPA_i = CAPPAR_i * (XD_i - XS_i)$ where: $CAPPAR_i$ is the pollution abatement capital stock to output ratio--i.e., the amount of pollution abatement equipment required for each dollar of gross output If, however, $EINVPA_i$ is greater than or equal to $TMAX_i$ (as modified in step d) then $EINVPA_i$ is set equal to $TMAX_i$--i.e., all remaining capital is used, and there will be no further investment for this simulation year. Skip to step 1.

(Steps f through k are performed if pollution abatement capacity is to be constraining)

Step	Description
f.	Calculate total replacement investment (RINV): 4. $RINV_i = CADEPR_i + CADEPA_i$ where: $CADEPA_i$ is amount of pollution abatement equipment depreciation which occurred the previous year in sector i $CADEPR_i$ is the amount of production equipment depreciation which occurred the previous year in sector i If $RINV_i$ is less than or equal to $TMAX_i$ (as derived in step a) then perform equations 5 through 7 and skip to step i: 5. $RINVPR_i = CADEPR_i$ 6. $RINVPA_i = CADEPA_i$ 7. $TMAX_i = TMAX_i - RINV_i$

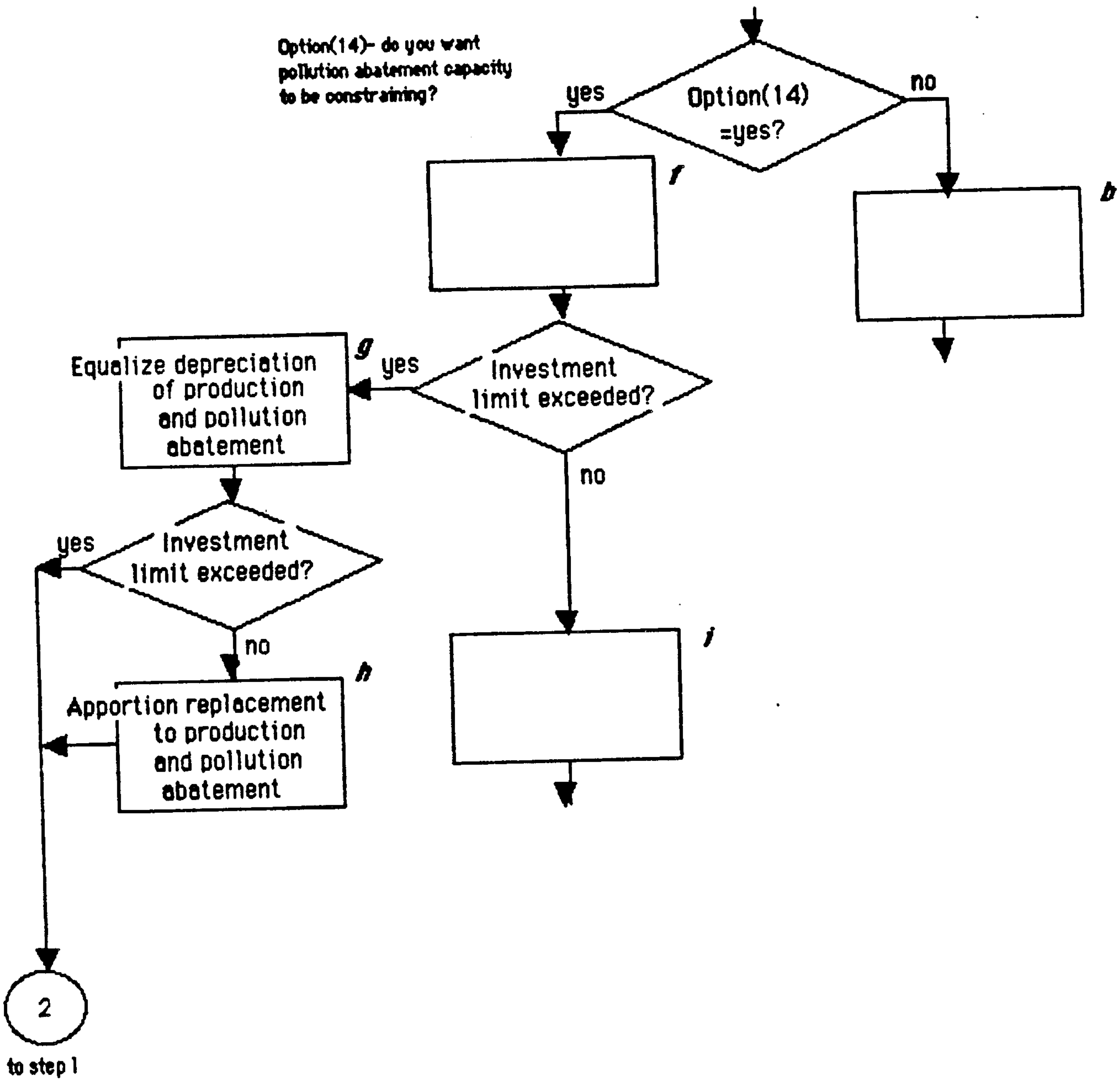

Figure 7.(Cont'd) Investment Module [Overlay(2,1)]

Table 5.(Cont'd) Investment Module [Overlay(2,1)]

Step	Description

(If the investment limit is exceeded by the replacement investment then steps g and h are performed and no other investments will be made. The program will then skip to step 1.)

g. If $RINV_i$ is greater than $TMAX_i$ then investment is made which will equally replace worn-out capacity for both production and pollution abatement equipment. The first step is to replace capacity for equipment that depreciated at a faster rate:

8. $DIF = CADEPR_i/CAPPRR_i - CADEPA_i/CAPPAR_i$

where: DIF if negative represents a greater loss of pollution abatement capacity and if positive represents a greater loss of production capacity.
$CADEPR_i/CAPPRR_i$ converts production equipment depreciation to total loss of production capacity
$CADEPA_i/CAPPAR_i$ converts pollution abatement equipment depreciation to total loss of pollution abatement capacity

If pollution abatement depreciates faster (DIF is negative) then we invest in pollution abatement equipment to make up that difference:

9a. $RINVPA_i = -DIF * CAPPAR_i$

Or if production equipment depreciates faster (DIF was positive) then we invest in production equipment:

9b. $RINVPR_i = DIF * CAPPRR_i$

In either case, if $RINVPA_i$ or $RINVPR_i$ are greater than $TMAX_i$ then $RINVPR_i$ (if DIF was positive) or $RINVPA_i$ (if DIF was negative) is set equal to $TMAX_i$ and there will be no other investment for this sector for the current simulation year so skip to step 1.

If investment limit is not exceeded, subtract investment made by equation 9a or 9b from the investment limit (Note that either RINVPA or RINVPR will be zero):

10. $TMAX_i = TMAX_i - RINVPA_i - RINVPR_i$

h. Formulas 11 and 12 apportion the remaining $TMAX_i$ to pollution abatement and production equipment such that their capacities are replaced equally. Then skip to step 1.

11. $RINVPA_i = RINVPA_i + TMAX_i/(1 + [CAPPRA_i/CAPPAR_i])$

12. $RINVPR_i = RINVPR_i + TMAX_i/(1 + [CAPPAR_i/CAPPRA_i])$

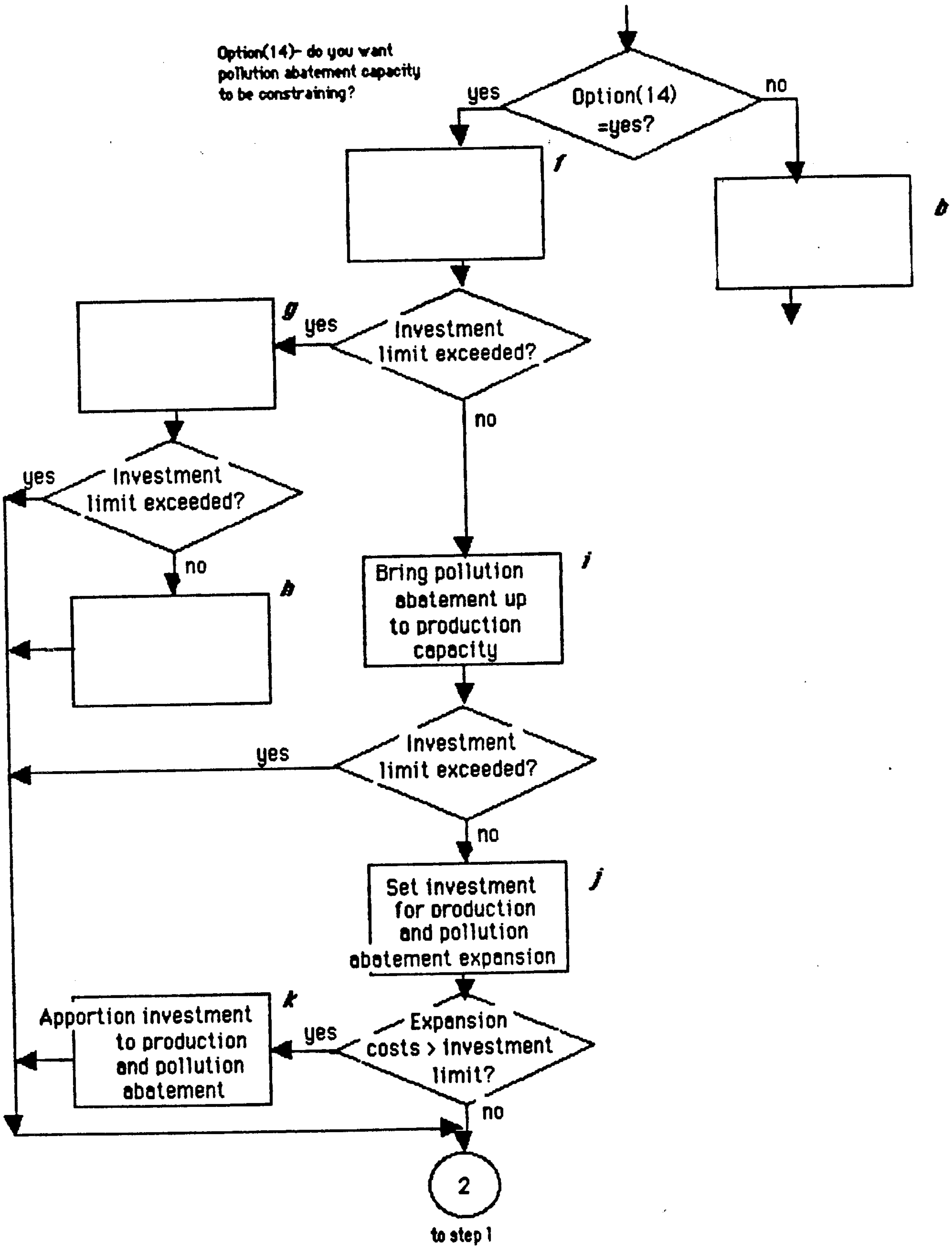

Figure 7.(Cont'd) Investment Module [Overlay(2,1)]

Table 5.(Cont'd) Investment Module [Overlay(2,1)]

Step	Description
i.	If the pollution abatement constraint is invoked after the initial data base year, the existing industries must retrofit their production capacities. The first step is to determine the shortfall of pollution abatement capacity:
	13. $DIF = PRCAP_i/CAPPRR_i - PACAP_i/CAPPAR_i$
	where: $PRCAP_i/CAPPRR_i$ converts total production stock ($PRCAP_i$) to output capacity using the production capital stock to output ratio ($CAPPRR_i$)
	$PACAP_i/CAPPAR_i$ converts total pollution abatement stock ($PACAP_i$) to abatement capacity using pollution abatement capital stock to output ratio ($CAPPAR_i$)
	If DIF from equation 13 is less than or equal to zero then pollution abatement equipment has already caught up to output capacity. If not the following equation will trigger the expansion investment to do so:
	14. $EINVPA_i = DIF/CAPPAR_i$
	If $EINVPA_i$ is greater than or equal to $TMAX_i$ (as modified in step f) then $EINVPA_i$ is set equal to $TMAX_i$ and all remaining capital is used. there will be no further investment for this sector for this simulation year so skip to step 1.
j.	If output demanded is greater than output supplied then output-expansion investment (EINV) desired is derived by multiplying the shortfall by the capital stock to output ratios:
	15. $EINV = (XD_i - XS_i) * (CAPPRR_i + CAPPAR_i)$
	If EINV is greater than $TMAX_i$ then the EINV is set equal to $TMAX_i$ and investment is apportioned (step k). If not the expansion investment is set as follows (note that expansion investment from equation 14 (step i) is added in):
	16. $EINVPR_i = (XD_i - XS_i) * (CAPPRR_i)$
	17. $EINVPA_i = EINVPA_i + (XD_i - XS_i) * (CAPPAR_i)$
k.	Expansion investment must be apportioned between pollution abatement and production equipment if the investment limit is constraining. The following equations allow division of remaining investment capital allowing an equal increase in capacities:
	18. $EINVPA_i = EINVPA_i + TMAX_i/(1 + [CAPPRA_i/CAPPAR_i])$
	19. $EINVPR_i = TMAX_i/(1 + [CAPPAR_i/CAPPRA_i])$

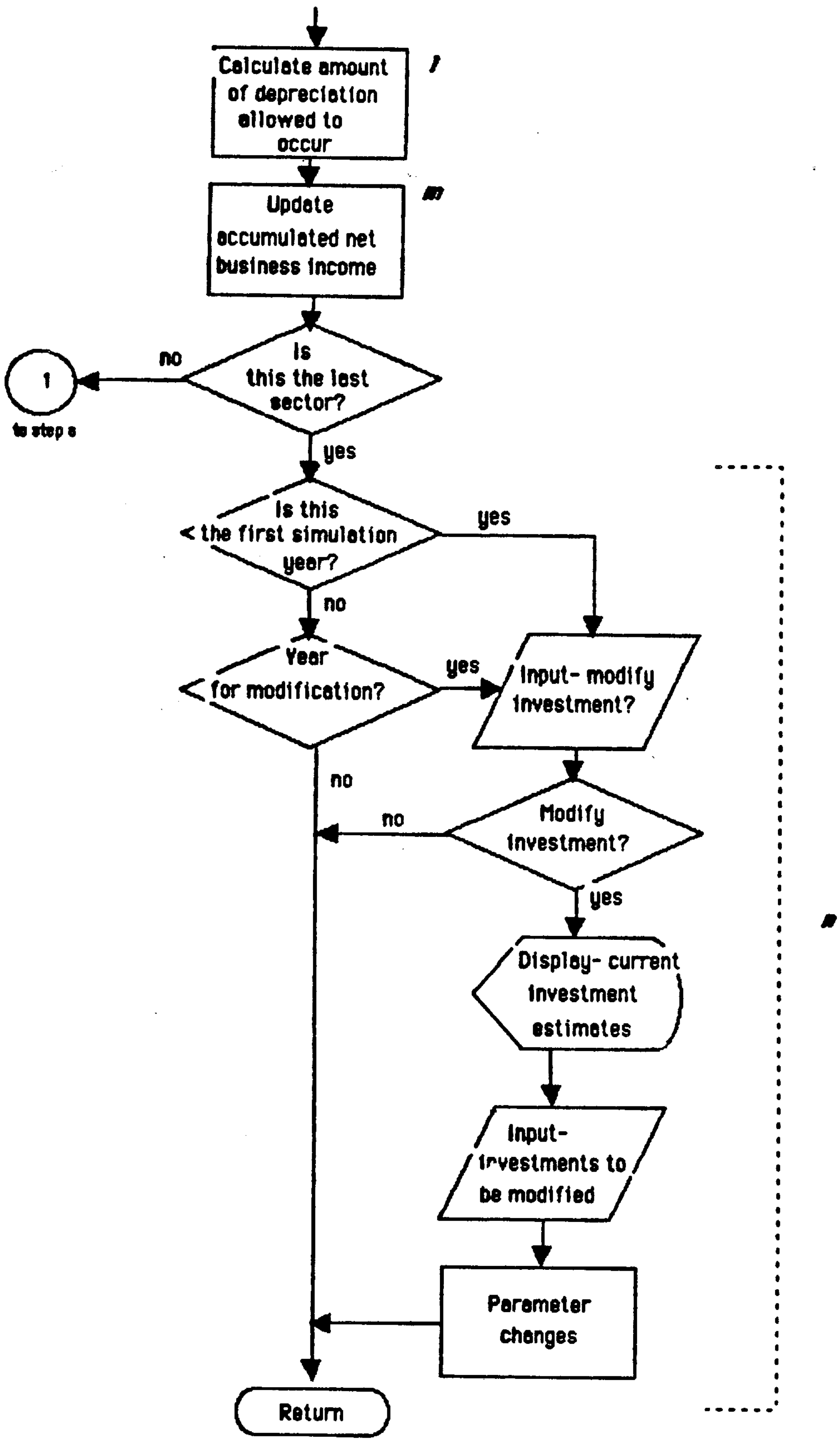

Figure 7.(Cont'd) Investment Module [Overlay(2,1)]

Table 5.(Cont'd) Investment Module [Overlay(2,1)]

Step	Description
l.	Depreciation from the previous year not replaced is calculated: 20. $CADEPR_i = CADEPR_i - RINVPR_i$ 21. $CADEPA_i = CADEPA_i - RINVPA_i$
m.	Accumulated net business income is adjusted by adding previous year's net business income ($NBUSINC_i$) minus all investments: 22. $ACNETBI_i = ACNETBI_i + NBUSINC_i - RINVPR_i - RINVPA_i - EINVPR_i - EINVPA_i$

(The logic progression described above is repeated for each sector of the model excepting the last sector, "Other Government". A government module is being developed to track this sector.)

n.	The user may modify investment during the first simulation or as specified in step h of the Control module. Attempts to modify these "special" variables at step j of the Control module would have been nullified by the calculations in this module.

(Control is returned to Final Demands module [overlay(2,0)].)

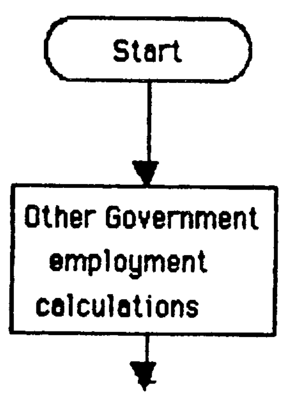

Figure 8. Other Government Module [Overlay(3,0)]

Other Government Module [Overlay(3,0)]

The "Other Government" (i.e., non-enterprise government agencies) sector contains government activity which are non-market driven --i.e., decisions regarding activity of this sector are based largely on political and social considerations. It is not appropriate to include this sector "endogenous" to the input-output model. Currently, calculations in this model are relatively crude; however, a government module which allows a more accurate simulation of the budgeting process is being tested. Since this sector is unlike market-driven sectors, calculations are performed separately.

The Other Government sector is by, IPASS convention, the last sector of the model. Hence, variables for this sector are always subscripted "nis" --i.e., i=nis (number of industrial sectors).

Table 6. Other Government Module [Overlay(3,0)]

Step	Description
a.	To calculate state and local government employment (SGEMP) IPASS assumes change is proportional to the rates of change in population (PT) and total personal income (PI). RSGEMP is rate of change of state and local government employment in addition to population and income changes. The Federal civilian government employment (FCEMP) calculation is similar to state and local employment except that Federal civilian employment is assumed to be unaffected by local income. RFCEMP is the annual rate of change for Federal civilian employment in addition to population changes. Federal military employment (FMEMP) remains unchanged throughout the simulation. 1. SGEMP = SGEMP * (1+ RSGEMP + (PT-1) + (PI-1)) 2. FCEMP = FGEMP * (1+ RFCEMP + (PT-1)) Total employment in Other Government ($EMPLOY_{nis}$) is the sum: 3. $EMPLOY_{nis}$ = SGEMP + FCEMP + FMEMP

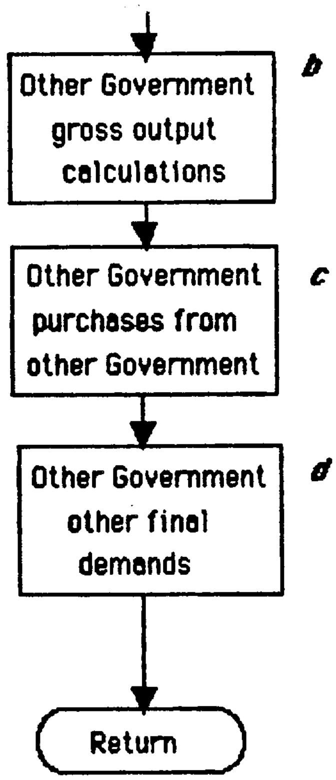

Figure 8.(Cont'd) Other Government Module [Overlay(3,0)]

Table 6.(Cont'd) Other Government Module [Overlay(3,0)]

Step	Description
b.	IPASS defines the value of gross output of the Other Government sector (X_{nis}) as total wage and salary paid to the employees of this sector because a value is not applied to the major output of this sector which is administration. 4. $X_{nis} = EARPWK_{nis} * EMPLOY_{nis}/1000$ where: $EARPWK_{nis}$ is earnings per worker (in dollars)
c.	Purchases by Other Government from itself increases at the same rate as its gross output: 5. $SGOVE_{nis} = SGOVE_{nis} * X_{nis}/XM1_{nis}$ 6. $FGOVE_{nis} = FGOVE_{nis} * X_{nis}/XM1_{nis}$ where: $SGOVE_{nis}$ is state and local government expenditures from sector nis (other government) $FGOVE_{nis}$ is federal government expenditures from sector nis (other government) X_{nis} output of sector nis for current simulation year $XM1_{nis}$ output of sector nis for the year previous
d.	All other Other Government final demands are set equal to zero: 7. PCE_{nis} (personal consumption expenditures) = 0. 8. $GPCF_{nis}$ (gross private capital formation) = 0. 9. $BINCH_{nis}$ (change in business inventory) = 0. 10. $EXPORT_{nis}$ (exports) = 0.

(Control is returned to the Control module.)

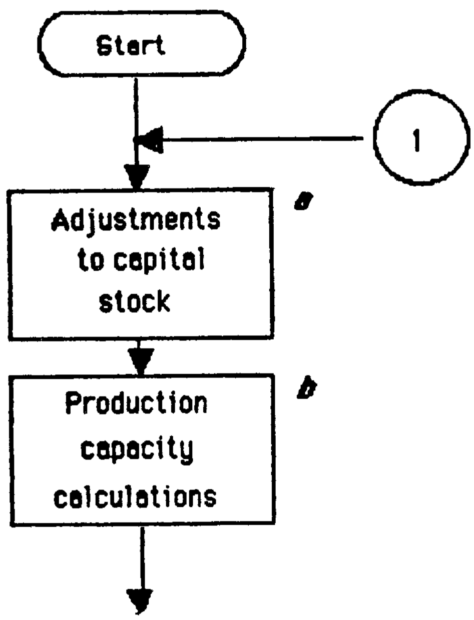

Figure 9. Regional Output Module [Overlay(4,0)]

Regional Output Module [Overlay(4,0)]

When multiplied by the Leontief inverse, total final demand from the final demand model yields gross output demanded. In this module, capacity constraints for the current year are calculated. Any sector whose output exceeds its capacity is adjusted to meet the constraint.

Table 7. Regional Output Module [Overlay(4,0)]

Step	Description
a.	Capital stocks for production and pollution abatement are adjusted in accordance with investment made for the current year (as derived in the Investment module). Worn out equipment for which no replacement investment was made is subtracted from the capital stocks: 1. $PRCAP_i = PRCAP_i + EINVPR_i - CADEPR_i$ 2. $PACAP_i = PACAP_i + EINVPA_i - CADEPA_i$ where: $PRCAP_i$ is production capital stock for sector i $PACAP_i$ is pollution abatement capital stock for sector i $EINVPR_i$ is expansion investment in production capital stock for sector i $EINVPA_i$ is expansion investment in pollution abatement capital stock $CADEPR_i$ is depreciation of production capital stock not replaced (from equation 20 in Investment module) $CADEPA_i$ is depreciation of pollution abatement capital stock not replaced (from equation 21 in Investment module)
b.	Output and pollution abatement capacity of the capital stock is calculated as follows: 3. $XPR = PRCAP_i/CAPPRR_i$ 4. $XPA = PACAP_i/CAPPAR_i$ where: XPR is capacity of production capital stock XPA is capacity of pollution abatement capital stock $CAPPRR_i$ is the production capital stock to output ratio $CAPPAR_i$ is the pollution abatement stock to output ratio

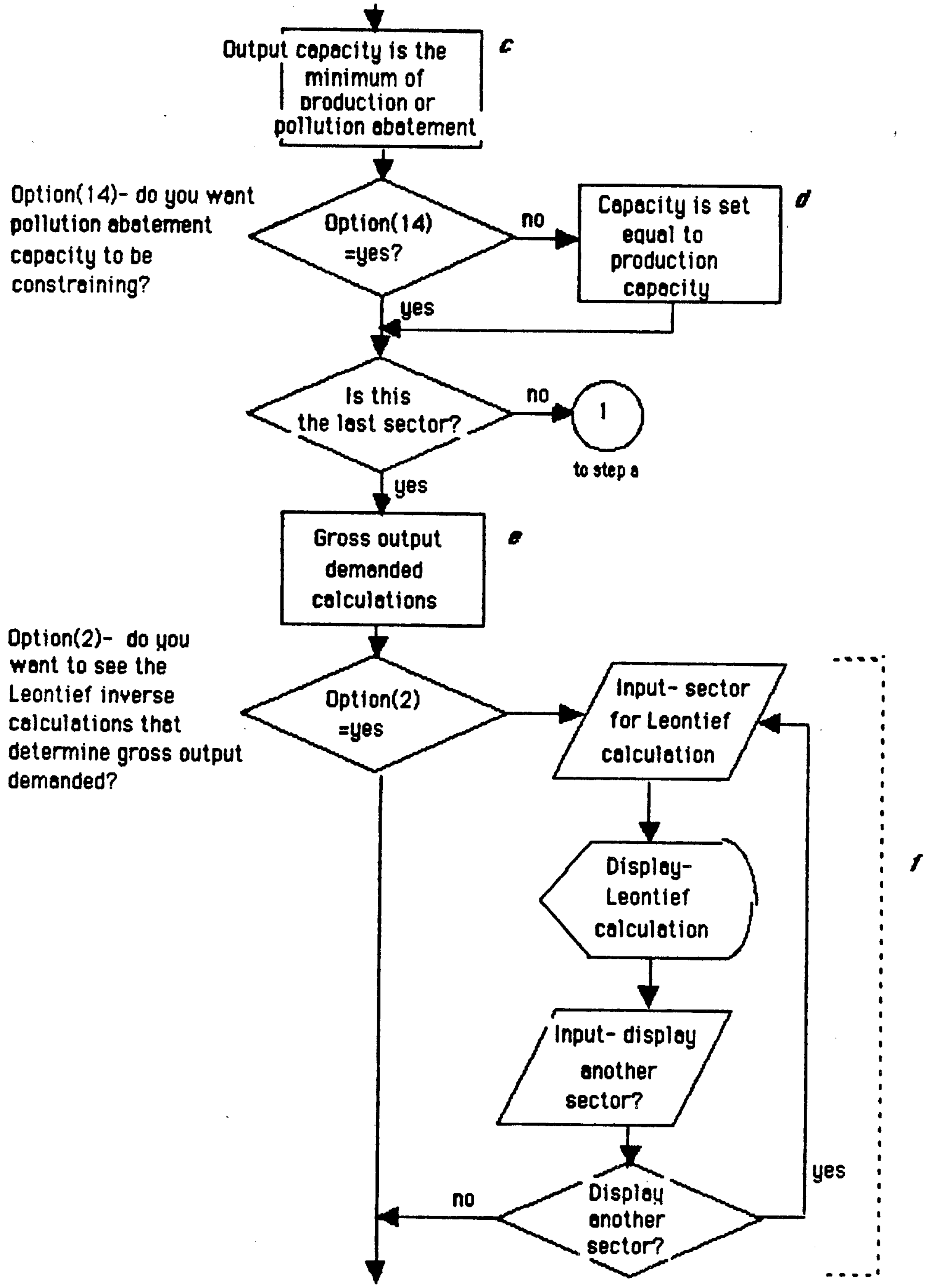

Figure 9.(Cont'd) Regional Output Module [Overlay(4,0)]

Table 7.(Cont'd) Regional Output Module [Overlay(4,0)]

Step	Description
c.	The output capacity (XS_i) of all capital stock, for sector i, is the minimum of production output capacity (XPR) and pollution abatement capacity (XPA). 5. XS_i = minimum (XPR,XPA)
d.	The pollution abatement output capacity is only allowed to be constraining when the user answers "yes" to the question --do you want pollution abatement capacity to be constraining? If the user has answered "no" [or relied on the options defaults (see options module)] then output capacity (XS_i) will be set to the production stock capacity (XPR): 6. XS_i = XPR

(These calculations are performed for each of the industry sectors [except for i=nis, Other Government, whose values are derived in the Other Government module]).

e.	Calculate output required by total final demand of each sector i (XD_i) by post-multiplying the Leontief inverse matrix ($LEMAT_{ij}$) by the final demand vector (FD_j): 7. $XD_i = \sum_{j=1}^{nis-1} (LEMAT_{i,j} * FD_j)$ where: nis-1 is the number of industrial sectors minus one to exclude the Other Government sector
f.	The results of the calculations in step e as it moves through each sector element, j, for the sector, i, specified by the user are displayed. An example of this display can be found in Appendix A (page 43) of the IPASS user manual.

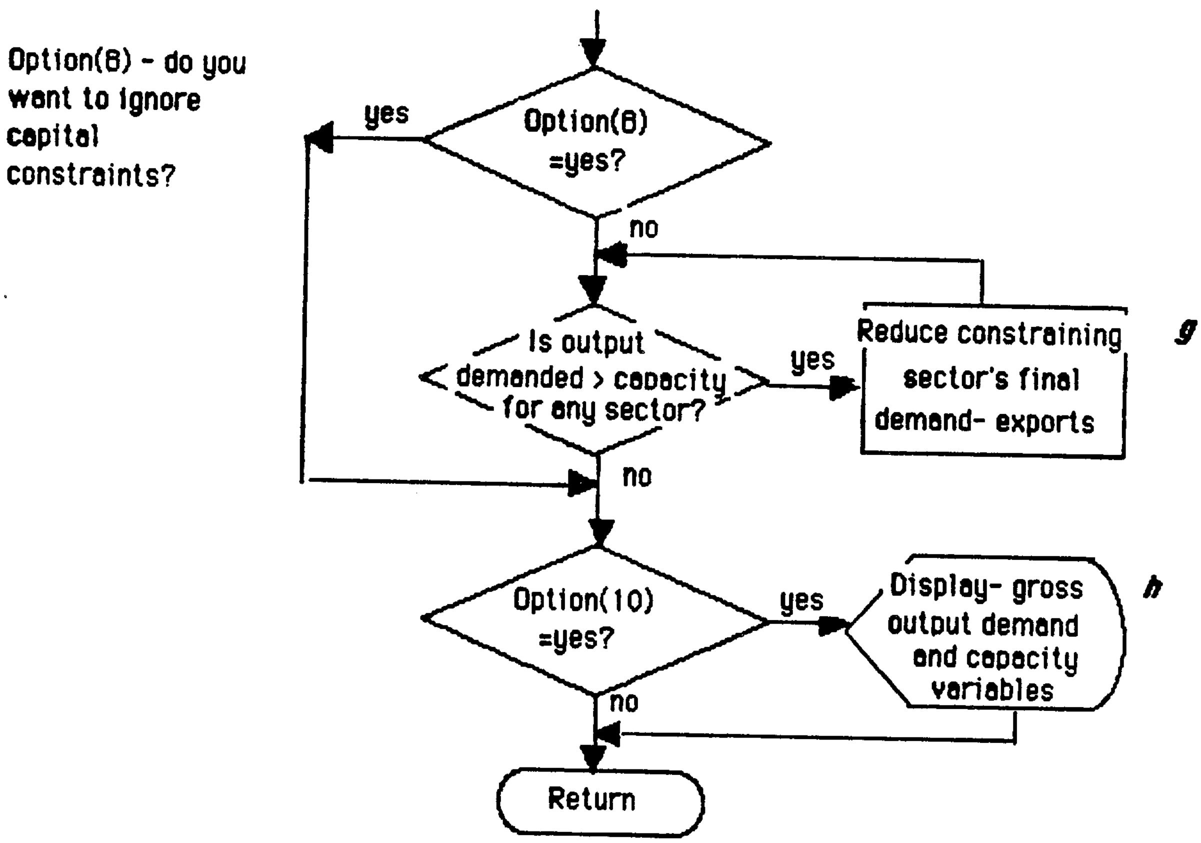

Figure 9.(Cont'd) Regional Output Module [Overlay(4,0)]

Table 7.(Cont'd) Regional Output Module [Overlay(4,0)]

Step	Description
	(IPASS will not constrain gross output according to the capital stock constraint if so specified by the user. The program will skip to step h.)
	(The program compares gross output demanded (XD_i), based on current total final demands (FD), to the capacity constraint (XS_i) for all sectors i (except for sector i=nis). If there is any sector(s) for which XS is less than XD, final demand will need to be reduced for that sector(s). If not then skip to step h.)
g.	An iterative process was developed to reduce exports ($EXPORT_i$) of the constraining sectors (i). By reducing exports to meet the constraint, IPASS is implicitly assuming that local demands are met first. A description of this procedure is included in appendix 1.
h.	Gross output demanded (XD_i), the capital stock constraint (XS_i), the output resulting from the capital stock constraint (X_i) and the difference between XD and X are displayed. A sample output can be found in Appendix A (page 45) of the IPASS user manual.
	(Control is returned to the Control module.)

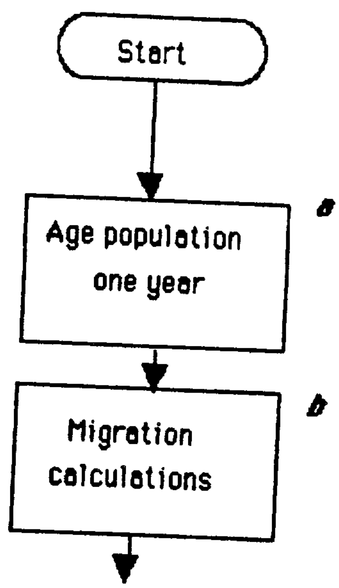

Figure 10. Population Module [Overlay(5,0)]

Population Module [Overlay(5,0)]

Population is calculated by 66 one-year age classes and sex [male ($POPM_i$) and female ($POPF_i$)]. Age class 1 is birth up to one year of age, 2 is from one year to two, and so on up to age class 66 which includes ages 65 and over. Population of the study region is aged one year, births and deaths are calculated and migration and cohort movements are calculated for each simulation year.

Table 8. Population Module [Overlay(5,0)]

Step	Description
a.	Aging population one year consists of setting the number of the current year's age class equal to the number of last year's one-year-younger age class except for the last age class which combines the previous year's two oldest age class: 1. $POPM_{66} = POPM_{66} + POPM_{65}$ 2. $POPF_{66} = POPF_{66} + POPF_{65}$ For age classes i = 2 through 65: 3. $POPM_i = POPM_{i-1}$ 4. $POPF_i = POPF_{i-1}$ Note that until births and inmigration are calculated age class 1 is set equal to zero.
b.	The number of inmigrants ($INMIGOC_j$) and outmigrants ($OTMIGOC_j$) by occupation (j) is caluclated in the labor force and employment module, step g from the previous year, and summed for all occupations: 5. $TOTIN = \sum_{j=1}^{noc} INMIGOC_j$ 6. $TOTOUT = \sum_{j=1}^{noc} OTMIGOC_j$

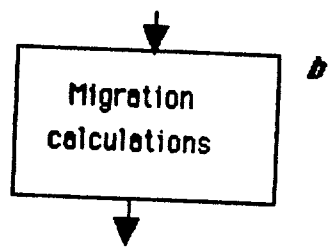

Figure 10.(Cont'd) Population Module [Overlay(5,0)]

Table 8.(Cont'd) Population Module [Overlay(5,0)]

Step	Description
b.	(Cont'd)

Associated with each occupational migrant is a number of household members. An annual rate of change is applied to the total size of household migrating in (NEMDEPR) for each occupational migrant and for those migrating out (REMDEPR):

7. NEMDEPR = NEMDEPR * (1 + RNEMDEPR)

8. REMDEPR = REMDEPR * (1 + RREMDEPR)

where: RNEMDEPR is the annual rate of change of NEMDEPR
RREMDEPR is the annual rate of change of REMDEPR

Therefore, the total number of inmigrants (TOTIN) and total number of outmigrants (TOTOUT) is increased by the number of household members involved:

9. TOTIN = TOTIN * NEMDEPR

10. TOTOUT = TOTOUT * REMDEPR

The next step is to distribute the migration into the 66 age classes and by sex. The distribution variables are first subject to an annual rate of change:

11. $NMIGDIS_{i,s} = NMIGDIS_{i,s} * (1 + NMIGDIR_{i,s})$

12. $RMIGDIS_{i,s} = RMIGDIS_{i,s} * (1 + RMIGDIR_{i,s})$

where: $NMIGDIS_{i,s}$ is the national (inmigrating) age class distribution, i, by sex, s (1=male, 2=female)
$RMIGDIS_{i,s}$ is the regional (outmigrating) age class distribution, i, by sex, s (1=male, 2=female)
$NMIGDIR_{i,s}$ is the annual rate of change of NMIGDIS by age class distribution, i, by sex, s (1=male, 2=female)
$RMIGDIR_{i,s}$ is the annual rate of change of RMIGDIS by age class distribution, i, by sex, s (1=male, 2=female)

We apply the distributions to the total number of migrants:

13. $INMIGM_i = NMIGDIS_{i,1} * TOTIN$

14. $INMIGF_i = NMIGDIS_{i,2} * TOTIN$

15. $OUTMIGM_i = RMIGDIS_{i,1} * TOTOUT$

16. $OUTMIGF_i = RMIGDIS_{i,2} * TOTOUT$

where: $INMIGM_i$ is the number of inmigrating males for age i

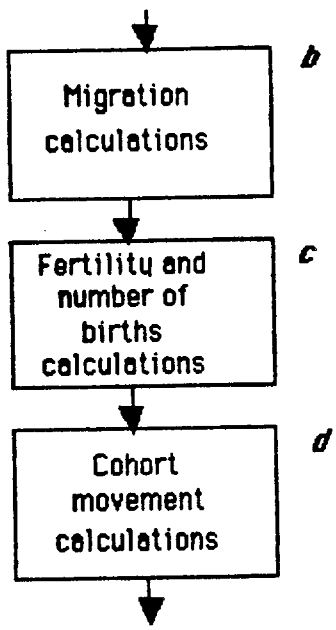

Figure 10.(Cont'd) Population Module [Overlay(5,0)]

Step	Description
b.	(Cont'd) $INMIGF_i$ is the number of inmigrating females for age i $OUTMIGM_i$ is the number of outmigrating males for age i $OUTMIGF_i$ is the number of outmigrating females for age i The final step, for migration calculations, is to update population for the current year: 17. $POPM_i = POPM_i + INMIGM_i - OUTMIGM_i$ 18. $POPF_i = POPF_i + INMIGF_i - OUTMIGF_i$
c.	The number of births is calculated as a number of births per 1000 females by age class ($FERTILY_i$). This birth rate ($FERTILY_i$) is also subject to an annual rate of change: 19. $FERTILY_i = FERTILY_i * (1 + ACFERTY_{i,j})$ where: $ACFERTY_{i,j}$ is the annual rate of change of FERTILY by age class i by time period j (j=1 for 1970 to 1979) (j=2 for 1980 to 1984) (j=3 for 1985 to 1989) (j=4 for 1990+) The number of births is calculated as follows: 20. $BIRTH = \sum_{i=1}^{66} FERTILY_i * POPF_i/1000$ The total births are divided into male and female by the male/female birth ratio (MFBIRTR) and added to the population (age class 1) who migrated in: 21. $POPM_1 = POPM_1 + BIRTH * MFBIRTR$ 22. $POPF_1 = POPF_1 + BIRTH * (1 - MFBIRTR)$
d.	Cohort movement represent any group of migrators who do so for non-job-related purposes, for example, retirees and college students. The cohort movement parameter ($CORTMVM_i$ for males, $CORTMVF_i$ for females) represents the proportion of an age class, i, that participates in such a movement: 23. $POPM_i = POPM_i * (1 + CORTMVM_i)$ 24. $POPF_i = POPF_i * (1 + CORTMVF_i)$

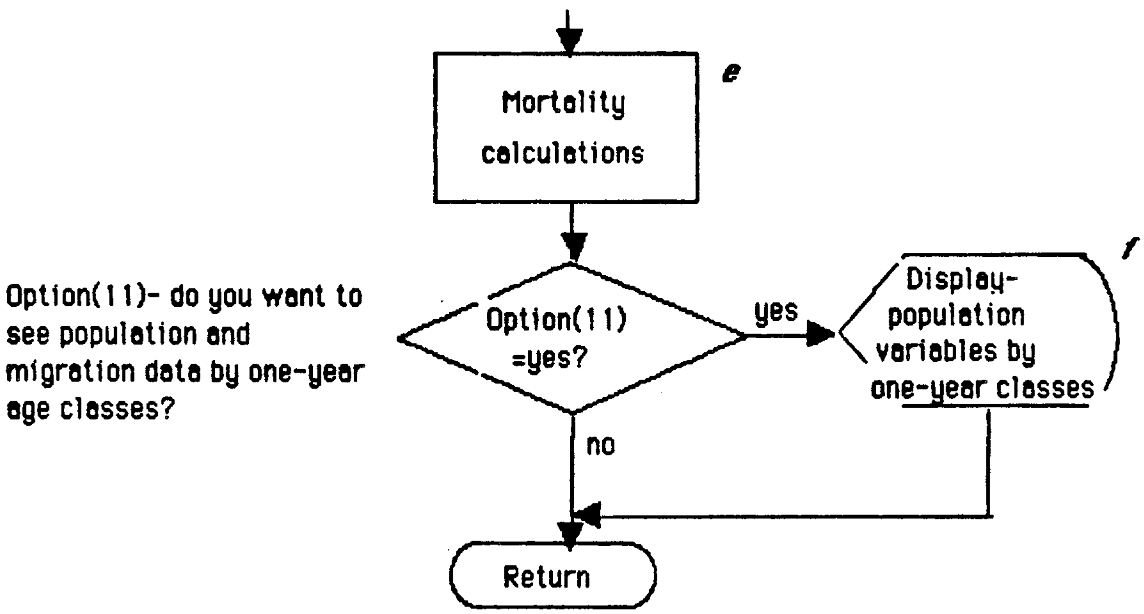

Figure 10.(Cont'd) Population Module [Overlay(5,0)]

Table 8. (Cont'd) Population Module [Overlay(5,0)]

Step	Description
e.	The death rate ($DEATHRM_i$ for males, $DEATHRF_i$ for females) is the death rate per person in each age class: 25. $POPM_i = POPM_i * (1 - DEATHRM_i)$ 26. $POPF_i = POPF_i * (1 - DEATHRF_i)$
f.	IPASS displays population variables by one-year age classes. An example can be found in Appendix A (page 48) of the IPASS user manual.

(Control is returned to the Control module.)

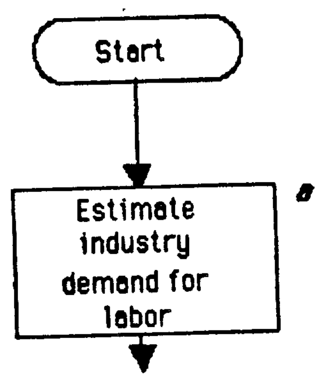

Figure 11. Labor Force and Employment Module [Overlay(6,0)]

Labor Force and Employment Module [Overlay(6,0)]

Although figure 1 (page 3) shows Labor Force and Employment as two separate modules, there are too many interactions to keep them separate. Briefly, the employment required is calculated based on output derived in the Regional Output module. The labor force available to satisfy that demand is then calculated based on population. If there is not enough labor available output is constrained so that the final employment required is within those constraints. Unemployment is calculated as the difference between labor available and the actual employment by occupation.

Table 9. Labor Force and Employment Module [Overlay(6,0)]

Step	Description
a.	Employment demanded by industry ($EMPWFD_i$) is derived by dividing gross output (X_i) by output per worker ($OUTPWK_i$). However, employee productivity is based on a number of parameters, some of which are subject to an annual rate of change: 1. $OUTPHW_i = OUTPHW_i * (1 + OUTPHWR_{i,j})$ where: $OUTPHW_i$ is output per worker per hour for sector i $OUTPHWR_{i,j}$ is the annual rate of change of $OUTPHW_i$ for time period j 2. $HRWPW_i = HRWPW_i * (1 + HRWPWR_i)$ where: $HRWPW_i$ is hours worked per week for sector i $HRWPWR_i$ is annual rate of change for HRWPW for sector i 3. $WKWPY_i = WKWPY_i * (1 + WKWPYR_i)$ where: $WKWPY_i$ is weeks worked per year for each sector i $WKWPYR_i$ is the annual rate of change for $WKWPY_i$ The three variables defined by equations 1, 2 and 3 are used to derive $OUTPWK_i$:

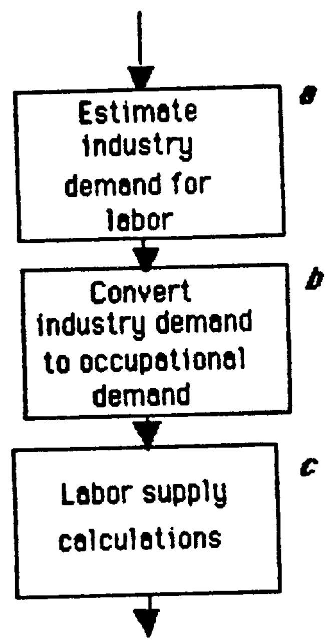

Figure 11.(Cont'd) Labor Force and Employment Module [Overlay(6,0)]

Step	Description
a.	(Cont'd)
	4. $HRWPY_i = HRWPW_i * WKWPY_i$
	where: $HRWPY_i$ is hours worked per year per worker for each sector i
	5. $OUTPWK_i = HRWPY_i * OUTPHW_i$
	Employment demanded by each sector i ($EMPWFD_i$) can now be derived using the updated $OUTPWK_i$:
	6. $EMPWFD_i = X_i * 1000/ OUTPWK_i$
b.	Employment demanded by sector is converted to employment required by occupation:
	7. $EMPLOYD_j = \sum_{i=1}^{nis} EMPWFD_i * OCUP_{i,j}$
	where: $EMPLOYD_j$ is employment demanded by occupation j $OCUP_{i,j}$ is the industry by occupational matrix --i.e., the proportion of occupation j required by each sector i. Note that the sum of the rows in this matrix is equal to 1.0
c.	Labor force supply by occupation is dependent on the occupational distribution of the participating population. The labor force occupation distribution ($LBFOCUR_i$) must be updated to reflect changes in the distribution as a result of the previous year's activity:
	8. $LBFT = LBFT + \sum_{j=1}^{noc} INMIGOC_j - \sum_{j=1}^{noc} OTMIGOC_j$
	9. $LBFOCUR_j = (EMPLOYS_j - COMIN_j + COMOUT_j + INMIGOC_j - OTMIGOC_j) / LBFT$
	where: $EMPLOYS_j$ is employment available by occupation j as derived the previous year. $COMIN_j$ is commuters from outside the region by occupation j who are included in $EMPLOYS_j$ $COMOUT_j$ is commuters who leave the region by occupation j who are part of the local labor force yet not considered part of $EMPLOYS_i$
	We now need a preliminary calculation of total size of labor force (LBFT) for the current year. Labor force participation data tends to be available by the following age class breakdowns:

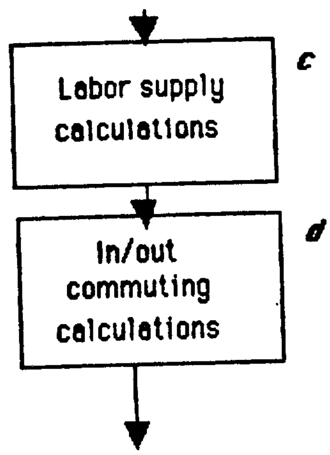

Figure 11.(Cont'd) Labor Force and Employment Module [Overlay(6,0)]

Step	Description
c.	(Cont'd)
	less than 14 years old (n = 1) 14 to 15 (n = 2) 16 to 17 (n = 3) 18 to 19 (n = 4) 20 to 24 (n = 5) 25 to 29 (n = 6) 30 to 34 (n = 7) 35 to 44 (n = 8) 45 to 54 (n = 9) 55 to 59 (n = 10) 60 to 64 (n = 11) 65 and over (n = 12)
	Labor force participation rates for each age class, n ($LFPARM_n$ for males, $LFPARF_n$ for females), are updated annually:
	10. $LFPARM_n = LFPARM_n * (1 + LFPARMR_{n,j})$
	11. $LFPARF_n = LFPARF_n * (1 + LFPARFR_{n,j})$
	where: $LFPARMR_{n,j}$ is the annual rate of change of LFPARM for age class n for time period j $LFPARFR_{n,j}$ is the annual rate of change of LFPARF for age class n for time period j
	The updated participation rates are then applied to the current population of males and females whose one year age classes are summed to correspond to the age groups above ($POPM_n$, $POPF_n$):
	12. $LBFAGEG_n = LFPARM_n * POPM_n + LFPARF_n * POPF_n$
	where: $LBFAGEG_n$ is the number of persons male and female who make up the labor force by age class, n.
	The total labor force for the current year (LBFT) is:
	13. $LBFT = \sum_{n=1}^{12} LBFAGEG_n$
	A preliminary calculation of the employment supplied by occupation ($EMPLOYS_j$) is the sum of the local population distributed by occupation ($LBFOCUR_j$) plus commuters from outside ($COMIN_j$) minus local commuters who travel to another region ($COMOUT_j$) from the previous year:
	14. $EMPLOYS_j = LBFT * LBFOCUR_j + COMIN_j - COMOUT_j$
d.	Whether employment demanded by occupation exceeds supply or supply exceeds demand, a fraction of the imbalance will be alleviated by a net

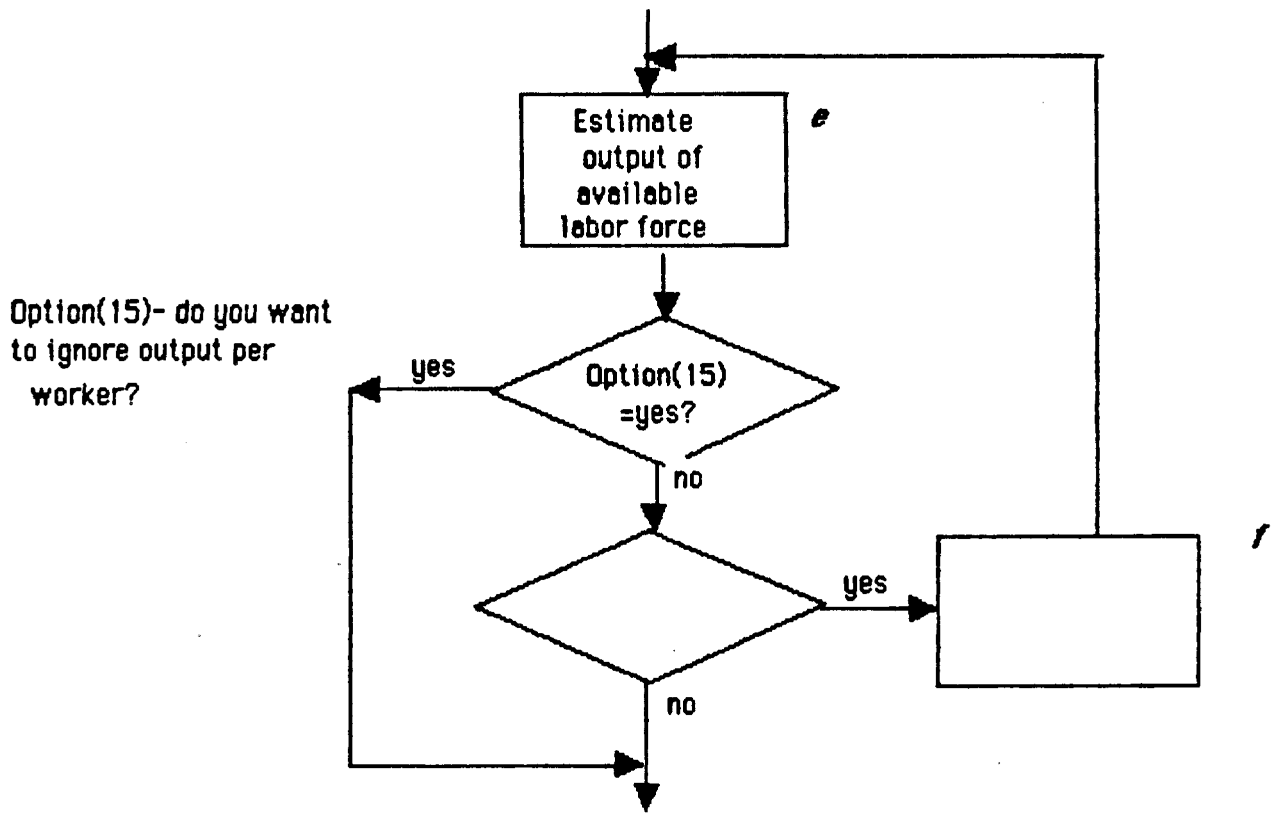

Figure 11.(Cont'd) Labor Force and Employment Module [Overlay(6,0)]

Table 9.(Cont'd) Labor Force and Employment Module [Overlay(6,0)]

Step	Description
d.	(Cont'd) shift in the number of commuters. This fraction--i.e., commuting rate, is subject to an annual rate of change: 15. $COMINR_j = COMINR_j * (1 + RCOMINR_j)$ 16. $COMOUTR_j = COMOUTR_j * (1 + RCOMOTR_j)$ where: $COMINR_j$ is the in-commuting rate by occupation j $RCOMINR_j$ is the annual rate of change of $COMINR_j$ $COMOUTR_j$ is the out-commuting rate by occupation j $RCOMOTR_j$ is the annual rate of change of $COMOUTR_j$ The net number of commuters from the previous year (HOLD) is calculated: 17. $HOLD = COMIN_j - COMOUT_j$ If $EMPLOYS_j$ exceeds $EMPLOYD_j$, then HOLD will decreased by a fraction of the excess employees--i.e., there will be more commuting out: 18a. $HOLD = HOLD - (EMPLOYS_j - EMPLOYD_j) * COMOUTR_j$ On the other hand, if $EMPLOYD_j$ exceeds $EMPLOYS_j$, then HOLD will be increased by a fraction of the shortfall in labor--i.e., there will be more commuting in: 18b. $HOLD = HOLD + (EMPLOYD_j - EMPLOYS_j) * COMINR_j$ Since there is now a shift in the labor force available by occupation it must be recalculated: 19. $EMPLOYS_j = LBFT * LBFOCUR_j + HOLD$ If resulting HOLD is positive then there is a net number of in-commuters for the current year: 20a. $COMIN_j = HOLD$, and $COMOUT_j = 0$ If HOLD is negative then there is a net number of out-commuters for the current year: 20b. $COMOUT_j$ = (absolute value of) HOLD, and $COMIN_j = 0$
e.	The first step is to redefine $OCUP_{i,j}$ so that it forms an occupational use-by-industry matrix --i.e., it shows what ratio of each occupation j is used by sector i. Note that the sum of each column, j, of the variable $OCUP_{i,j}$ will equal 1.0: 21. $OCUP_{i,j} = OCUP_{i,j} * EMPWFD_i / EMPLOYD_j$

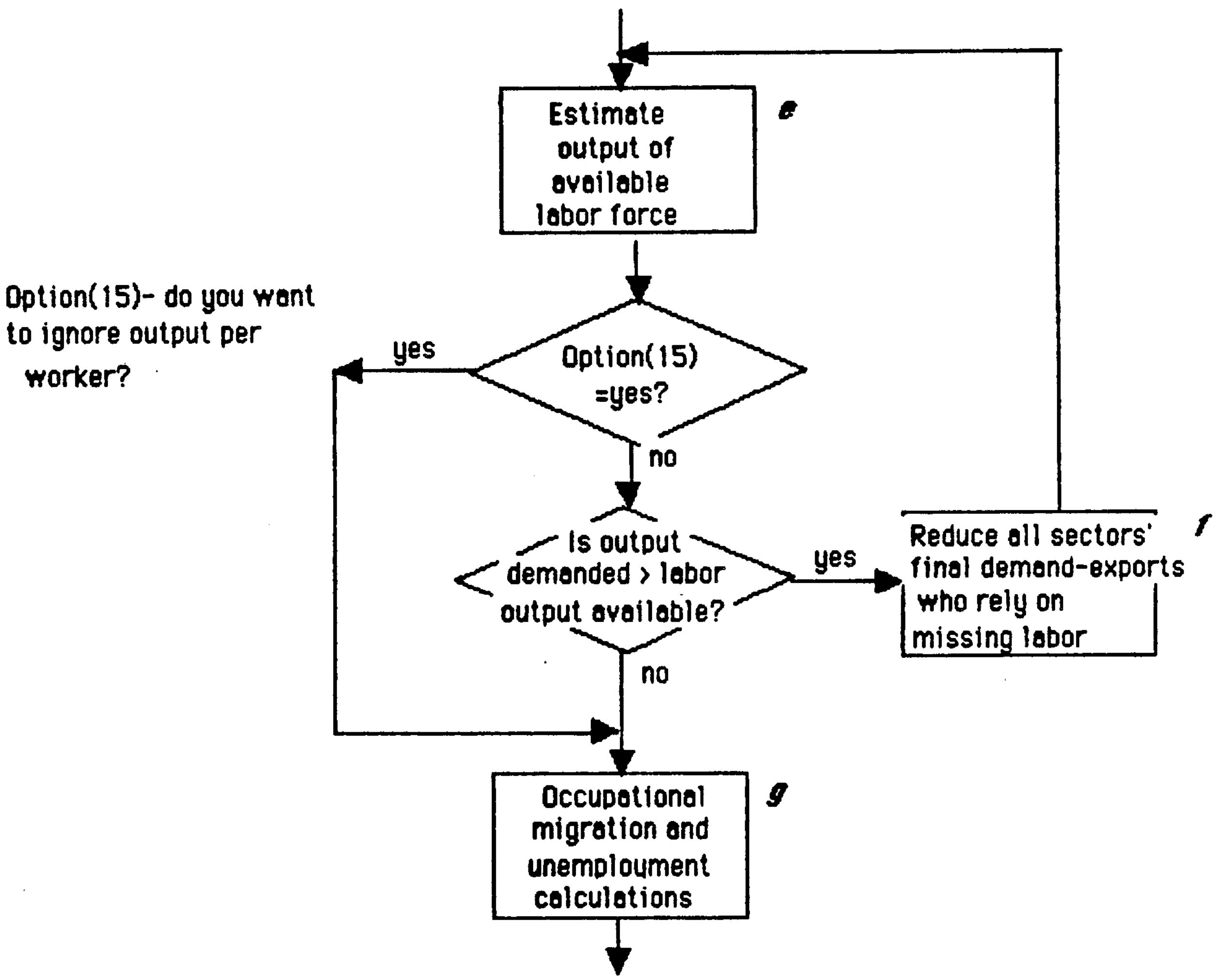

Figure 11.(Cont'd) Labor Force and Employment Module [Overlay(6,0)]

Table 9.(Cont'd) Labor Force and Employment Module [Overlay(6,0)]

Step	Description
e.	(Cont'd) The employment available for each sector i, will be calculated:

22. $EMPLOY_i = \sum_{j=1}^{noc} OCUP_{i,j} * \text{minimum} (EMPLOYS_j, EMPLOYD_j)$

where: $EMPLOY_i$ is preliminary estimate of employment in sector i

In effect, equation 22 will distribute any shortfall in labor supply to all sectors who require labor from the constraining occupations. The implicit assumption is that no sector has a comparative advantage for attracting labor.

If there is no constraining occupation then $EMPLOY_i$ equals $EMPWFD_i$ for all sectors. Otherwise, $EMPLOY_i$ will be less and the output capacity will be constrained by that shortage of labor:

23. $XL_i = EMPLOY_i * OUTPWK_i / 1000$

where: XL_i is output capacity based on labor

Finally, $OCUP_{i,j}$ must be reconverted to its original form for use in step g and in step b for the subsequent simulation year:

24. $OCUP_{i,j} = OCUP_{i,j} * EMPLOYD_j / EMPWFD_i$

(If labor is to be non-constraining, then IPASS will skip to step g.)

f. Reduce the export component of final demand for all sectors constrained by labor until regional output (X_i) no longer exceeds the labor "capacity" (XL_i). This will be accomplished in the same manner as the capital stock constraint was performed and is described in Appendix A.

g. The excess labor force are, simply, the unemployed. A proportion of the unemployed will migrate from the region. If there was a shortfall in an occupation then a proportion of that shortfall will migrate into the region.

Due to the interindustry purchases, gross output, hence, employment demanded for all occupations will be less than or equal to the labor constraint. The actual occupational employment ($ACTEMP_j$) by occupation will be calculated as follows:

25. $ACTEMP_j = \sum_{i=1}^{nis} (X_i/XL_i * \text{minimum} (EMPLOYS_j/EMPLOYD_j , 1.0) * EMPWFD_i * OCUP_{i,j})$

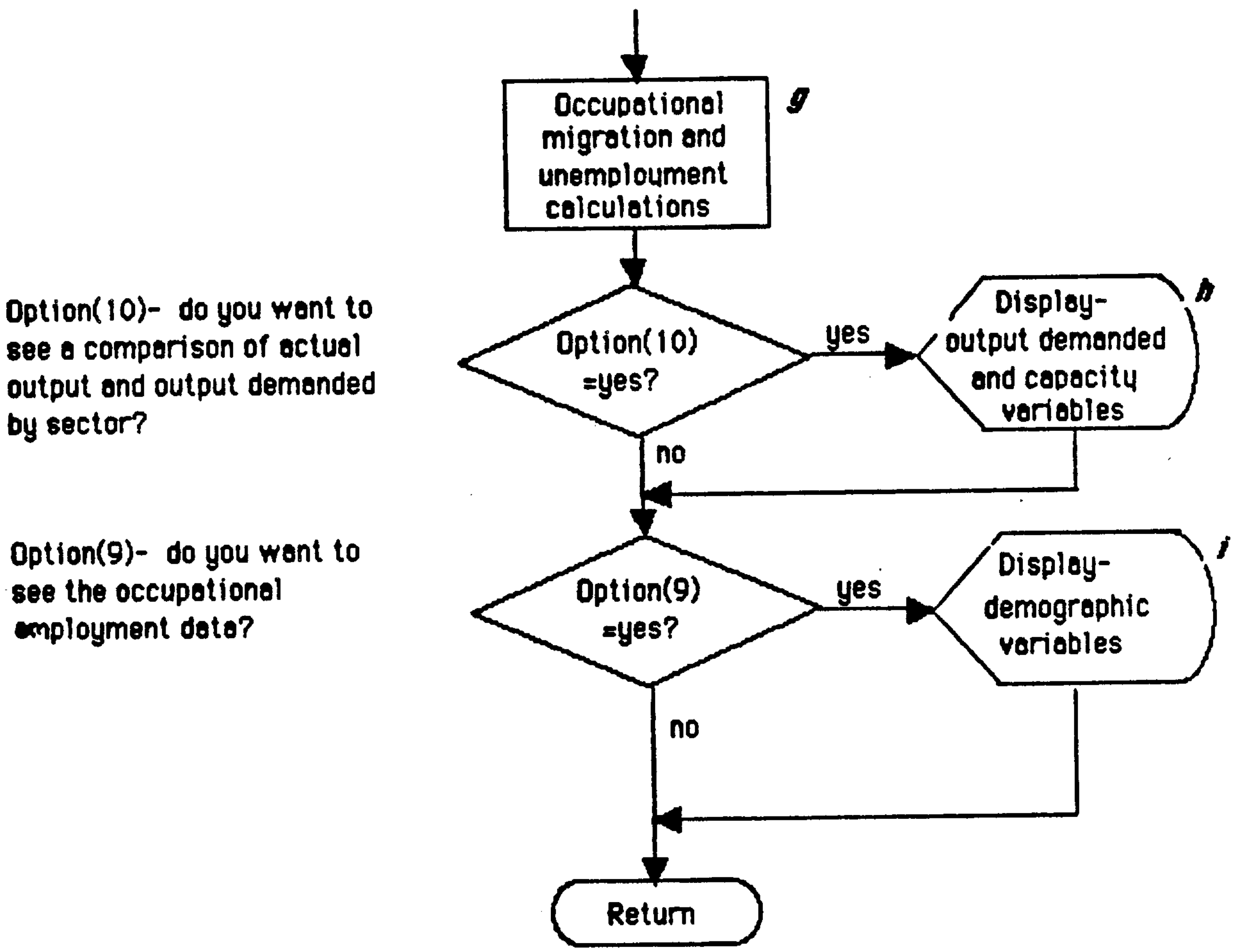

Figure 11.(Cont'd) Labor Force and Employment Module [Overlay(6,0)]

Table 9.(Cont'd) Labor Force and Employment Module [Overlay(6,0)]

Step	Description
g.	(Cont'd) Employment by sector ($EMPLOY_i$) will be similarly affected: 26. $EMPLOY_i = EMPLOY_i * X_i/XL_i$ A ratio ($OTMIGR_j$) is applied to the the excess labor force to determine the number who will migrate out by occupation ($OTMIGOC_j$): 27. $OTMIGOC_j = (EMPLOYS_j - EMPLOYD_j) * OTMIGR_j$ If, on the other hand, the labor demand is greater than the supply, a ratio ($INMIGR_j$) is applied to determine the number who will migrate in by occupation ($INMIGOC_j$): 28. $INMIGOC_j = (EMPLOYS_j - EMPLOYD_j) * INMIGR_j$ Unemployment for each occupation ($UNEMP_j$) is the labor force minus the actual employment: 29. $UNEMP_j = EMPLOYS_j - ACTEMP_j$
h.	IPASS displays a comparison of actual estimated output and the original output demanded by sector as constrained by the capital and labor constraints. An example of this output can be found in Appendix A (page 46) of the IPASS user manual.
i.	IPASS displays occupational labor force and employment data. An example of this output can be found in Appendix A (page 47) of the IPASS user manual.

(Control returns to the Control module)

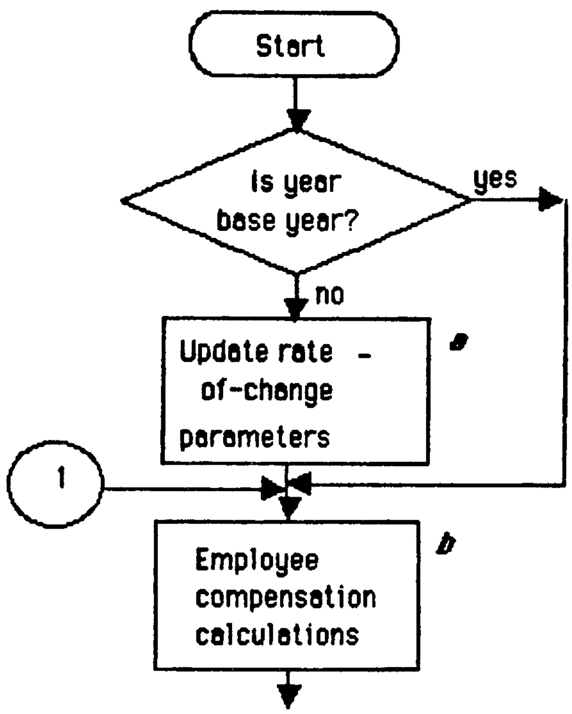

Figure 12. Primary Inputs Module [Overlay(7,0)]

Primary Inputs Module [Overlay(7,0)]

Primary inputs module includes calculations of value added (taxes, wage and salary, and other value added which includes payments to stockholders, proprietor income, and retained earnings), imports, and personal income. Depreciation of capital equipment, based on the current year's output, is also calculated.

Table 10. Primary Inputs Module [Overlay(7,0)]

Step	Description
	(The Primary Inputs module is called once at the very beginning of the simulation in order to calculate net business income for the base year. IPASS skips to step b so that the annual rates of change are not allowed to update at this time.)
a.	Annual rates-of-change are applied to IPASS variables. Update business tax rate ($BUSTAXR_i$) using the annual rate of change ($PCHITR_i$) for industry i: 1. $BUSTAXR_i = BUSTAXR_i * (1 + PCHITR_i)$ Update earnings per worker for industry i ($EARPWK_i$) using the annual rate of change for industry i for time period n ($EARPWKR_{i,n}$) unless the wage freeze flag is in effect (i.e., $MEARPWK_i = 1.$) in which case earnings per worker is frozen at last year's value: 2. $EARPWK_i = EARPWK_i * (1 + EARPWKR_i)$ where: n = 1 is 1970 - 1979 n = 1 is 1980 - 1984 n = 3 is 1985 - 1989 n = 4 is 1990 - 1994 n = 5 is 1995 + After earnings per worker is updated or skipped over (because it was frozen) the freeze wage flag is set to 0. If wages are to be frozen in subsequent years the flag will be so set in this module.
b.	Employee compensation currently consists of only wages paid by each sector so that earnings ($EARN_i$) equals employment compensation ($EMPCOM_i$) and is quite simply the earnings per worker ($EARPWK_i$) times

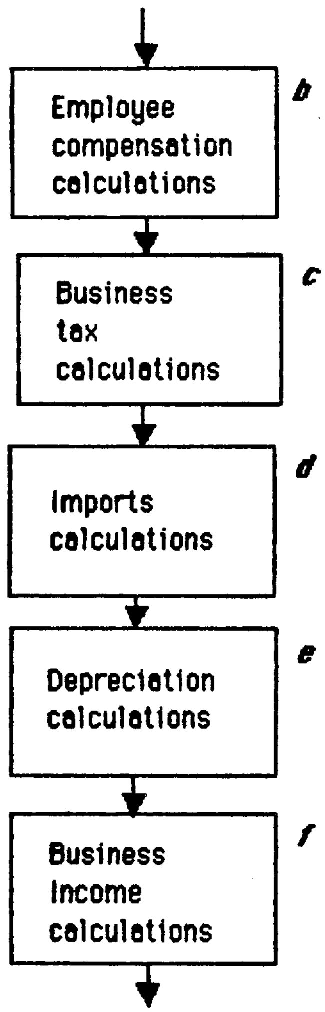

Figure 12.(Cont'd) Primary Inputs Module [Overlay(7,0)]

Table 10.(Cont'd) Primary Inputs Module [Overlay(7,0)]

Step	Description
b.	(Cont'd) the employment in the sector ($EMPLOY_i$): 3. $EARN_i = EMPCOM_i = EARPWK_i * EMPLOY_i$
c.	The indirect tax rate ($IBTR_i$) times the current year's regional output (X_i) yields the indirect business tax for the sector (BUSTAXI): 4. $BUSTAXI = X_i * IBTR_i$
d.	Imports ($IMPORT_i$) is the rate of imports required ($REGIMPR_i$) for the current year's output: 5. $IMPORT_i = X_i * REGIMPR_i$
e.	Depreciation of production capital stock ($CADEPR_i$) is based on a proportion ($DEPRPR_i$) of the use of that capital stock as indicated by the regional gross output: 6. $CADEPR_i = X_i * DEPRPR_i$ Similarly, depreciation of pollution abatement capital stock ($CADEPA_i$) is based on a proportion ($DEPRPA_i$) of the use of that capital stock as indicated by the regional gross output: 7. $CADEPA_i = X_i * DEPRPA_i$ Note that depreciation (in IPASS) refers to the actual wearing out of equipment as opposed to reported book value depreciation. The capacity of a sector is not necessarily related to book value depreciation.
f.	Business income ($BUSINC_i$) is value added less wages and indirect business taxes: 8. $BUSINC_i = X_i * VALADR_i - EARN_i - BUSTAXI$ where: $VALADR_i$ is the value added to gross output ratio for sector i Net business income for the current year ($NBUSINC_i$) is business income after income taxes (BUSTAX) are removed (note that BUSTAX will be set to zero if negative): 9. $BUSTAX = (BUSINC_i - CADEPR_i - CADEPA_i) * BUSTAXR_i$ where $BUSTAXR_i$ is the business income tax rate

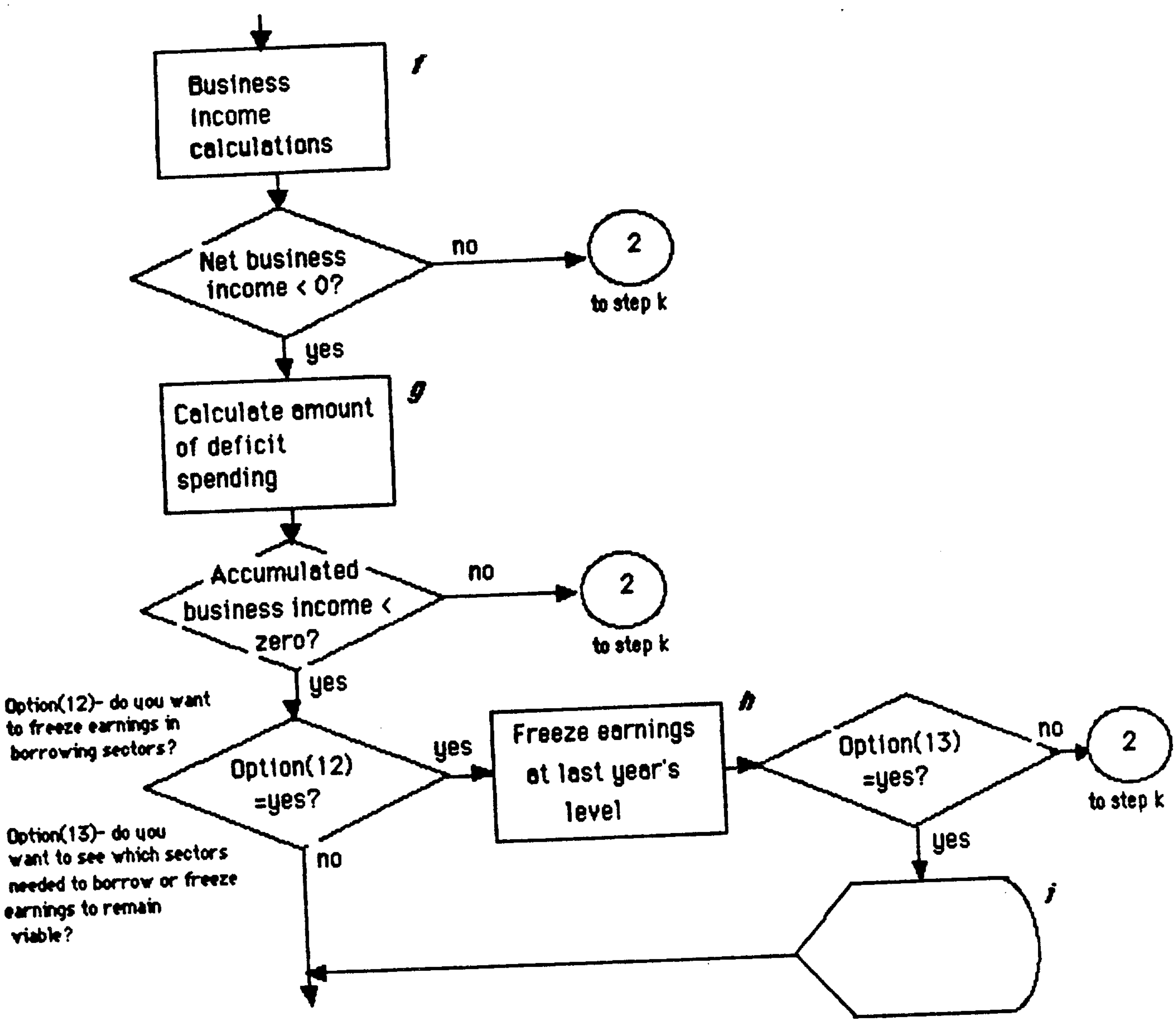

Figure 12.(Cont'd) Primary Inputs Module [Overlay(7,0)]

Step	Description
f.	(Cont'd) 10. $NBUSINC_i = BUSINC_i - BUSTAX$

(If $NBUSINC_i$ is greater than zero skip to step k)

g.	If net business income is less than zero-- i.e., there is not enough income to cover wages and taxes, then the deficit will be added to accumulated business income ($ACNETBI_i$), which will reduce its value: 11. $DEFICIT = NBUSINC_i$ 12. $ACNETBI_i = ACNETBI_i + DEFICIT$ If both net and accumulated business income are negative then the sector has no internal capital resources. Implicitly this means that the sector must borrow money to pay off its taxes and employees. Also, this sector will not be able to replace worn out machinery in the next simulation year, causing output capacity to decline. The amount borrowed is the absolute value of DEFICIT.

(If $ACNETBI_i$ is greater than zero skip to step k.)

(If wages are not to be frozen skip to step j.)

h.	Wages will be frozen. IPASS sets the wage freeze flag ($MEARPWK_i$) for the affected industry to 1. Since there will be no replacement of worn out machinery, the labor required to run that machinery is no longer needed. This labor will be in effect, "laid off". To calculate the number of persons laid off we need to find the output ($DIFINXS_i$) of equipment depreciated: 13. $DIFINXS_i = CADEPR_i * CAPPRR_i$ If pollution abatement equipment is constraining ($IOPTION_{14}$ equals "yes") then $DIFINXS_i$ will be the greater of two values -- production capacity lost (current value of DIFINXS) or pollution abatement capacity lost: 14. $DIFINXS_i = \text{maximum}(DIFINXS_i, CADEPA_i * CAPPAR_i)$ Layoffs as a result of $DIFINXS_i$ are: 15. $LAYOFF = DIFINXS_i * 1000 / OUTPWK_i$

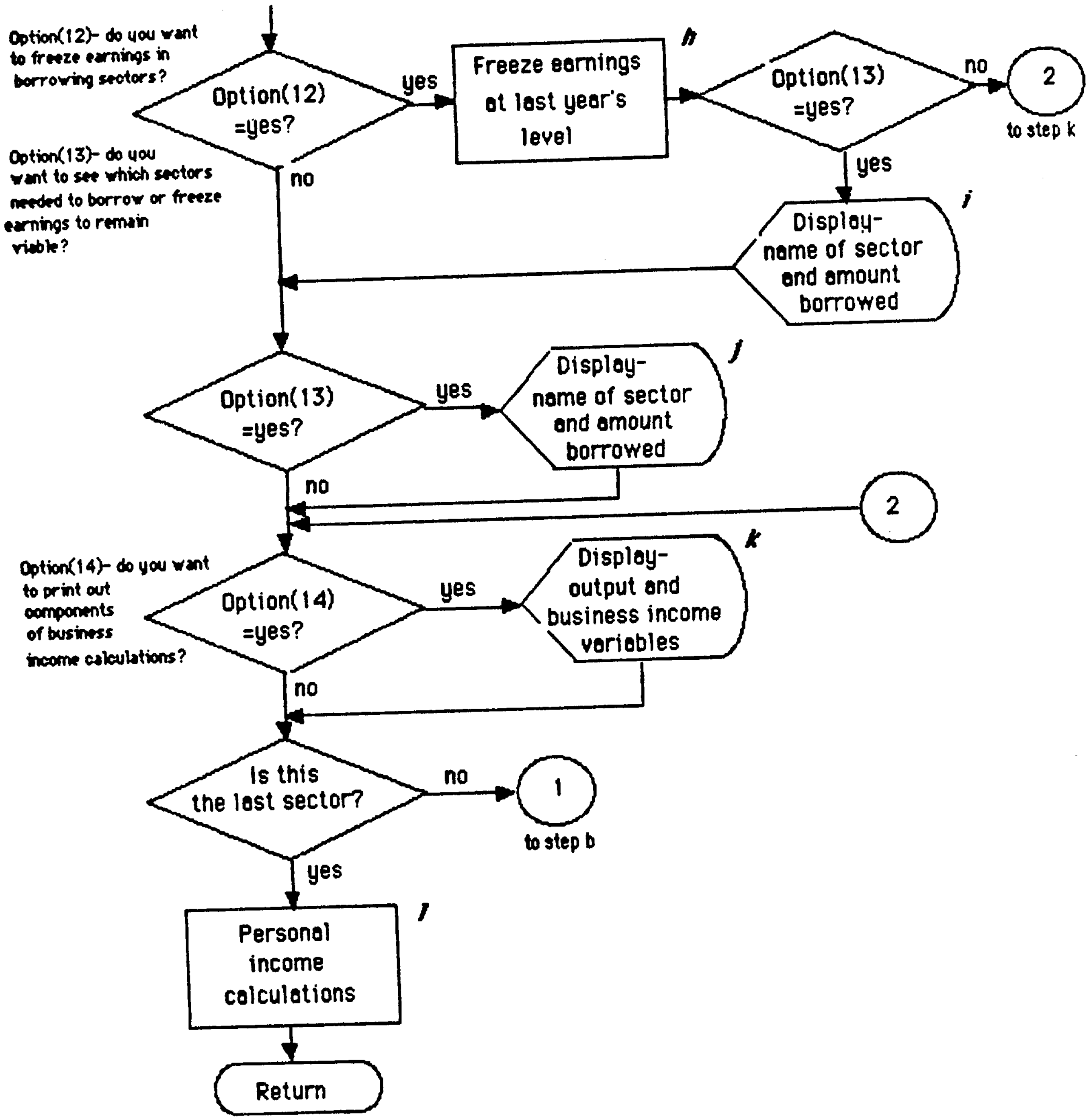

Figure 12.(Cont'd) Primary Inputs Module [Overlay(7,0)]

Table 10.(Cont'd) Primary Inputs Module [Overlay(7,0)]

Step	Description
i.	IPASS will display the name of the sector and number of layoffs in the deficit spending sector. Below is an example output: SECTOR 24 PULP & PAP NEEDED TO FREEZE EARNINGS PER WORKER AT 13211.22. IN ADDITION THEY LAID OFF 6. WORKERS. THIS WILL ALLOW THE INDUSTRY TO PAY WAGES AND ITS BUSINESS TAXES.
j.	IPASS will display the name and amount borrowed of the deficit spending sector. Below is an example output: SECTOR 24 PULP & PAP NEEDED TO BORROW $ 27421.43 AND 100% OF ITS DEPRECIATION ALLOWANCE TO PAY WAGES AND BUSINESS TAXES.
k.	IPASS will display components of business income calculations. An example output can be found in Appendix A (page 49) of the IPASS user manual.

(These Primary Input module calculations are performed on every sector i except i = nis --i.e., the Other Government sector.)

1.	Total personal income (PIT) is derived by applying a total personal income to wage and salary ratio (PIEARNR) to total wages and salaries (EARNT): 16. PIT = EARNT * PIEARNR

(Control is returned to the Control module.)

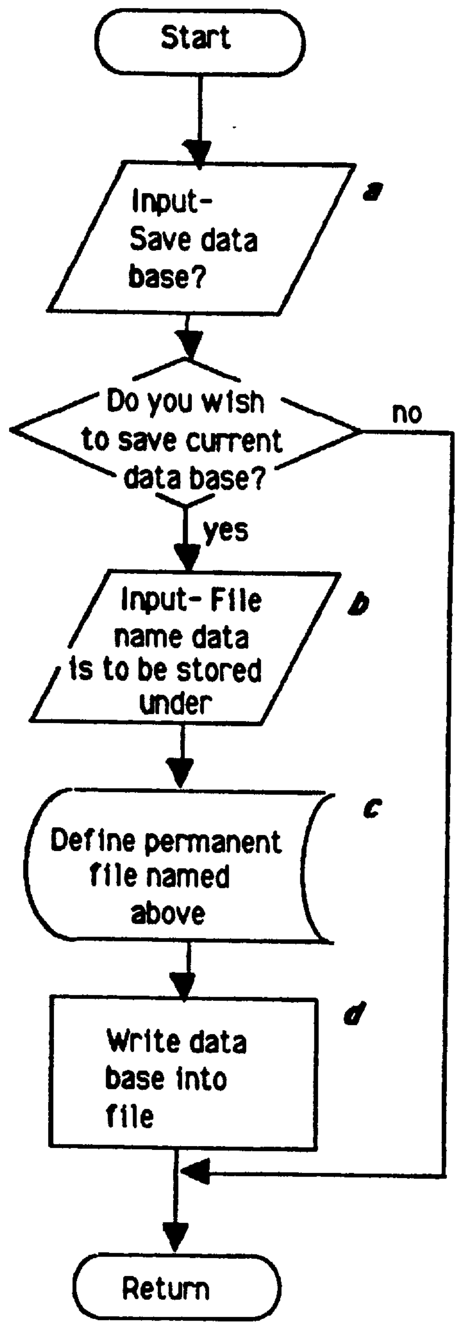

Figure 13. Save Data Base Module [Overlay(13,0)]

Save Data Base Module [Overlay(13,0)]

At the end of the simulation, the user is allowed to save the data base as a permanent file. This data base can then used as the original data of a new simulation by specifying it at step a of the Read in Data module and .

Table 11. Save Data Base Module [Overlay(13,0)]

Step	Description
a.	The user may ask to save the final year of simulation as a data base.
(If the user does not wish to save the data base the program returns control to the Control module.)	
b.	The user is required to give a name to the data base being saved. On the Cyber computer the name can be no longer than seven characters and must begin with a letter (i.e., not a number).
c.	IPASS creates a permanent file using the name provided in step b.
d.	The entire data base is written to the permanent file in a form that can be directly accessed by the Read in Data module [overlay(1,0)].
(Control returns to the Control module.)	

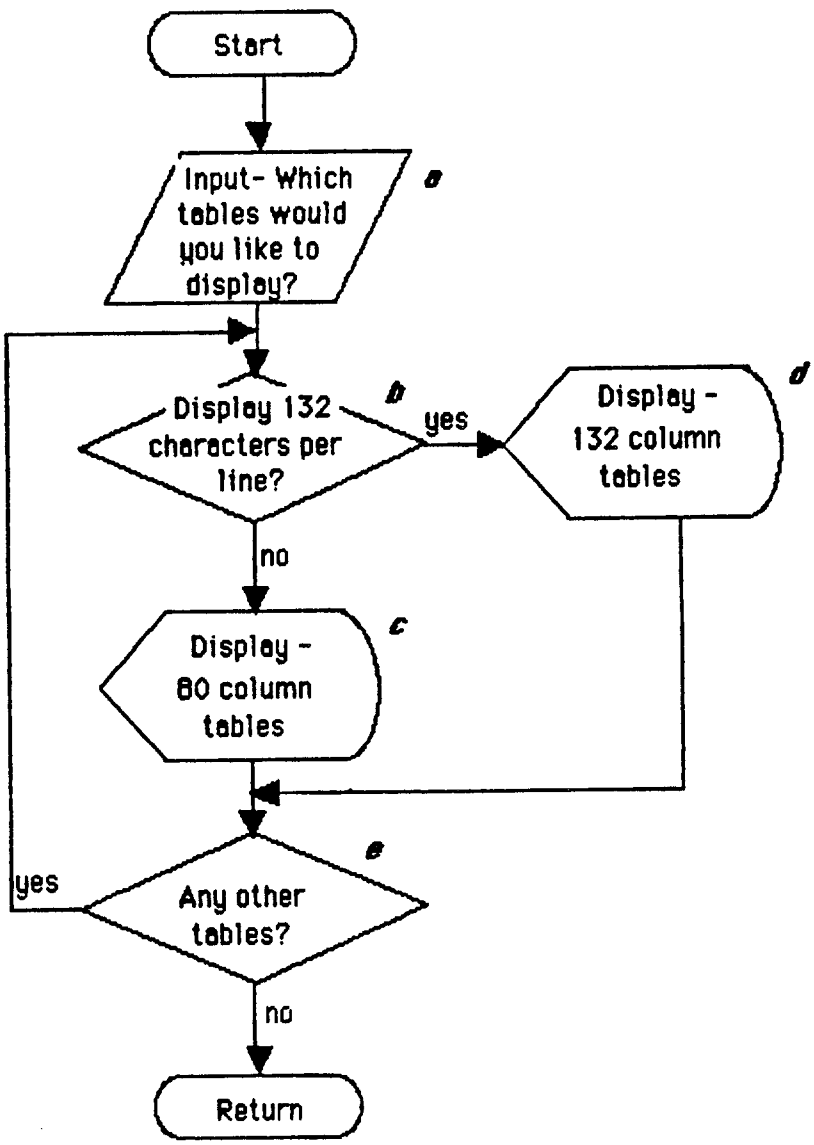

Figure 14. Data Table Display Modules [Overlays(11,0), (12,0)]

Data Table Display Modules [Overlays(11,0), (12,0)]

IPASS displays prepared tables for the user. The tables provide complete industrialy sector and occupational breakdowns. An example of the eight tables currently available can be found in Appendix A of the IPASS user manual.

Table 12. Data Table Display Modules [Overlays(11,0), (12,0)]

Step	Description
a.	The user may ask for any or all of the eight tables available.
b.	All tables may be printed in 132 or 80 column displays. The column width was specified by the user in step c of the Read in Data module.
c.	The 80 column tables are printed by overlays (11,1), (11,2), (11,3), (11,4), (11,5), (11,6), (11,7), and (11,10).
d.	The 132 column tables are printed by overlays (12,1), (12,2), (12,3), (12,4), (12,5), (12,6), (12,7), and (12,10).
e.	If the user asks for more than one table, IPASS will display them in the order listed.

(Control is returned to the Control module)

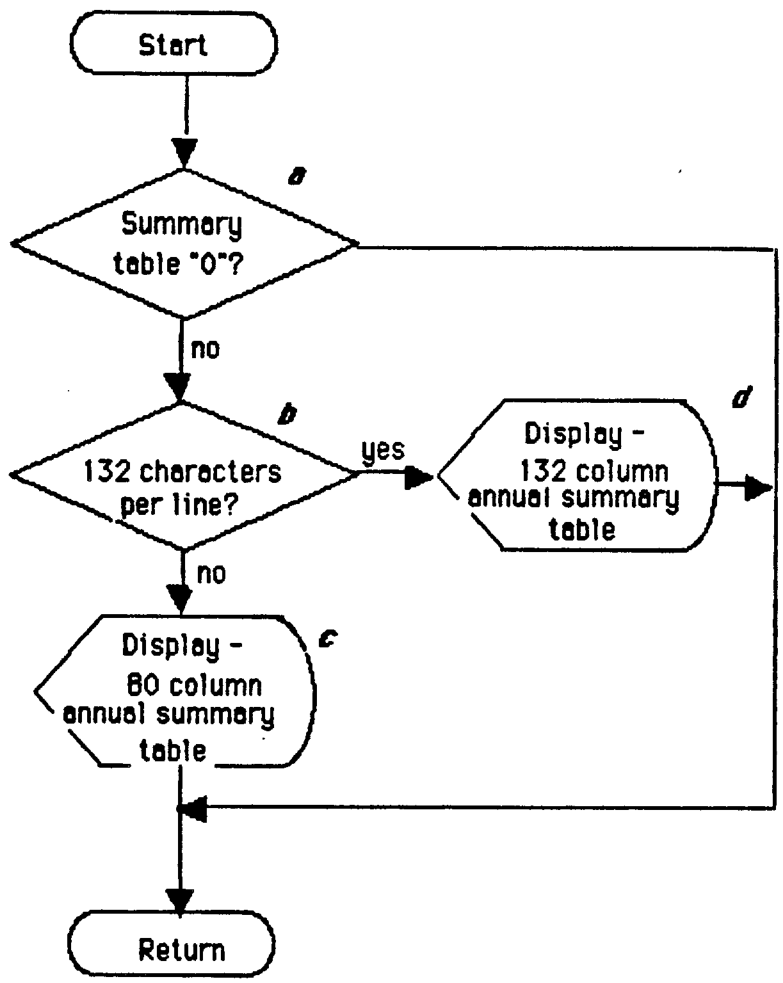

Figure 15. Annual Summary Table Modules [Overlays(21,0), (10,0)]

Annual Summary Table Modules [Overlays(21,0), (10,0)]

The user may choose to have any one of six summary tables printed each year of the simulation at step d of the Read in Data module. An example of each is available in Appendix A of the IPASS user manual.

Table 13. Annual Summary Table Modules [Overlays(21,0), (10,0)]

Step	Description
a.	If the user selected table 0 --i.e., no summary table, then IPASS immediately returns control to the Control module.
b.	The table may be printed in 132 or 80 column display. The column width was specified by the user in step c of the Read in Data module.
c.	The 80 column summary table is printed by overlay (21,1), (21,2), (21,3), (21,4), (21,5), or (21,6).
d.	The 132 column summary table is printed by overlay (10,1), (10,2), (10,3), (10,4), (10,5), or (10,6).

(Control is returned to the Control module)

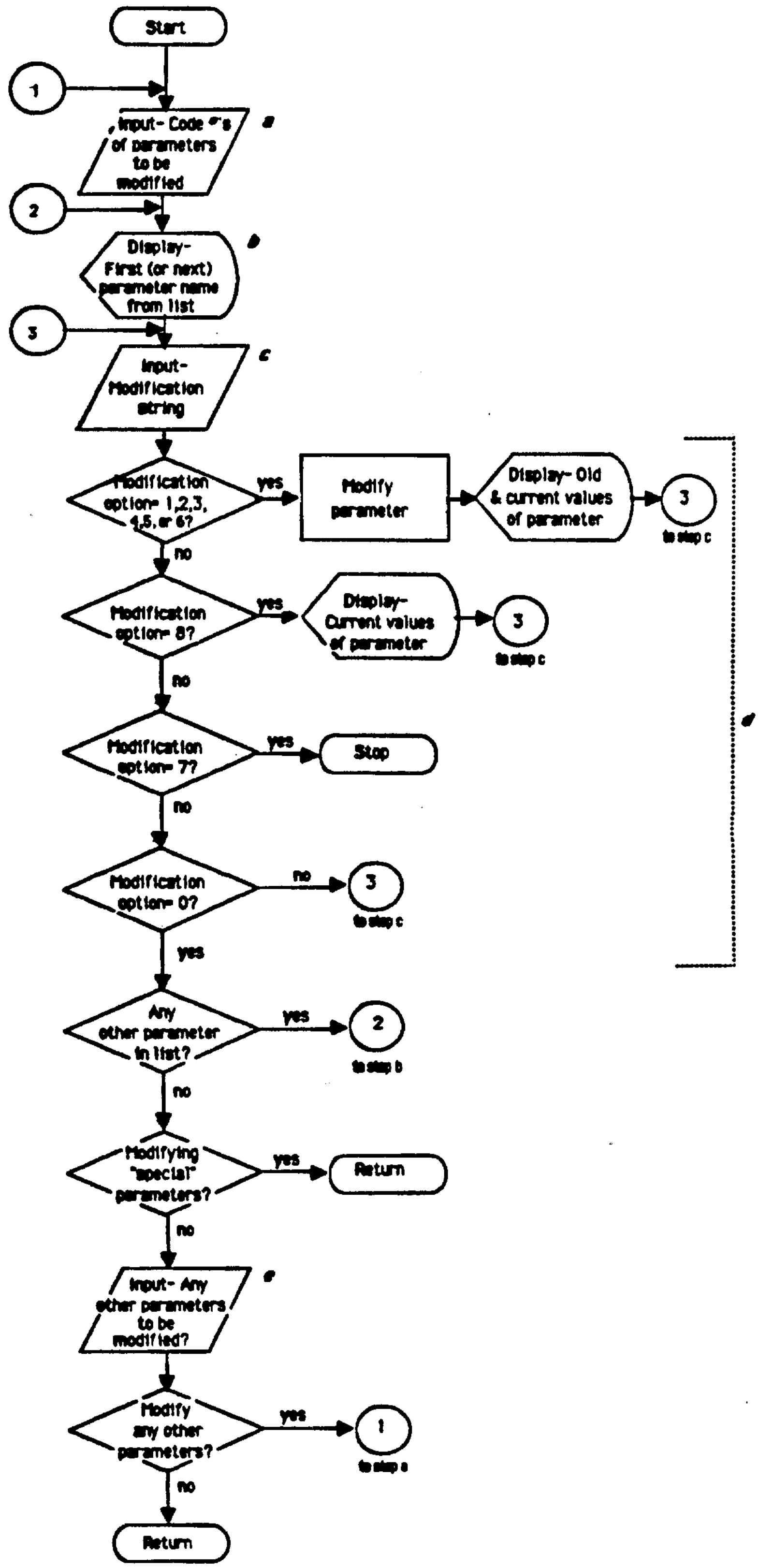

Figure 16. Parameter Change Module [Overlay(14,0)]

Parameter Change Module [Overlay(14,0)]

The Parameter Change module allows the user to externally change current IPASS ratios and variables for "fine tuning" of the data base for impact analysis. The user may modify any of the 120 parameters listed in Appendix C of the IPASS user manual.

Table 14. Parameter Change Module [Overlay(14,0)]

Step	Description
a.	The user may list up to 10 code numbers corresponding to parameters that are to be modified.
b.	IPASS asks "How do you want to Modify # XX (parameter name)". Overlays (14,1), (14,2), (14,3), (14,4), (14,5), (14,6), (14,7), (14,10) store the programming for identifying and listing the parameters to be modified.
c.	The user responds to the "?" prompt by inputting the type of modification, the elements of the parameter to be modified, and the value of the change for each parameter in its turn. A description of this procedure is provided by the IPASS user manual in Appendix B.
d.	A summary of the modification options are provided in the IPASS user manual in table 4 of Appendix B.

(The program returns to step b for each parameter to be modified.)

(If the Parameter Change module was called by either the Final Demand or the Investment modules then control will return to the calling module. If called by the Control module then continue to step e.)

e.	Since IPASS allows only 10 parameters to be listed in step a, it now asks, "Do you want to make any other modifications?". This enables us to request an additional group of parameters.

(If the user requires additional parameters to be modified go back to step a.)

(Control returns to the Control module.)

APPENDIX A -- How to constrain Gross Output demanded

The problem is to constrain final demand so that total gross output (X_i) is less than or equal to output capacity (XS_i for capital constraint, XL_i for labor constraint) for each sector.

1. [X] = [LEMAT]*[FD] subject to the condition that X_i is less than or equal to XS_i for all i.

where: [LEMAT] is the Leontief inverse matrix
[FD] is total final demand vector for all sectors i
[XS] is the capital stock constraint for all sectors i
(note that throughout the rest of this appendix only XS will be used. The labor constraint [XL] ,however, is used in the exact same manner to constrain [X].)

Reducing final demands for constrained industries needs to be accomplished under the following three conditions:

a) A non-arbitrary reduction of final demand must occur --i.e., no reduction of final demand for a constrained sector may be disproportionately greater than another without a reasonable assumption

b) Final demands of unconstrained sectors will not change --i.e., only the final demands of the constrained sector will be directly affected.

c) The final demand of any sector may not be increased as a result of constraining total outputs.

The methodology chosen for use in IPASS follows.

An element of [X] is derived through the multiplication shown in equation 1 above.

2. $X_i = b_{i,1}*FD_1 + b_{i,2}*FD_2 + \ldots + b_{i,n}*FD_n$

where: $b_{i,j}$ is an element of the matrix [LEMAT]

If X_i must be constrained by amount (X_i - XS_i), the amount that FD_i must be reduced can be easily derived by equations 3 and 4:

3. $X_i - XS_i = b_{i,1}*0 + \ldots + b_{i,i}*\triangle FD_i + \ldots + b_{i,n}*0$

4. $\triangle FD_i = (X_i - XS_i)/b_{i,i}$

Note that if there is only one constrained sector then equation 4 will provide the exact reduction in final demand needed to satisfy the constraint. However, if more than one sector is constrained then for each constrained sector i, the off-diagonal elements of the Leontief inverse (elements other than $b_{i,i}$) will also be multiplied by the change in final demands in equation 3. This reflects the interactive nature of input/output analysis and may result in a final gross output of all sectors (X) far below the original output demanded (XD) and even far below capital stock capacity (XS) for those sectors which were constraining.

To solve this problem we revised equation 4:

$$5. \quad \Delta FD_i = \begin{cases} -(X_i - XS_i)/(f*b_{i,i}), & \text{if } X_i \text{ is greater than } XS_i \text{ --i.e., the ith sector is constrained} \\ 0 & \text{if } X_i \text{ is less than } XS_i \text{ --i.e., the ith sector is not constrained} \end{cases}$$

The new final demand vector $FD^{(1)} = FD - \Delta FD$ is then used to compute the new gross output vector $X^{(1)} = X - \Delta X$.

We experimented with four possible methods of constraining output based on equation 5 above.

Method 1. We have shown in equation 4 that by chosing f = 1 that we are guaranteed that in one iteration X to $X^{(1)}$ yields a gross output satisfying all constraints.

Method 2. Choosing f = 2 (bisection) X to $X^{(1)}$ may or may not satisfy all constraints. But calculating $FD^{(2)} = FD^{(1)} - \Delta FD^{(1)}$ based again on equation 5 with f = 2 yields an iterative process X to $X^{(1)}$ to $X^{(2)}$ to $X^{(3)}$..., until all constraints are satisfied.

Method 3. Choose f, at each iteration, to be the number of sectors for which X_i is greater than XS_i. Again we can iterate until all constraints are satisfied using equation 5 with f equal to the number of constrained sectors. The greater the number of constraining sectors the larger the f and the smaller the reduction in gross output will be at that iteration.

While experimenting with methods 2 and 3, when the process reached the point at which either:

(i) only one sector is constrained, or
(ii) no sector has output exceeding capacity by more than some predetermined e (we chose e = 0.2) --i.e., when $(X_i^{(k)} - XS_i^{(k)})$ is less than or equal to e, i=1 to n

then the value of f was changed to 1, and the one final iteration yielded a gross output satisfying all constraints.

Calculations using numerical examples show that method 3 consistently yields the largest gross outputs within capacity (hence, the least amount of unused capacity), and method one yields the smallest gross output and final demands. How far gross output derived by methods 1 and 2 are overconstrained depends on how many sectors are constraining and how strongly they are linked together. However, method 1 is the fastest, hence, the cheapest, and method three can be the slowest if there are many constraining sectors. Alternately, method 3 may also overconstrain if there are few constraining sectors. Method 4, below, was developed to maximize output within the constraint and minimize iterations.

Method 4. "Fixed number of iterations." We choose a fixed finite sequence $f_1 > f_2 > \ldots > f_m = 1$ of positive integers decreasing to $f_m = 1$. (In IPASS we use the sequence 5,4,3,2,1.) This yields a fixed number of iterations resulting in gross output $X^{(m)}$ satisfying all constraints. By choosing a fairly large initial value of f, we improve on method 1, which tends to produce an overly large decrement in gross output. In moving towards f_m=1 we take larger percentage reductions of a progressively smaller constraints. We end the process with at most m iterations which limits the computer time required.

APPENDIX B -- Complete Flow Charts

List of figures

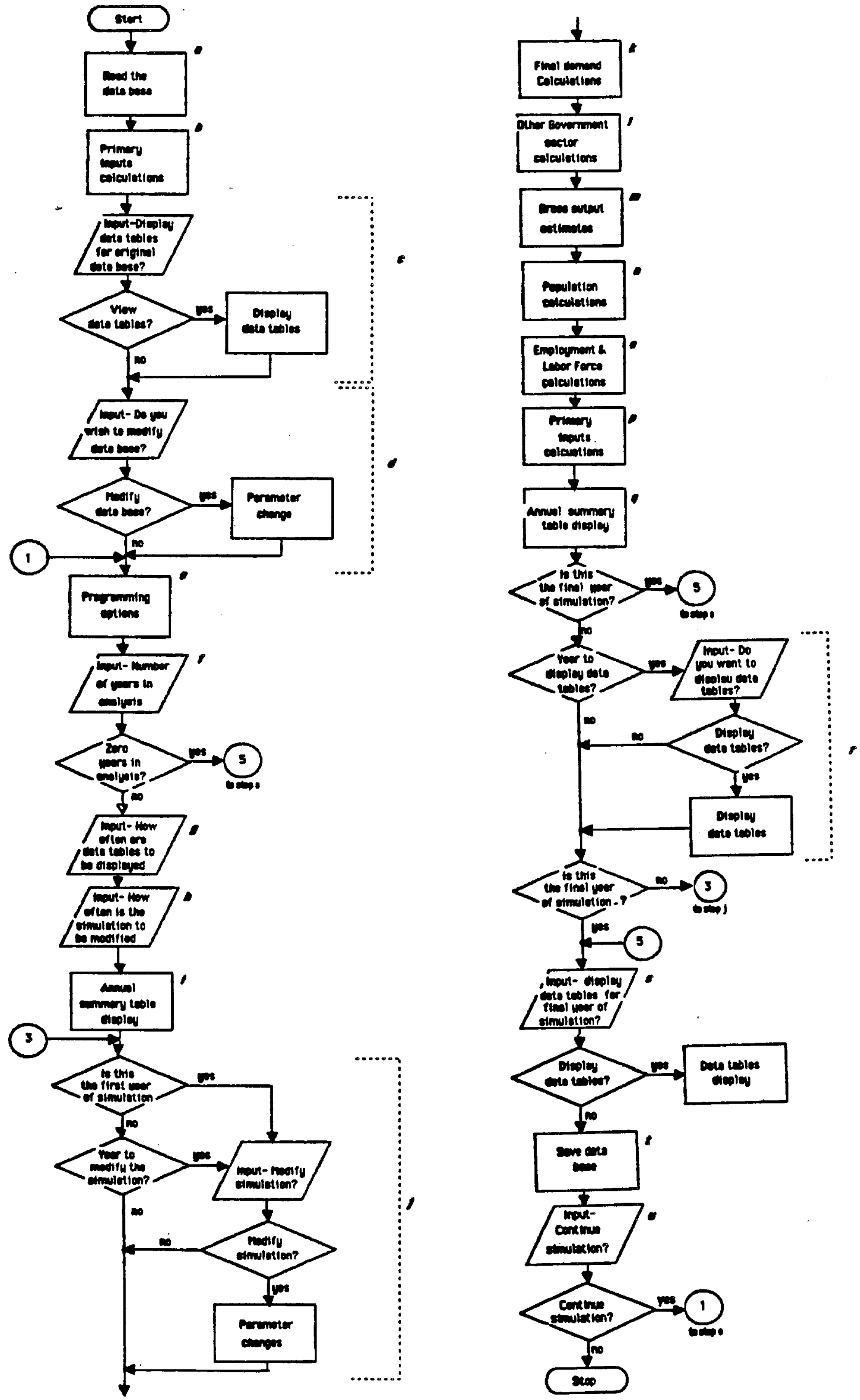

Figure 17. Main Control Module [Overlay(0,0)]

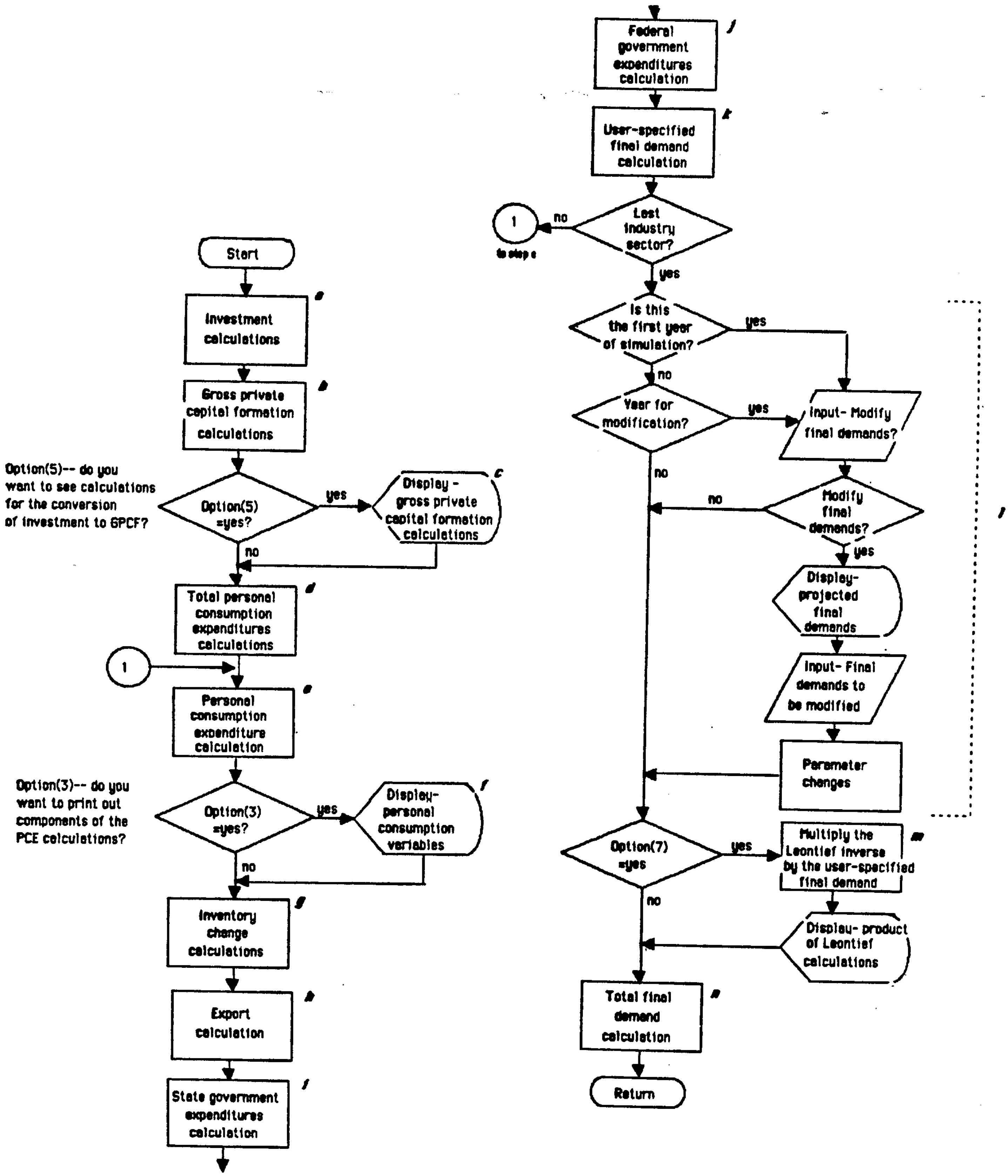

Figure 18. Final Demands Module [Overlay(2,0)]

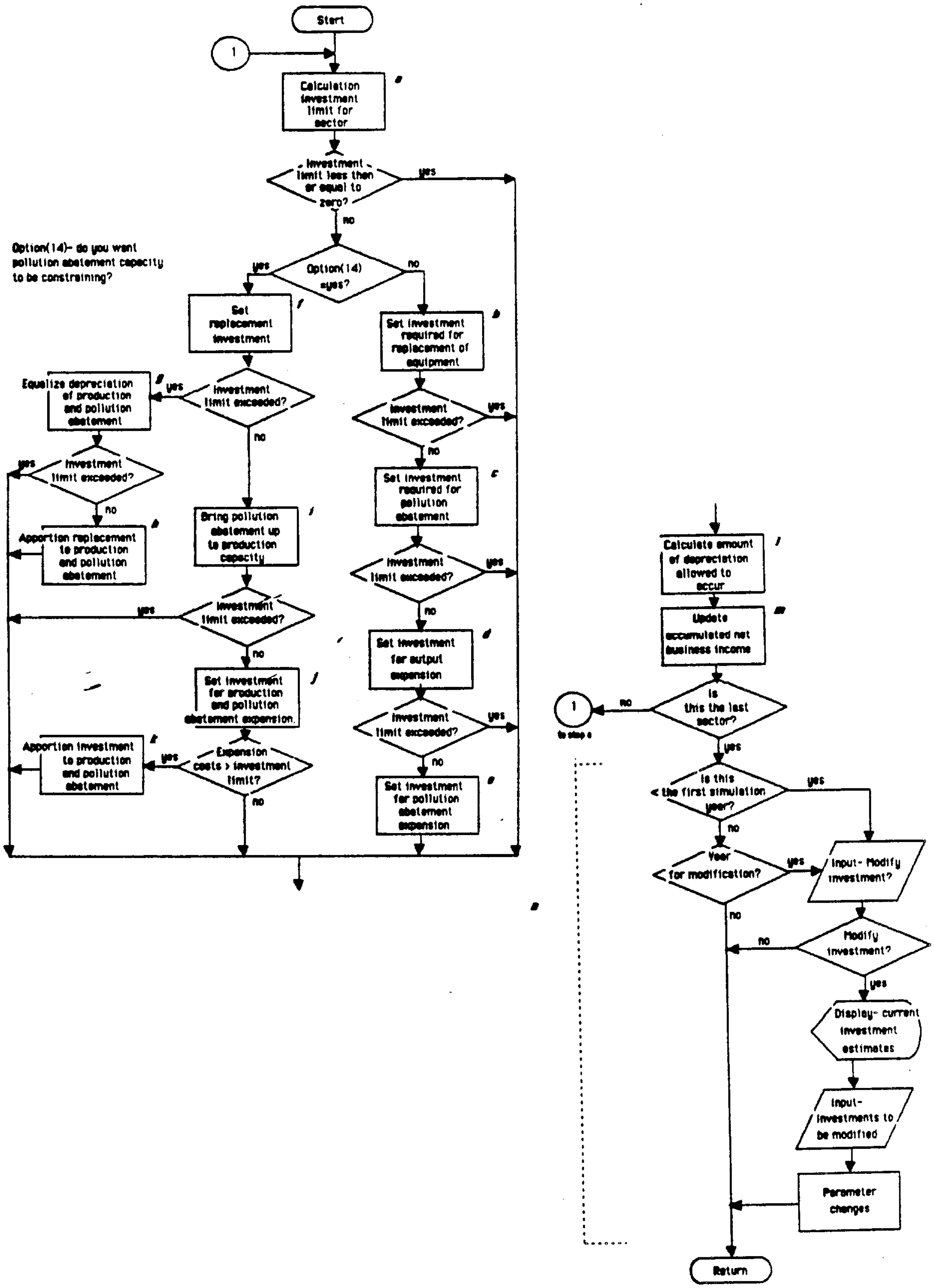

Figure 19. Investment Module [Overlay(2,1)]

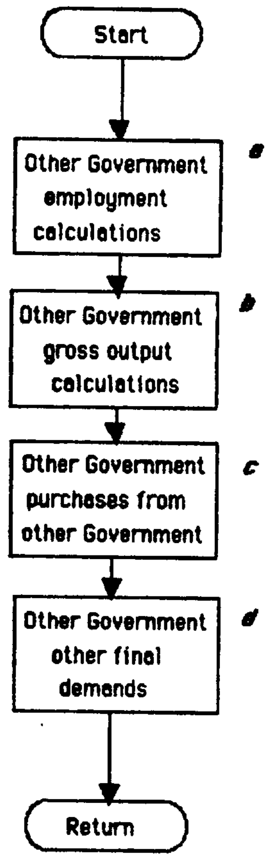

Figure 20. Other Government Module [Overlay(3,0)]

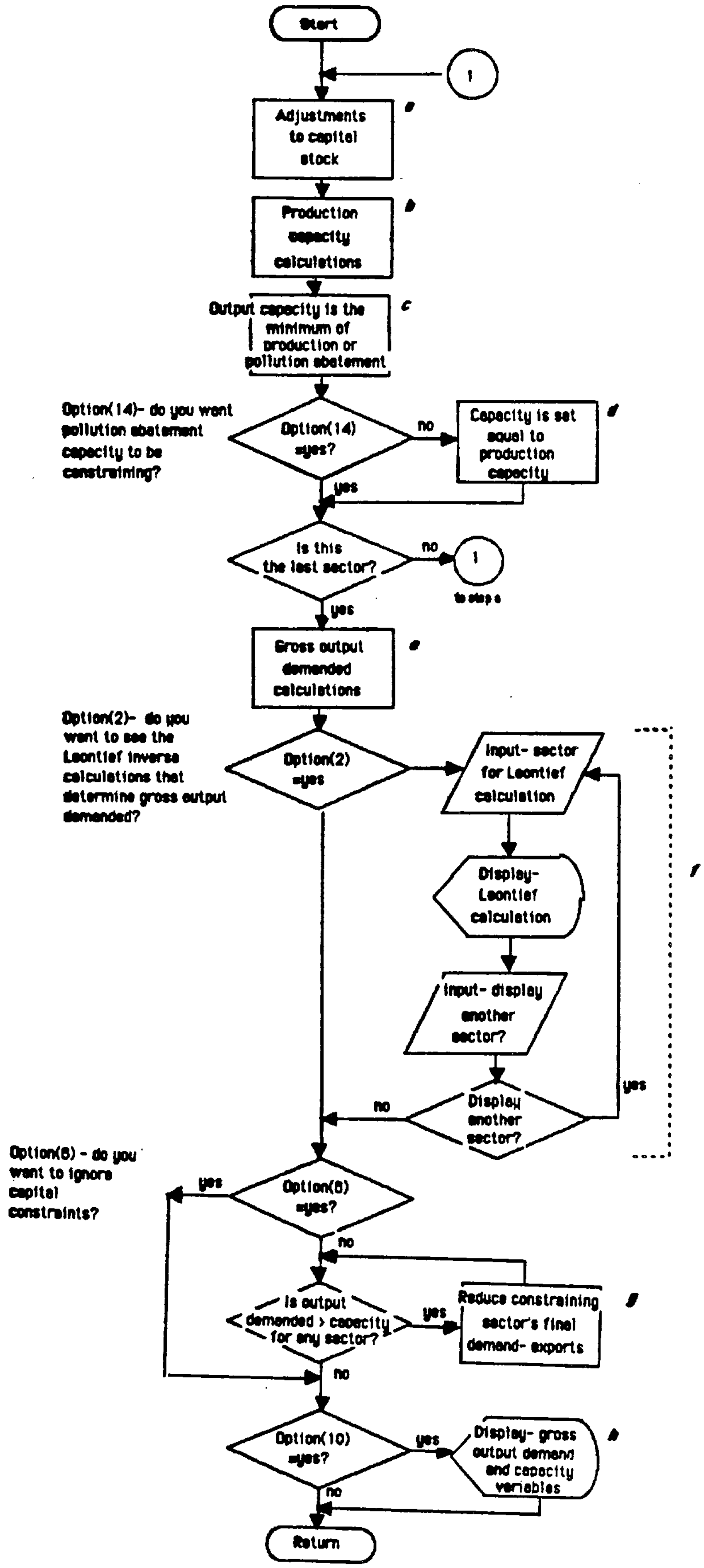

Figure 21. Regional Output Module [Overlay(4,0)]

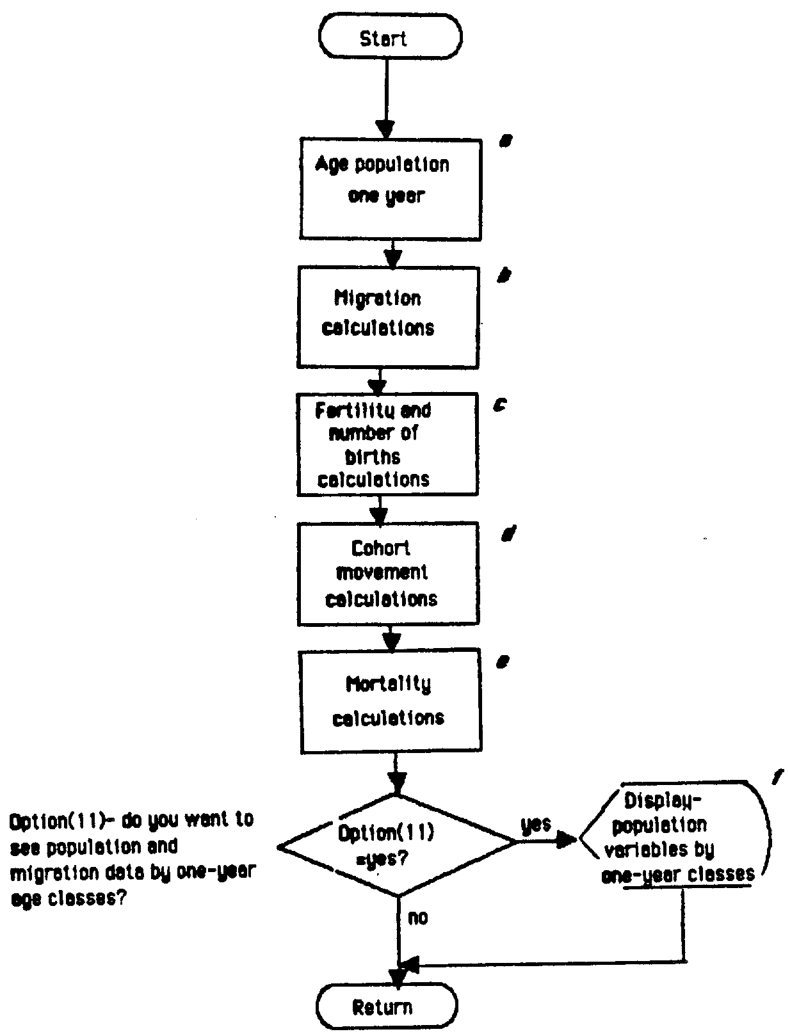

Figure 22. Population Module [Overlay(5,0)]

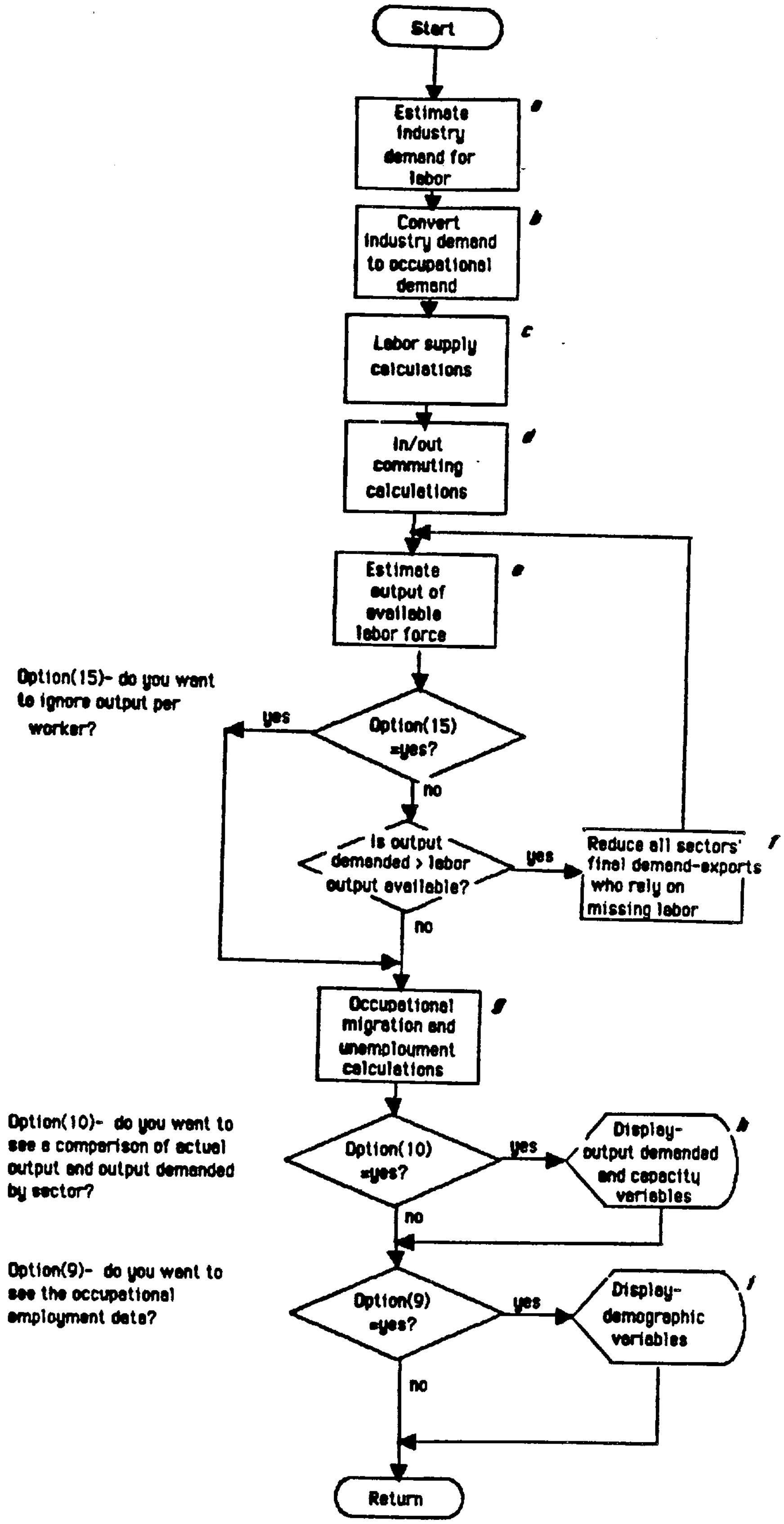

Figure 23. Labor Force and Employment Module [Overlay(6,0)]

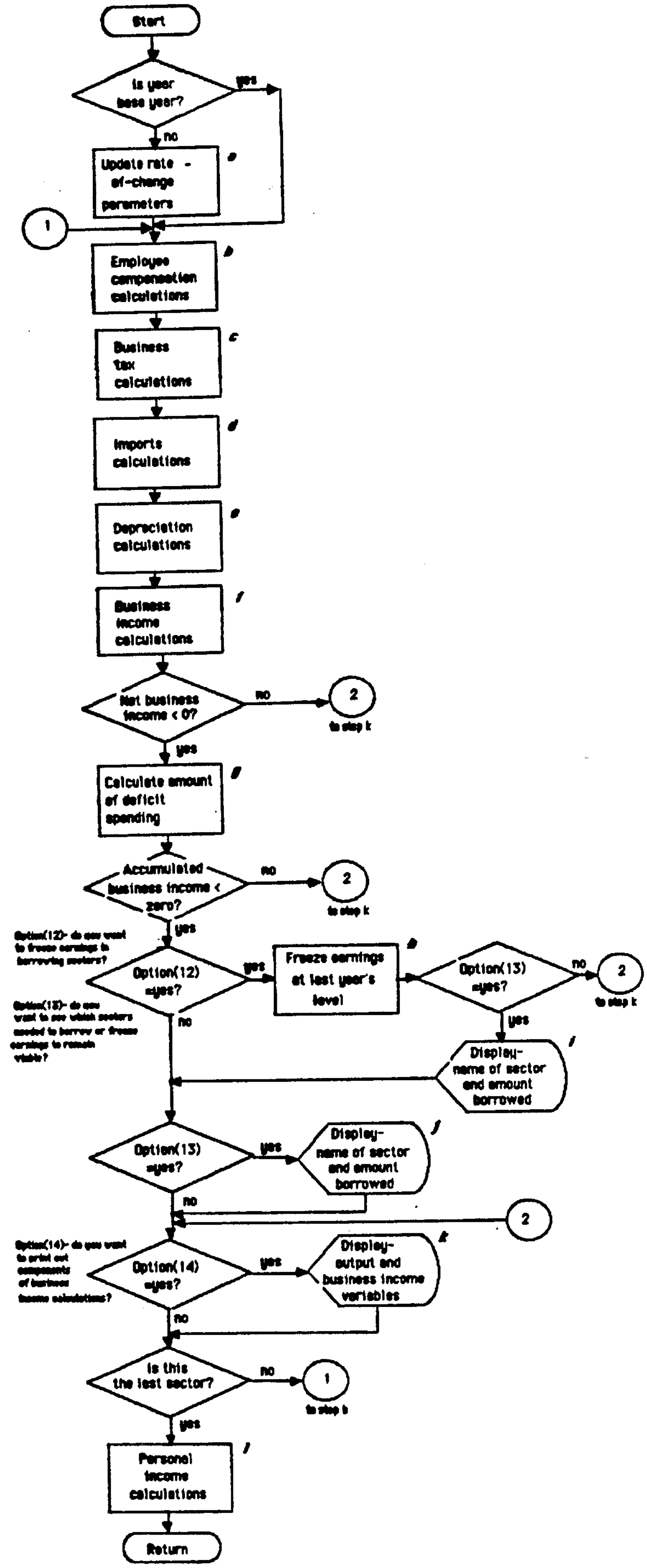

Figure 24. Primary Inputs Module [Overlay(7,0)]

Index and Glossary

Variable name	Pages	Definition
$ACNETBI_i$,	27, 29, 35, 73,	Accumulated net business income after taxes, including depreciation allowances, by sector i
$ACFERTY_{a,v}$,	53,	Annual rate of change in the fertility rate (FERTILY) by one-year age classes over time intervals (v) 1970-79, 80-84, 85-89, and 1990+
$ACTEMP_j$,	65, 67,	Final estimate of employment by occupation j
$AINV_i$,	19, 21,	Sum of all investments made by industry i ($1000s)
$BINCH_i$,	19, 23, 25, 41,	Business inventory change over the previous year ($1000's), by sector i
$BINCHR_i$,	23,	Rate of change in business inventory to change in gross output, by sector i
BINCHT,		Total business inventory change ($1000's)
BIRTH,	53,	Total number of births
$BUSINC_i$,	71, 73,	Business income net of wages and indirect business taxes by sector i, ($1000s)
BUSTAX,	71, 73,	Business income tax for sector, ($1000s)
$BUSTAXR_i$,	69,	Ratio of business income taxes to pre-tax business income, by sector i
$CADEPA_i$,	29, 31, 33, 37, 41, 71, 73,	Depreciation of pollution abatement equipment by sector i, ($1000s)
$CADEPR_i$,	29, 31, 33, 37, 41, 71, 73,	Depreciation of production equipment by sector i, ($1000s)
$CAPPAR_i$,	29, 31, 33, 35,	Pollution-abatement-capital/output ratio, by sector i
$CAPPRR_i$,	29, 31, 33, 35,	Production-capital/output ratio, by sector i

Variable name	Pages	Definition
$COMIN_j$,	59, 61, 63,	Number of in-commuters (those who work in but live outside the region), by occupation j
$COMINR_j$,	63,	Fraction of otherwise vacant jobs filled by incommuters, by occupation j
$COMOUT_j$,	59, 61, 63,	Number of out-commuters (those who work outside but live inside the region), by occupation j
$COMOUTR_j$,	63,	Fraction of those otherwise unemployed who commute to jobs outside the region
$CORTMVF_a$,	53,	Fraction of each female cohort by one-year age class which moves in (+) or out (-) of the region for reasons other than job availability (e.g. college, retirement)
$CORTMVM_a$,	53,	Same as $CORTMVF_a$ for male cohorts
$DEATHRF_a$,	55,	Female death rate (per capita) by one-year age class
$DEATHRM_a$,	55,	Male death rate (per capita) by one-year age class
DEFICIT,	73,	Amount borrowed by sector to cover operating expenses
$DEPRPA_i$,	71,	Depreciation rate for pollution-abatement capital (expressed as a fraction of gross output), by sector
$DEPRPR_i$,	71,	Depreciation rate for production capital (expressed as a fraction of gross output), by sector i
DIF,	33, 35,	Dummy variable, defined as the difference between two variables
$DIFINXS_i$,	73,	Loss of output due to depreciated equipment not replaced by sector, ($1000s)
DIT,	21,	Total disposable income
DITM1,	21,	Total disposable income for the previous year

Index and Glossary (Cont'd)

Variable name	Pages	Definition
$EARN_i$,	71,	Worker earnings (wages and salaries only; $1000's), by sector i
EARNT,	75,	Total worker earnings for all sectors ($1000's)
$EARPWK_i$,	41, 69, 71,	Average earnings per worker by sector i
$EARPWKR_{i,v}$,	69,	Annual rate of change in EARPWKi over time intervals (v) 1970-80, 81-85, 86-90, 91-95, and 1996+
EINV,	35,	Total expansion investment for sector
$EINVPA_i$,	19, 27, 29, 35, 37, 41,	Expansion investment in pollution abatement capital ($1000's), by sector i
$EINVPR_i$,	19, 27, 29, 35, 37, 41,	Expansion investment in production capital ($1000's), by sector i
$ELASIN_i$,	23,	Income elasticity of demand for the output of sector i
$EMPCOM_i$,	71,	Employment compensation by sector i, ($1000s)
$EMPLOY_i$,	39, 41, 65, 67, 71,	Wage and salary employment, by sector i
$EMPLOYD_j$,	59, 63, 65, 67,	Employment demanded, by occupation j
$EMPLOYS_j$,	59, 61, 63, 65, 67,	Employment supplied, by occupation j
EMPLOYT,	21,	Total employment for all sectors
EMPM1T,	21,	Total employment for the previous year
$EMPWFD_i$	57, 59, 63, 65,	Employment demanded by sector i
$EXPORT_i$,	19, 25, 41, 47,	Exports from the study region ($1000's), by sector i
EXPORTT,		Total exports from the study region ($1000's)
FCEMP,	25, 39,	Federal civilian administrative government employment
FD_i,	25, 45, 83, 84,	Final demand ($1000's), by sector i
FDT,		Total final demand ($1000's)

Variable name	Pages	Definition
$FERTILY_a$,	35,	Fertility rate in live births per 1000 females, by 66 1-year age classes
$FGOVE_i$,	19, 25, 39, 41,	Federal government purchases ($1000's) from each industry i
FGOVET,		Total federal government purchases ($1000's)
FMEMP,	39,	Federal military employment
$GPCF_i$,	19, 21, 25, 41,	Gross private capital formation ($1000's), by sector i
GPCFT,		Total gross private capital formation ($1000's)
$GROWTHR_i$,	23,	Annual rate of growth of $USGO_i$ for time intervals (v) 1970-79, 80-84, 85-89, 90-94, and 1995+
HOLD,	63,	Dummy variable
$HRWPW_i$,	57, 59,	Average hours worked per week per worker, by sector i
$HRWPWR_i$,	57,	Annual rate of change in $HRWPW_i$, by sector i
$HRWPY_i$,	59,	Average hours worked per year per worker, by sector i
$IBTR_i$,	71,	Ratio of indirect business taxes to gross output, by sector i
ICOUNT1,	9, 13,	Number of years since last data table display
ICOUNT2,	9,	Number of years since last parameter modification
$IOPTION_n$		Option flags set in Options module
$IMPORT_i$,	71,	Imorts from outside the region ($1000's), by sector i
$INDUSN_i$,		The name given to each industrial sector (10 characters maximum)
$INMIGF_a$,	51, 53,	Number of inmigrating females by 1-year age class

Variable name	Pages	Definition
$INMIGM_a$,	51, 53,	Number of inmigrating males by 1-year age class
$INMIGR_j$,	67,	Fraction of any unfilled jobs (net of those filled by incommuters) which will be filled by inmigrants during the coming year, by occupation j
$INMIGOC_j$,	49, 59, 67,	Number of inmigrants, by occupation j
$INVLMA_i$,	27, 29,	Liquidity preference; i.e. the investment limit for accumulated net business income (fraction re-invested), by sector i
$INVLMC_i$,	27,	Leverage ratio; i.e. the investment limit for current net business income (borrowing power as a multiple of income), by sector i
$INVMAT_{k,i}$,	21,	Investment matrix: the fraction of sector k capital purchases supplied by capital-goods-producing sector i
IYB,	9,	Beginning year of simulation
IYE,	9,	Ending year of simulation
IYEAR,	9, 21, 23,	The "current year" of the simulation-i.e. the year for which present calculations and actions are occuring
LAYOFF,	73,	Layoffs by sector due to reduced production capacity
$LBFAGEG_g$,	61,	Number in labor force by age groups (g) 0-13 years, 14-15, 16-17, 18-19, 20-24, 25-29, 30-34, 35-44, 45-54, 55-59, 60-64, and 65+
$LBFOCUR_j$,	59, 61,	Fraction of the total labor force represented by each occupation j
LBFT,	59, 61,	Total labor force
$LEMAT_{i,j}$,	45, 83,	The $(I-A)^{-1}$ input-output matrix, also called the inverse or Leontief matrix.
$LFPARF_g$,	61,	Female labor force participation rates for 12 age groups (see LBFAGEG above)

Variable name	Pages	Definition
$LFPARFR_{g,v}$,	61,	Annual rate of change in $LFPARF_g$, for time intervals (v) 1970-79, 80-84, 85-89, and 1990+
$LFPARM_g$,	61,	Male labor force participation rates by age group (see LBFAGEG above)
$LFPARMR_{g,v}$,	61,	Annual rate of change in $LFPARM_g$ (see LFPARFR above)
$MEARPWK_i$,	73,	Wage freeze flag
MFBIRTR,	53,	Ratio of male births to total births
MFREQ1,	9, 13,	Interval by which the user may display data tables
MFREQ2,	9,	Interval by which the user may modify parameters
NAMER,		Name of region (first ten characters)
NAMER1,		Name of region (second 10 characters)
$NBUSINC_i$,	29, 37, 73,	Net business income for sector i, ($1000s)
NEMDEPR,	51,	National employee dependent rate; i.e. average population per member of the labor force who is age 20 or older
NIS,	21, 45, 59, 65,	Number of industrial sectors
$NMIGDIR_{a,s}$,	51,	Annual rate of change in $NMIGDIS_{a,s}$
$NMIGDIS_{a,s}$,	51,	Nation migration distribution; i.e. age-sex distribution of any net outmigrants from the region, by one-year age class a and sex s
NOC,	49, 59, 65,	Number of occupational groups
$NOCUP1_j$,		The first six characters of the given to occupational group j.
$NOCUP2_j$,		The rest of the name given to occupational group j.
$OCUP_{i,j}$,	59, 63, 65,	Industry-occupation matrix: the fraction of employment in industry i represented by occupation j

Variable name	Pages	Definition
$OTMIGOC_j$,	49, 59, 67,	Number of outmigrants by occupation j
$OTMIGR_j$,	67,	Fraction of any unemployed workers (net of those who out-commute) migrating out of the region in the coming year, by occupation j
$OUTMIGM_a$,	51, 53,	Number of outmigrating males, by one-year age class
$OUTMIGF_a$,	51, 53,	Number of outmigrating females, by one-year age class
$OUTPHW_i$,	57, 59,	Output per hour worked per worker, by sector i
$OUTPHWR_{i,v}$,	57,	Annual rate of change in $OUTPHW_i$ by time intervals (v) 1970-79, 80-84, 85-89, 90-94, and 1995+
$OUTPWK_i$,	57, 59, 63, 73,	Average annual output per worker, by sector i
$PACAP_i$,	35, 41,	Pollution abatement capital stock for each sector i ($1000's)
PCE_i,	19, 23, 41,	Personal consumption expenditure by sector i, ($1000's)
PCEM1,	23,	Personal consumption expenditure for the previous year by sector, ($1000s)
PCER,		Ratio of total disposable income not saved
PCESUBT,		Total personal consumption expenditure for output of regional sectors, ($1000's)
PCET,	21,	Total personal consumption expenditure (includes imports, in $1000's)
PCETM1,	21,	Total personal consumption expenditures for the year previous ($1000s)
PCHITR,	69,	Annual rate of change in $BUSTAXR_i$, by sector i
$PCHCOR_i$,		(Not currently used by IPASS)

Variable name	Pages	Definition
PI,	21, 23,39,	Rate of change in total personal consumption expenditures per wage earner
PIDITR,	21,	Ratio of disposable income to personal income
PIEARNR,	75,	Ratio of personal income to earnings
PIT,	21, 75,	Total base-year personal income
PITM1,	21,	Total personal income for the year prior to the base year
$POPF_a$,	49, 53, 55,	Female population, subdivided into 66 1-year age classes (age 0-1, 1-2,..., 64-65, and 65+)
POPFT,		Total female population
$POPM_a$,	49, 53, 55,	Male population, by age (see $POPF_a$)
POPMT,		Total male population
POPT,	21,	Total population
POPTM1,	21,	Total population for the previous year
$PRCAP_i$,	35, 41,	Production capital stock ($1000's), by sector i
PROPINR,		Ratio of total proprietors' income to total earnings
PT,	21, 23, 25, 39,	Annual rate of change in total population
$RCOMINR_j$,	63,	Annual rate of change in $COMINR_j$
$RCOMOTR_j$,	63,	Annual rate of change in $COMOUTR_j$
$REGIMPR_i$,	71,	Ratio of regional imports ($IMPORT_i$) to gross output (X_i), by sector i
$REGMKS_i$,	23,	Regional market share ($EXPORT_i$ as a fraction of $USGO_i$) for each sector i
$REGMKSR_i$,	23,	Annual rate of change in $REGMKS_i$
REMDEPR,	51,	Regional employee dependent rate, i.e. the average population per member of the regional labor force of age 20 or greater

Variable name	Pages	Definition
RFCEMP,	39,	Annual rate of change in FCEMP (federal civilian employment)
RINV,	31, 33,	Total replacement investment for sector, ($1000s)
$RINVPA_i$,	19, 29, 31, 33, 37,	Replacement investment in pollution-abatement capital (1000's), by sector
$RINVPR_i$,	19, 29, 31, 33, 37,	Replacement investment in production capital by sector i, ($1000's)
$RMIGDIR_{a,s}$,	51,	Annual rate of change in $RMIGDIS_{a,s}$
$RMIGDIS_{a,s}$,	51,	Fractional distribution, by single year of age and by sex, of any net outmigrants from the region
RNEMDEP,	51,	Annual rate of change in NEMDEPR
RREMDEP,	51,	Annual rate of change in REMDEPR
RSGEMP,	23, 39,	Annual rate of change of state and local employment, or expenditures, not related to population or income
SGEMP,	39,	State and local administrative-government employment
$SGOVE_i$	19, 25, 41,	State and local government purchases (in $1000's) from each sector i
SGOVET		Total state and local government purchases ($1000's)
$TMAX_i$	27, 29, 31, 33, 35,	Investment limit for sector i ($1000s)
TOTIN,	49, 51,	Total number of inmigrants over all occupations
TOTOUT,	49,51,	Total number of outmigrants over all occupations
TRANPYR,		Ratio of total transfer payments to total earnings
UNCOMPR,		Ratio of unemployment compensation to total earnings
$UNEMP_j$,	67,	Unemployment by occupational group j
$USERFD_i$,	25,	User-specified final demand by sector i, ($1000s)

Index and Glossary (Cont'd)

Variable name	Pages	Definition
$USERFDR_i$,	25,	Annual rate of change in user-specified final demand by sector i
$USGO_i$,	23,	U.S. Gross Output ($1000's), by sector i
$VALADR_i$,	71,	Ratio of value added to gross output (X_i), by sector i
$WKWPY_i$,	57, 59,	Average number of weeks worked per year per worker, by sector i
$WKWPYR_i$,	57,	Annual rate of change in $WKWPYR_i$
X_i,	23, 41, 47, 65, 67, 71, 83, 84,	Estimate of gross output ($1000's), by sector i
XD_i,	29, 31, 35, 45, 47,	Gross output required to satisfy final demand ($1000's), by sector i
XL_i,	65, 67,	Maximum gross output possible given current labor force (and capital stock) constraints ($1000's), by sector i
$XM1_i$,	23, 41,	Gross output for the previous year by sector i, ($1000s)
XPA,	43, 45,	Output capacity of pollution abatement for sector, ($1000s)
XPR,	43, 45,	Output capacity of production stock for sector, ($1000s)
XS_i,	29, 31, 35, 45, 47, 83, 84,	Maximum gross output possible given current capital stock constraints ($1000's), by sector i

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