Documentation For The Virginia Impact Projections Template

by

Paula M. Engel
Stephen C. Cooke*

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*Paula Engel is a Research Associate and Stephen Cooke is an Assistant Professor in the Department of Agricultural Economics and Rural Sociology, University of Idaho, Moscow, Idaho.

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Introduction

Local government leaders face difficult decisions concerning how to provide sufficient quantity and quality services demanded by constituents with the lowest possible tax burden. Decisions must be made on investments in infrastructure, allocating scarce resources to competing ends, development strategies, and tax structures for finding new and existing projects. The funds necessary to provide these services come from local government taxes, revenues and non local State and Federal aid.

Increasing demands for better services at higher levels of availability is the goal. However people are also expecting the lowest possible tax burden. State and Federal governments are also decreasing aid available to local governments. These trends coupled with uncertain demographic, fiscal, and economic conditions make economic and policy decisions particularly difficult.

Local governments are becoming aware of the need for accurate and complete information for improving the decision and policy making process. To address this need Tom Johnson and his graduate students at Virginia Polytechnic Institute developed a micro computer based fiscal impact model. The model provides decision makers a framework to use in planning for future public service needs under alternative economic scenarios. (Johnson)

Johnson et al. identified relationships between demographic, fiscal and economic conditions to construct the Virginia Impact Projection (VIP) model. Users supply the model specific data to simulate the impacts of various changes in the community. The model allows the user to predict future conditions with and without potential shocks such as plant closures, declines in enrollment, and changes in tax rates.

The equations and relationships implemented in the VIP model may seem overwhelming at first. Therefore a need existed to document and explain the equations used in the VIP template for other states to easily adapt the model. The general objective of this document is to provide potential VIP users a technical guide for understanding the system of equations used in the VIP scenario template. The following tasks are addressed in this paper to accomplish the overall objective of this paper.

1. To provide a map and explanation of the six major sections of the VIP model template. To provide the user a schematic of the model's sections, rows, and columns to illustrate the locations of titles, data, and equations. Section one of this document addresses this objective.

2. To provide a description and code for each variable within each section used in the VIP model. To identify the units and spreadsheet locations for the variables. The variables are organized according to dependent, independent, and the growth and change variables.

3. To describe the function and relationships that estimate each dependent variable. To provide a mathematical explanation for deriving the "independent" variables used in the function for the first and second iteration. This section lists the model section, where the calculation takes place, cell address, equation, and description for each step of the estimation. Section two of this document contains this information.

4. To describe the independent variables and provide a mathematical explanation for deriving each variable. This section lists the section of the model where the calculation takes place, cell address, equation, and description for each step of the estimation. This information is found in section three of this document.

SECTION ONE

THE "GEOGRAPHY" OF THE VIRGINIA IMPACT PROJECTIONS MODEL

Virginia Impact Projections Model Geography

Section one provides the user a general overview of the "geography" or layout of the VIP model. Figure one illustrates the sections of the Lotus 123 template used by VIP to predict fiscal impact up to nine years in the future. Each section is listed along with their cell addresses. Figure two is a schematic of the model which illustrates the locations of titles, data, and equations. The following is a brief description of each section.

Section one also contains the variables in which the user makes exogenous changes or establishes growth rates to simulate a scenario in question. Scenarios may simulate the effects of changes in economic, fiscal, or demographic circumstances within a county. For example the user creates a baseline scenario or without case by supplying data in lines 27 - 34. The baseline scenario projects future changes in the economic, fiscal or demographic circumstances under "normal" growth. The user creates the scenario in lines 5 - 26 that provides a "shock" to the economy. The subsequent growth shows the effects as the model moves toward a new equilibrium after the shock.

Section two contains data for the base year (column B) and nine year of projections (columns C-K) for the different categories of variables. These data are in total values. This section contains a without sub-section. The without sub-section allows users to compare the scenario with to a without change scenario.

Section three is similar to section two except per capita values are reported. Section three also contains variables included for computational reasons, for example population squared. Users are required to supply one column of data of baseline data in column B in both of these sections. The model generates the remaining data in columns C-K (one column for each projected year) using the growth rates supplied by the user in section one. Section three contains a without sub-section similar to section two.

Section four is a summary or bottom line section that identifies the tax burden faced by the county. This section also contains a without sub-section. The without sub-section allows users to compare the scenario with changes to a scenario without changes.

Section five contains econometrically calculated coefficients that link the dependent and independent variables. These coefficients are based on cross sectional data for Virginia counties. Column A lines 165-192 contain the dependent variables. Row 165 contains the independent variables. Data appearing in the B165-BE192 matrix are the coefficients for independent variables that statistically effect the dependent variables.

Section six describes the changes between the initial year and each of the nine projected subsequent years. This section contains 30 rows for each year projected. Line 195 contains the change in independent variables. The remainder of the matrix contains the products of the econometrically calculated coefficients found in section five and the changes in row 195. VIP sums across rows of dependent variables to determine the net effect of the independent variables in any year. Section six contains nine separate blocks for each of the years projected in the model.

Figure 1 - Virginia Impact Projections Model Geography Map

Titles

A1......C1*

.

.

A4

Section One - Scenerio Section

A5......L5

.

.

A34

Section Two - Total	Without
A39......K39	AC39........AK39
.	.
.	.
A76	AC76

Section Three - Per Capita	Without
A79......K79	AC79........AK79
.	.
.	.
A149	AC149

Section Four - Summary	Without
A153......K153	AC153........AK153
.	.
.	.
A161	AC159

Section Five - Coefficients

A164......BB164

.

.

A192

Section Six - Delta

A195......BB195

.

.

A223

---

* Note: the letters under each section title stand for Lotus 123 cell addresses.

Figure 2 - Virginia Impact Projections model section, row, and column schematic.

Section	Row	Column													
		A	B	C	D	E	F	G	H	I	J	K	L	....	BB
Titles	1	T	T	T											
	.	T		T											
	3	T													
1. Scenerio	4			Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9		
(change data)	5	T	T	D	D	D	D	D	D	D	D	D	D		
	.														
(growth rates)	27	T	T	D	D	D	D	D	D	D	D	D	D		
	.														
	34	T	T	D	D	D	D	D	D	D	D	D	D		
	35	BLANK ROW													
	36	BLANK ROW													
2. Total	37	T	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9			
	38	BLANK ROW													
	39	T	D	E	E	E	E	E	E	E	E	E			
	.														
	76	T	D	E	E	E	E	E	E	E	E	E			
3. Per Capita	77	BLANK ROW													
	78	BLANK ROW													
	79	T	D	E	E	E	E	E	E	E	E	E			
	.														
	149	T	D	E	E	E	E	E	E	E	E	E			
4. Summary	150	BLANK ROW													
	151	T	T												
	152	BLANK ROW													
	153	T	E	E	E	E	E	E	E	E	E	E			
	.														
	161	T	E	E	E	E	E	E	E	E	E	E			
5. Coefficients	162	T	T												
	163	BLANK ROW													
	164	T	T	T	T	T	T	T	T	T	T	T		....	T
	165	T	D	D	D	D	D	D	D	D	D	D		....	D
	.														
	192	T	D	D	D	D	D	D	D	D	D	D		....	D

where:

A-BB = columns found in the Lotus 123 template.
T = Titles
D = Data
E = Equations
Yt = Years

Figure 2 cont. - Virginia Impact Projections model section, row, and column schematic.

Section	Row	Column
		A B C D E F G H I J K L . . . . BB
6. Delta	193	BLANK ROW
	194	T Y1
	195	T E E E E E E E E E E . . . . E
	:	
	223	T E E E E E E E E E E . . . . E
	224	T Y2
	225	T E E E E E E E E E E . . . . E
	:	
	253	T E E E E E E E E E E . . . . E
	254	T Y3
	255	T E E E E E E E E E E . . . . E
	:	
	283	T E E E E E E E E E E . . . . E
	284	T Y4
	285	T E E E E E E E E E E . . . . E
	:	
	313	T E E E E E E E E E E . . . . E
	314	T Y5
	315	T E E E E E E E E E E . . . . E
	:	
	343	T E E E E E E E E E E . . . . E
	344	T Y6
	345	T E E E E E E E E E E . . . . E
	:	
	373	T E E E E E E E E E E . . . . E
	374	T Y7
	375	T E E E E E E E E E E . . . . E
	:	
	403	T E E E E E E E E E E . . . . E
	404	T Y8
	405	T E E E E E E E E E E . . . . E
	:	
	433	T E E E E E E E E E E . . . . E
	434	T Y9
	435	T E E E E E E E E E E . . . . E
	:	
	463	T E E E E E E E E E E . . . . E

where:

A-BB = columns found in the Lotus 123 template.
T = Titles
D = Data
E = Equations
Yt = Years

SECTION TWO

VARIABLES USED BY THE VIRGINIA IMPACT PROJECTIONS MODEL

Table 1 - Section One or Scenerio Section of the Virginia Impact Projection Model.

Row Numbers (Columns C-L)	Row Titles (Columns A-B)	Cell Code	Units
5	change in county population	CHCPOP	percent
6	change in county area	CHCA	percent
7	change in county base employment	CHCBEMP	percent
8	change in total employment	CHEMP	percent
9	change in town population	CHTPOP	percent
1	change in contiguous employment	CHCGEMP	percent
11	change in contiguous laborforce	CHCGLAB	percent
12	change in school enrollment	CHENRL	percent
13	change in real property taxbase	CHRPTPC	percent
14	change in pers property taxbase	CHPPTPC	percent
15	change in per capita income	CHIPC	percent
16	change in grads per 100	CHG100	percent
17	change in teachers per pupil	CHTPC	percent
18	change in sales per capita	CHSLSPC	percent
19	change in mortality	CHMOR	percent
20	change in percent non white	CHPNW	percent
21	change in fire protection rate	CHFPR	percent
22	change in crime	CHC	percent
23	change in solved crime	CHSC	percent
24	change in pro/vol rating	CHRVPF	percent
25	change in federal aid	CHFA	percent
26	response to change in fed aid	RCFA	percent
27	contiguous employment growth rate	CGEMPGR	percent
28	county base employment growth rate	CBEMPGR	percent
29	town population growth rate	TPOPGR	percent
30	contiguous laborforce growth rate	CGLABGR	percent
32	real per capita income growth rate	RIPCGR	percent
33	number of unemployed	UNEMP	persons
34	marginal multiplier (base employment multiplier)	MM	

Table 2 - Section Two or Total Variables Section of the Virginia Impact Projection Model.

Row Numbers (Columns C-K)	Row Titles (Column A)	Cell Code	Units
-----Dependent Variables-----			
39	population	POP	persons
40	laborforce	LABF	persons
41	number of outcommuters	OUT	persons
42	number of incommuters	INC	persons
43	enrollment	ENRL	students
44	real property taxbase	RPT	dollars
45	personnel property taxbase	PPT	dollars
46	public works expenditures	PWE	dollars
47	court expenditures	CRE	dollars
48	police expenditures	PLE	dollars
49	administration expenditures	ADE	dollars
50	recreation expenditures	RCE	dollars
51	welfare expenditures	WE	dollars
52	per pupil expenditures	EDE	dollars
53	development expenditures	DE	dollars
54	sales tax revenues	STR	dollars
55	other tax revenues	OTR	dollars
56	jail expenditures	JE	dollars
57	mental health and health	MHE	dollars
58	fire expenditures	FE	dollars
59	non local public work aid	NLPWA	dollars
60	non local court aid	NLCRA	dollars
61	non local public safety aid	NLPS	dollars
62	non local administration aid	NLADA	dollars
63	non local recreation aid	NLRCA	dollars
64	non local health and welfare aid	NLHW	dollars
65	non local education aid	NLED	dollars
66	non local development aid	NLDA	dollars
-----Independent Variables-----			
67	non local miscellaneous	NLMISC	dollars
68	town population	TPOP	persons
69	residentiary employment	RE	persons
70	number of businesses	BUS	businesses
71	total federal aid	FA	dollars
72	total state aid	SA	dollars
73	actual total aid federal and state	ATA	dollars
74	predicted total aid federal and state	PTA	dollars
75	actual ratio of federal aid:total aid	AFA	dollars
76	base employment	BEMP	persons

Table 3 - Section Three or Per Capita Variables Section of the Virginia Impact Projection Model.

Row Numbers (Columns C-K)	Row Titles (Column A)	Cell Code	Units
-----Dependent Variables-----			
79	population	POP	persons
80	laborforce	LABF	persons
81	number of outcommuters	OUTPC	persons/person
82	number of incommuters	INCPC	persons/person
83	enrollment	ENRL	students
84	real property taxbase	RPTPC	dollars/person
85	personnel property taxbase	PPTPC	dollars/pers
86	public works expenditures	PWEPC	dollars/person
87	court expenditures	CREPC	dollars/pers
88	police expenditures	PLEPC	dollars/person
89	administration expenditures	ADEPC	dollars/person
90	recreation expenditures	RCEPC	dollars/person
91	welfare expenditures	WEPC	dollars/pers
92	per pupil expenditures	EDEPC	dollars/person
93	development expenditures	DEPC	dollars/pers
-----Independent Variables-----			
94	population sqaured	POPSQ	persons
95	population density	POPD	persons/miles
96	percent change in population	PCHPOP	percent person
97	percent population in towns	PTPOP	percent town pop/persons
98	percent population in towns squared	TPOPSQ	percent town pop/persons
99	unemployment rate	UR	number unemployed/laborforce
100	graduates per 100 population	G100	graduates/100 persons
101	percent non white	PNW	nonwhite/population
102	mortality	MOR	deaths/persons
103	employment	EMP	persons
104	employment per capita	EMPPC	employment/person
105	residentiary employment	REMPPC	persons
106	per capita income	IPC	income/person
107	per capita income squared	IPCSQ	income/person
108	number of businesses	BUSPC	businesses/person
109	sales	SLS	dollars
110	sales per capita	SLSPC	dollars/person
113	enrollment sqaured	ENRLSQ	persons
114	percent change enrollment	PCHENRL	persons
115	instructor personnel/1000	IP1000	instructers/1000
116	square miles in county	MISQC	miles
117	square miles per capita	MISQPC	miles/person
118	solved crimes per capita	SCPC	solved crimes/person
119	crimes per capita	CPC	crimes/person
120	fire protection rating	FPR	rating
121	ratio of volunteer/professional firemen	RVPF	volunteer/professionals
122	development groups	DG	groups
123	miles to SMSA	SMSA	miles
124	total local government expenditures per capita	LGEPC	dollars/person
125	total federal aid per capita	FAPC	dollars/person

Table 3 cont. - Section Three or Per Capita Variables Section of the Virginia Impact Projection Model.

Row Numbers (Columns C-K)	Row Titles (Column A)	Cell Code	Units
126	public safety expense per capita	PSEPC	dollars/person
127	contiguous laborforce	CGLAB	persons
128	contiguous employment	CGEMP	persons
129	outcommuters per capita	OUTPC	outcommuters/person
130	incommuters per capita	INCPC	incommuters/person
131	number of unemployed	UEMP	persons
-----Dependent Variables-----			
134	sales tax revenues	STRPC	dollars/person
135	other tax revenues	OTRPC	dollars/person
136	jail expenditures	JEPC	dollars/person
137	mental health and health	MHEPC	dollars/person
138	fire expenditures	FEPC	dollars/person
139	non local public work aid	NLPWAPC	dollars/person
140	non local court aid	NLCRAPC	dollars/person
141	non local public safety aid	NLPSPC	dollars/person
142	non local administration aid	NLADAPC	
143	non local recreation aid	NLRCAPC	dollars/person
144	non local health and welfare aid	NLHWPC	dollars/person
145	non local education aid	NLEDAPC	dollars/person
146	non local development aid	NLDAPC	dollars/person
-----Independent Variables-----			
147	constant cost service	CCS	dollars/person
148	total expense per capita	TEPC	dollars/person
149	quantity quality change	QQCH	

Table 4 - Section Four or Summary Section of the Virginia Impact Projection Model.

Row Numbers (Columns C-K)	Row Titles (Column A)	Cell Code	Units
153	total expenditures	TE	dollars
154	total non local aid	ATA	dollars
155	sales tax revenues	STR	dollars
156	other tax revenues	OTR	dollars
157	local tax burden	LTB	dollars
158	property tax base	PTB	dollars
159	proxy tax burden	TB	dollars
160	bottom line (cash flow)	BLCF	dollars
161	bottom line (constant quality)	BLCQ	dollars

Table 15 - System of equations used by the VIP model to calculate ADMINISTRATION EXPENDITURES PER CAPITA. y = f(OUTPC, LGEPC, and FAPC)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION:-----			
(2)	B49		Total Administration Expenditures (base year)
(3)	B89		per capita Administration Expenditures (base year)
(3)	B89	@if(M89>0,M89,0)	
	M89	B49/B79	
(3)	B79	Input Value	population per capita
-----SECOND ITERATION:-----			
(3)	C89	@if(N89>0,N89,0)	per capita administration expenditure (t+1 year)
	N89	B89+@SUM(B206..BE206)	
-----OUTPC-----			
(6)	AH206	AH175*AH195	outcommuters per capita
(see Table 7 for system of equations)			
-----LGEPC-----			
(6)	AU206	AU175*AU195	total expenditures
(5)	AU175	econometrically calculated	coefficient admin exp/total expenditures
(6)	AU195	C124-B124	difference in total expenditures between base and t+1 years
(3)	B124	(B58+B50+B56+B48+B57+B51 +B47+B53+B46)/B79 (base year)	total local government expenditures
(2)	B58	Input Value	fire protection expenditure (base year)
(2)	B50	Input Value	parks and rec expenditure (base year)
(2)	B56	Input Value	correction and detention expense (base year)
(2)	B48	Input Value	police expenditure (base year)
(2)	B57	Input Value	health expenditure (base year)
(2)	B51	Input Value	welfare expenditure (base year)
(2)	B47	Input Value	court expenditure (base year)
(2)	B53	Input Value	development expenditure (base year)
(2)	B46	Input Value	public works expenditures (base year)
-----FAPC-----			
(6)	AV206	AV175*AV195*D26	total federal aid
(5)	AV175	econometrically calculated	coefficient public works/tot fed aid
(6)	AV195	C125-B125	difference in total federal aid between base and t+1 years
(1)	D26	Input Value	response to change in federal aid
(3)	C125	C71/C79	total federal aid (t+1 year)
(2)	C71	(B75*B74)+C25	total federal aid (t+1 year)
(2)	C25	Input Value	change in federal aid
(2)	B74	@sum(B59..B67)	predicted total aid (federal and state)
(2)	B75	B71/B73	actual federal aid (base year)
(2)	B71	Input Value	total federal aid (base year)
(2)	B73	B74	actual total aid (base year)

Explanation of Table 15 - System of equations used by the VIP model to calculate ADMINISTRATION EXPENDITURES PER CAPITA.

Variable Descriptions:

Administration expenditures per capita are a function of outcommuters, total local government expenditures, and total federal aid.

1) $ADEPC = \alpha_0 + \beta_1 OUTPC + \beta_2 LGEPC + \beta_3 FAPC$

where α_0, β_1, β_2, and β_3 are econometrically estimated coefficients. These estimates are found in section five of the model.

Total level of government services is expected to have a positive relationship with administrative expenditures. This relationship is hypothesized because administrative services are not tied to any particular service. Government support or total federal aid positively effects administrative expenses. It is expected that areas with large numbers of outcommuters have a unique demand for administrative services therefore a positive relationship may exist. Income is expected to positively effect administrative expenses. (Keeling)

Derivation:

Using the total derivative of the administration expenditures per capita function (equation 1) the model calculates the rate of change (dADEPC) between the initial year (ADEPC1) and the subsequent year (ADEPC2) (equation 2).

2) $dADEPC = \beta_1 dOUTPC + \beta_2 dLGEPC + \beta_3 FAPC$

The model calculates dOUTPC, dLGEPC, and dFAPC as the difference between the initial user supplied values (OUTPC1, LGEPC1, and FAPC1) and the second iteration values (OUTPC2, LGEPC2, and FAPC2) for each independent variable in the function (equation 3).

3) OUTPC2 - OUTPC1 = dOUTPC
LGEPC2 - LGEPC1 = dLGEPC
FAPC2 - FAPC1 = dFAPC

where dOUTPC, dLGEPC, and dFAPC are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dADEPC or the rate of change between the initial year (ADEPC1) and the second iteration (ADEPC2) for the dependent variable, administration expenditures per capita (equation 2). This addition takes place in section three of the model. The total rate of change (dADEPC), for the administration expenditures per capita function, is added to the initial values (ADEPC1) resulting in the projected administration expenditures per capita value (ADEPC2) in the second iteration (equation 4).

4) ADEPC2 = dADEPC + ADEPC1

Future values for the subsequent year (ADEPC3) are calculated in the same manner, except the ADEPC2 values are used in place of the user supplied initial values (ADEPC1).

Table 16 - System of equations used by the VIP model to calculate RECREATION EXPENDITURES PER CAPITA. y = f(POP, RPTPC, POPSQ, PTPOP, IPC, INCPC, and FAPC)

Model Section	Cell Address	Equation	Variable Description
FIRST ITERATION:			
(2)	B50		Total Parks and Recreation (base year)
(3)	B90		per capita Parks and Recreation Expenditure (base year)
(3)	B90	@if(M90>0,M90,0)	
	M90	B50/B79	
(3)	B79	Input Value	population per capita
SECOND ITERATION:			
(3)	C90	@if(N90>0,N90,0)	per capita Parks and Recreation Expenditure
	N90	B90+@SUM(B207..BE207)	
POP			
(6)	B207	B176*B195	population
(see Table 6 for system of equations)			
RPTPC			
(6)	G207	G176*G195	real property taxbase
(see Table 10 for system of equations)			
POPSQ			
(6)	Q207	Q176*G195	population^2
(see Table 6 for system of equations)			
PTPOP			
(6)	T205	T174*T195	town percentage
(5)	T174	econometrically calculated	coefficient police expenditure/town percentage
(6)	T195	C97-B97	difference in percent population in town between base and t+1 years
(3)	B97	B68/B79*100	percent population in town (base year)
(2)	B68	Input Value	town population (base year)
(3)	B79	Input Value	population (base year)
(3)	C97	C68/C79*100	percent population in town (t+1 year)
(2)	C68	((1+C29/100)*B68)+C9	town population (t+1 year)
(3)	C79	B79 + @sum(B196..BE196)	population (t+1 year)
(1)	C29	Input Value	town population growth rate
(1)	C9	Input Value	change town population
IPC			
(6)	AC207	AC176*AC195	per capita income
(5)	AC176	econometrically calculated	coefficient recreation/per capita income
(6)	AC195	C106-B106	difference in per capita income between base and t+1 years
(3)	C106	(B106*(1+C32/100))+C15	per capita income (t+1 year)
(3)	B106	Input Value	per capita income (base year)
INCPC			
(6)	AI207	AI176*AI195	incommuters per capita
(see Table 8 for system of equations)			
FAPC			
(6)	AV207	AV176*AV195*D26	total federal aid
(5)	AV176	econometrically calculated	coefficient public works/tot fed aid
(6)	AV195	C125-B125	difference in total federal aid between base and t+1 years

Table 16 cont. - System of equations used by the VIP model to calculate RECREATION PER CAPITA. y = f(POP, RPTPC, POPSQ, PTPOP, IPC, INCPC, and FAPC)

Model Section	Cell Address	Equation	Variable Description
-----SECOND ITERATION:-----			
(1)	D26	Input Value	response to change in federal aid
(3)	C125	C71/C79	total federal aid (t+1 year)
(2)	C71	(B75*B74)+C25	total federal aid (t+1 year)
(1)	C25	Input Value	change in federal aid
(2)	B74	@sum(B59..B67)	predicted total aid (federal and state)
(2)	B75	B71/B73	actual federal aid (base year)
(2)	B71	Input Value	total federal aid (base year)
(2)	B73	B74	actual total aid (base year)

Explanation of Table 16 - System of equations used by the VIP model to calculate RECREATION EXPENDITURES PER CAPITA

Variable Descriptions:

Recreation expenditures per capita are a function of population, real property taxbase per capita, population squared, percent town population, per capita income, incommuters per capita, and total federal aid.

1) $RCEPC = \alpha_0 + \beta_1 POP + \beta_2 RPTPC + \beta_3 POPSQ + \beta_4 PTPOP + \beta_5 PTPOP + \beta_6 IPC + \beta_7 OUTPC + \beta_8 INCPC + \beta_9 FAPC$

where α_0, β_1, β_2, β_3, β_4, β_5, β_6, β_7, β_8, and β_9 are econometrically estimated coefficients. These estimates are found in section five of the model.

Population indicates recreations relationship with economies of scale. Wealth generates a greater demand for recreation therefore per capita income and real property per capita positively influence recreation expenditures. Incommuters utilize recreation in the areas they commute indicating a positive relationship with recreation expenditures. Federal aid has a positive relationship with recreation expenditures. (Keeling)

Derivation:

Using the total derivative of the recreation expenditures per capita function (equation 1) the model calculates the rate of change (dRCEPC) between the initial year (RCEPC1) and the subsequent year (RCEPC2) (equation 2).

2) $dRCEPC = \beta_1 dPOP + \beta_2 dRPTPC + \beta_3 dPOPSQ + \beta_4 dPTPOP + \beta_5 dPTPOP + \beta_6 dIPC + \beta_7 dOUTPC + \beta_8 dINCPC + \beta_9 dFAPC$

The model calculates dPOP, dRPTPC, dPOPSQ, dPTPOP, dIPC, dOUTPC, dINCPC, and dFAPC as the difference between the initial user supplied values (POP1, RPTPC1, POPSQ1, PTPOP1, IPC1, OUTPC1, INCPC1 and FAPC1) and the second iteration values (POP2, RPTPC2, POPSQ2, PTPOP2, IPC2, OUTPC2, INCPC2, and FAPC2) for each independent variable in the function (equation 3).

3) POP2 - POP1 = dPOP
RPTPC2 - RPTPC1 = dRPTPC
POPSQ2 - POPSQ1 = dPOPSQ
PTPOP2 - PTPOP1 = dPTPOP
IPC2 - IPC1 = dIPC

OUTPC2 - OUTPC1 = dOUTPC
INCPC2 - INCPC1 = dINCPC
FAPC2 - FAPC1 = dFAPC

where dPOP, dRPTPC, dPOPSQ, dPTPOP, dIPC, dOUTPC, dINCPC, and dFAPC are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dRCEPC or the rate of change between the initial year (RCEPC1) and the second iteration (RCEPC2) for the dependent variable, recreation expenditures per capita (equation 2). This addition takes place in section three of the model. The total rate of change (dRCEPC), for the recreation expenditures per capita function, is added to the initial values (RCEPC1) resulting in the projected recreation expenditures per capita value (RCEPC2) in the second iteration (equation 4).

4) RCEPC2 = dRCEPC + RCEPC1

Future values for the subsequent year (RCEPC3) are calculated in the same manner, except the RCEPC2 values are used in place of the user supplied initial values (RCEPC1).

Table 17 - System of equations used by the VIP model to calculate WELFARE EXPENDITURES PER CAPITA. y = f(UEMP, PNW, IPC, INCPC, and FAPC)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION:			
(2)	B51		Total Welfare Exp
(3)	B91		per capita Welfare Exp
(3)	B91	@if(M91>0,M90,0)	
	M91	B51/B79	
-----SECOND ITERATION:			
(3)	C91	@if(N91>0,N91,0)	
	N91	B91+@SUM(B208..BE208)	
-----UEMP			
(6)	V208	V177*V195	percent unemployment
(5)	V177	econometrically calculated	coefficient welfare/unemployment
(6)	V195	C99-B99	difference in the unemployment rate between base and t+1 years
(3)	B99	B131/B80*100	unemployment rate (base year)
(3)	B131	Input Value	number of unemployed (base year)
(3)	B80	Input Value	laborforce (base year)
(3)	C99	C131/C80*100	unemployment rate (t+1 year)
(3)	C131	C33	number unemployed
(1)	C33	Input Value	marginal multiplier
(3)	C80	see Table 6 for system of equations	
-----PNW			
(6)	X208	X177*X195	percent non white population
(5)	X177	econometrically calculated	coefficient welfare/percent non white population
(6)	X195	C101-B101	difference in percent non white population between base and t+1 years
(3)	B101	Input Value	percent non white (base year)
(3)	C101	B101+C20	percent non white (t+1 year)
(1)	C20	Input Value	change in percent non white population
-----IPC			
(6)	AC208	AC179*AC195	per capita income
(5)	AC179	econometrically calculated	coefficient per cap admin exp/per cap income
(6)	AC195	C106-B106	difference in per capita income between base and t+1 years
(3)	C106	(B106*(1+C32/100))+C15	per capita income
(3)	B106	Input Value	per capita income (base year)
(1)	C32	Input Value	real per capita income growth rate
(1)	C15	Input Value	change in per capita income
(6)	AI208	AI177*AI195	incommuters per capita
(see Table 8 for system of equations)			
-----INCPC			
(6)	AI207	AI176*AI195	incommuters per capita
(see Table 8 for system of equations)			
-----FAPC			
(6)	AV208	AV177*AV195*D26	total federal aid
(5)	AV176	econometrically calculated	coefficient public works/tot fed aid
(6)	AV195	C125-B125	difference in total federal aid between base and t+1 years

Table 17 cont. - System of equations used by the VIP model to calculate WELFARE EXPENDITURES PER CAPITA.
y = f(POP, PPTPC, POPSQ, UEMP, PNW, EMPPC, IPC INCPC, and FAPC)

Model Section	Cell Address	Equation	Variable Description
-----SECOND ITERATION:-----			
(1)	D26	Input Value	response to change in federal aid
(3)	C125	C71/C79	total federal aid (t+1 year)
(2)	C71	(B75*B74)+C25	total federal aid (t+1 year)
(1)	C25	Input Value	change in federal aid
(2)	B74	@sum(B59..B67)	predicted total aid (federal and state)
(2)	B75	B71/B73	actual federal aid (base year)
(2)	B71	Input Value	total federal aid (base year)
(2)	B73	B74	actual total aid (base year)

Explanation of Table 17 - System of equations used by the VIP model to calculate WELFARE EXPENDITURES PER CAPITA.

Variable Descriptions:

Welfare expenditures per capita are a function of percent unemployment, percent non white population, per capita income, incommuters per capita, and total federal aid.

1) $WEPC = \alpha_0 + \beta_1 UR + \beta_2 PNW + \beta_3 IPC + \beta_4 INCPC + \beta_5 FAPC$

where α_0, β_1, β_2, β_3, β_4, and β_5 are econometrically estimated coefficients. These estimates are found in section five of the model.

Unemployment rate, personal property per capita, and per capita income proxy for the economic conditions in an area. Welfare expenditures decrease as employment, personal wealth and income rise. Minorities generally receive higher amounts of welfare. (Washington Post, Jan. 19, 1986) Federal aid is positively related to welfare expenditures. Greater numbers of incommuters is hypothesized to increase welfare expenditures. (Keeling)

Derivation:

Using the total derivative of the welfare expenditures per capita function (equation 1) the model calculates the rate of change (dWEPC) between the initial year (WEPC1) and the subsequent year (WEPC2) (equation 2).

2) $dWEPC = \beta_1 dPOP + \beta_2 dPPTPC + \beta_3 dPOPSQ + \beta_4 dUR + \beta_5 dPNW + \beta_6 dEMPPC + \beta_7 dIPC + \beta_8 dINCPC + \beta_9 dFAPC$

The model calculates dUR, dPNW, dIPC, dINCPC, and dFAPC as the difference between the initial user supplied values (UR1, PNW1, IPC1, INCPC1 and FAPC1) and the second iteration values (UR2, PNW2, IPC2, INCPC2, and FAPC2) for each independent variable in the function (equation 3).

3) UR2 - UR1 = dUR
PNW2 - PNW1 = dPNW
IPC2 - IPC1 = dIPC
INCPC2 - INCPC1 = dINCPC
FAPC2 - FAPC1 = dFAPC

where dUR, dPNW, dIPC, dINCPC, and dFAPC are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dWEPC or the rate of change between the initial year (WEPC1) and the second iteration (WEPC2) for the dependent variable, welfare expenditures per capita (equation 2). This addition takes place in section three of the model. The total rate of change (dWEPC), for the welfare expenditures per capita function, is added to the initial values (WEPC1) resulting in the projected welfare expenditures per capita value (WEPC2) in the second iteration (equation 4).

4) $WEPC2 = dWEPC + WEPC1$

Future values for the subsequent year (WEPC3) are calculated in the same manner, except the WEPC2 values are used in place of the user supplied initial values (WEPC1).

Table 18 - System of equations used by the VIP model to calculate EDUCATIONAL EXPENDITURES. y = f(ENRL, IPC, ENRLSQ, PCHENRL, I1000, and FAPC)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION:-----			
(2)	B52		Total Education Expenses (base year)
(3)	B92		per pupil Education Expenses (base year)
(3)	B92	@if(M92>0,M92,0)	
	M92	B52/B83	
(2)	B83	Input Value	enrollment
-----SECOND ITERATION:-----			
(3)	C92	@if(N92>0,N92,0)	
	N92	B92+@SUM(B209..BE209)	
-----ENRL-----			
(6)	F209	F178*F195	enrollment
(see Table 9 for system of equations)			
-----IPC-----			
(6)	AC209	AC178*AC195	per capita income
(5)	AC178	econometrically calculated	coefficient per cap admin exp/per cap income
(6)	AC195	C106-B106	difference in per capita income between base and t+1 years
(3)	C106	(B106*(1+C32/100))+C15	per capita income (t+1 year)
(3)	B106	Input Value	per capita income (base year)
(1)	C32	Input Value	real per capita income growth rate
(1)	C15	Input Value	change in per capita income
-----ENRLSQ-----			
(6)	AJ209	AJ178*AJ195	enrollment^2
(see Table 9 for system of equations)			
-----PCHENRL-----			
(6)	AK209	AK178*AK195	percent change enrollment
(5)	AK178	econometrically calculated	coefficient educational exp/enrollment
(6)	AK195	C114-B114	percent change in enrollment (base year)
(3)	B114	Input Value	percent change in enrollment (base year)
(3)	C114	(C83-B83)/B83*100	percent change in enrollment (t+1 year)
(3)	C83	see Table 9 for system of equations	enrollment (t+1 year)
-----I1000-----			
(6)	AL209	AL178*AL195	instructors per 1000 pupils
(5)	AL178	econometrically calculated	coefficient educational exp/instructors per 1000 pupils
(6)	AL195	C115-B115	difference in instructor pers/1000 between base and t+1 years
(3)	B115	Input Value	instructors per 1000 pupil (base year)
(3)	C115	B115+C17	instructors per 1000 pupils (t+1 year)
(1)	C17	Input Value	change in teacher/pupil ratio
-----FAPC-----			
(6)	AV209	AV178*AV195*D26	total federal aid
(5)	AV176	econometrically calculated	coefficient public works/tot fed aid
(6)	AV195	C125-B125	difference in total federal aid between base and t+1 years
(1)	D26	Input Value	response to change in federal aid
(3)	C125	C71/C79	total federal aid (t+1 year)

Table 18 cont. - System of equations used by the VIP model to calculate EDUCATIONAL EXPENDITURES. y = f(ENRL, RPTPC, EMPPC, IPC, OUTPC, ENRLSQ, PCHENRL, I1000, and FAPC)

Model Section	Cell Address	Equation	Variable Description
-----SECOND ITERATION:			
(2)	C71	(B75*B74)+C25	total federal aid (t+1 year)
(1)	C25	Input Value	change in federal aid
(2)	B74	@sum(B59..B67)	predicted total aid (federal and state)
(2)	B75	B71/B73	actual federal aid (base year)
(2)	B71	Input Value	total federal aid (base year)
(2)	B73	B74	actual total aid (base year)

Explanation of Table 18 - System of equations used by the VIP model to calculate EDUCATIONAL EXPENDITURES.

Variable Descriptions:

Per pupil expenditures are a function of enrollment, per capita income, enrollment squared, percent change in enrollment, instructors per 1000, total federal aid.

1) $EDEPC = \alpha_0 + \beta_1 ENRL + \beta_2 IPC + \beta_3 ENRLSQ + \beta_4 PCHENRL + \beta_5 IP1000 + \beta_6 FAPC$

where α_0, β_1, β_2, β_3, β_4, β_5, and β_6 are econometrically estimated coefficients. These estimates are found in section five of the model.

Education expenditures are thought to be positively related to population. Per pupil expenditures lag behind shifts resulting in optimal levels of spending. Therefore it is difficult to vary expenditures resulting in enrollment changes. Educational expenditures increase with higher quality instruction. Instruction Personnel per 1000 pupils proxies for quality. Affluence may cause increased demand for quality education. This hypothesis is tested by the per capita income.. Education depends heavily on federal mandates therefore a positive relationship between federal aid and education is expected. Employers seek out well educated workers. Employment opportunities increased the need for higher quality education. (Keeling)

Derivation:

Using the total derivative of the per pupil expenditures function (equation 1) the model calculates the rate of change (dEDEPC) between the initial year (EDEPC1) and the subsequent year (EDEPC2) (equation 2).

2) $dEDEPC = \beta_1 dENRL + \beta_2 dIPC + \beta_3 dENRLSQ + \beta_4 dPCHENRL + \beta_5 dIP1000 + \beta_6 dFAPC$

The model calculates dENRL, dIPC, dENRLSQ, dPCHENRL, dIP1000, and dFAPC as the difference between the initial user supplied values (ENRL1, IPC1, ENRLSQ1, PCHENRL1, IP10001, AND FAPC1) and the second iteration values (ENRL2, IPC2, ENRLSQ2, PCHENRL2, IP10002, and FAPC2) for each independent variable in the function (equation 3).

3) ENRL2 - ENRL1 = dENRL
IPC2 - IPC1 = dIPC
ENRLSQ2 - ENRLSQ1 = dENRLSQ
PCHENRL2 - PCHENRL1 = dPCHENRL
IP10002 - IP10001 = dIP1000
FAPC2 - FAPC1 = dFAPC

where dENRL, dIPC, dENRLSQ, dPCHENRL, dIP1000, and dFAPC are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dEDEPC or the rate of change between the initial year (EDEPC1) and the second iteration (EDEPC2) for the dependent variable, per pupil expenditures (equation 2). This addition takes place in section three of the model. The total rate of change (dEDEPC), for the per pupil expenditures function, is added to the initial values (EDEPC1) resulting in the projected per pupil expenditures value (EDEPC2) in the second iteration (equation 4).

4) EDEPC2 = dEDEPC + EDEPC1

Future values for the subsequent year (EDEPC3) are calculated in the same manner, except the EDEPC2 values are used in place of the user supplied initial values (EDEPC1).

Table 19 - System of equations used by the VIP model to calculate DEVELOPMENT EXPENSES PER CAPITA. y = f(IPC, OUTPC, INCPC, DG, and FAPC)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION:			
(2)	B53		Total Development Expenditure (base year)
(3)	B93		per capita Development Expenditure (base year)
(3)	B93	@if(M93>0,M93,0)	
	M93	B93/B79	
(3)	B79	Input Value	population per capita (base year)
-----SECOND ITERATION:			
(3)	C93	@if(N93>0,N93,0)	per capita Development Aid (t+1 year)
	N93	@SUM(B210..BE210)	
-----IPC			
(6)	AC210	AC179*AC195	per capita income (t+1 year)
(5)	AC179	econometrically calculated	coefficient development/per cap income
(6)	AC195	C106-B106	difference in per capita income between base and t+1 years
(3)	C106	(B106*(1+C32/100))+C15	per capita income (t+1 year)
(3)	B106	Input Value	per capita income (base year)
(1)	C32	Input Value	real per capita income growth rate
(1)	C15	Input Value	change in per capita income
(3)	C110	C109/C79	sales per capita (t+1 year)
(3)	C109	C54*100	sales
(3)	C79	B79+@sum(B196..BE196)	population (t+1 year)
(2)	C54	C134*B39	sales tax revenue (t+1 year)
(3)	C134	B134+@sum(B211..BE211)	sales tax per capita (t+1 year)
(2)	B39	B79	population
(3)	B134	B54/B79	sales tax per capita (base year)
-----OUTPC			
(6)	AH210	AH179*AH195	outcommuters per capita
(see Table 7 for system of equations)			
-----INCPC			
(6)	AI210	AI179*AI195	incommuters per capita
(see Table 8 for system of equations)			
-----DG			
(6)	AS210	AS179*AS195	development group
(5)	AS179	econometrically calculated	coefficient public works/development group
(6)	AS195	C122-B122	difference in development group between base and t+1 year
(3)	B122	Input Value	development group (base year)
(3)	C122	B122	development group (t+1 year)
-----FAPC			
(6)	AV210	AV179*AV195*D26	total federal aid
(5)	AV176	econometrically calculated	coefficient public works/tot fed aid
(6)	AV195	C125-B125	difference in total federal aid between base and t+1 years
(1)	D26	Input Value	response to change in federal aid
(3)	C125	C71/C79	total federal aid (t+1 year)
(2)	C71	(B75*B74)+C25	total federal aid (t+1 year)
(1)	C25	Input Value	change in federal aid

Table 19 cont. - System of equations used by the VIP model to calculate DEVELOPMENT EXPENSE PER CAPITA.
y = f(employ/cap, per cap inc, sales per cap, outcom/cap, incom/cap, develop group, tot fed aid)

Model Section	Cell Address	Equation	Variable Description
-----SECOND ITERATION:-----			
(2)	B74	@sum(B59..B67)	predicted total aid (federal and state)
(2)	B75	B71/B73	actual federal aid (base year)
(2)	B71	Input Value	total federal aid (base year)
(2)	B73	B74	actual total aid (base year)

Explanation of Table 19 - System of equations used by the VIP model to calculate DEVELOPMENT EXPENDITURES PER CAPITA.

Variable Descriptions:

Development expenditures are a function of per capita income, outcommuters per capita, incommuters per capita, development group, and total federal aid.

1) $DEPC = \alpha_0 + \beta_1 IPC + \beta_3 OUTPC + \beta_4 INCPC + \beta_5 DG + \beta_6 FAPC$

where α_0, β_1, β_2, β_3, β_4, β_5, and β_6 are econometrically estimated coefficients. These estimates are found in section five of the model.

The ability to support development is associated with per capita income indicating a positive relationship. Incommuters positively influence development because of their position in economic activity. The development group variable is added to test the hypothesis that an active group increases development expenditures. Because of federal mandates, a positive relationship between development expenditures and total federal aid is expected. (Keeling)

Derivation:

Using the total derivative of the development expenditures function (equation 1) the model calculates the rate of change (dDEPC) between the initial year (DEPC1) and the subsequent year (DEPC2) (equation 2).

2) $dDEPC = \beta_1 dIPC + \beta_2 dOUTPC + \beta_3 dINCPC + \beta_4 dDG + \beta_5 dFAPC$

The model calculates dIPC, dOUTPC, dINCPC, dDG, and dFAPC as the difference between the initial user supplied values (IPC1, OUTPC1, INCPC1, DG1 and FAPC1) and the second iteration values (IPC2, OUTPC2, INCPC2, DG2, and FAPC2) for each independent variable in the function (equation 3).

3) IPC2 - IPC1 = dIPC
OUTPC2 - OUTPC1 = dOUTPC
INCPC2 - INCPC1 = dINCPC
DG2 - DG1 = dDG
FAPC2 - FAPC1 = dFAPC

where dIPC, dOUTPC, dINCPC, dDG, and dFAPC are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dDEPC or the rate of change between the initial year (DEPC1) and the second iteration (DEPC2) for the dependent variable, development expenditures (equation 2). This addition takes place in section three of the model. The total rate of change (dDEPC), for the development expenditures function, is added to the initial values (DEPC1) resulting in the projected development expenditures value (DEPC2) in the second iteration (equation 4).

4) $DEPC2 = dDEPC + DEPC1$

Future values for the subsequent year (DEPC3) are calculated in the same manner, except the DEPC2 values are used in place of the user supplied initial values (DEPC1).

Table 20 - System of equations used by the VIP model to calculate SALES TAX REVENUES PER CAPITA. y = f(POP and REMPPC)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION-----			
(3)	B134	B54/B79	sales tax per capita (base year)
(2)	B54	Input Value	sales tax revenues (base year)
(3)	B79	Input Value	population (base year)
-----SECOND ITERATION-----			
(3)	C134	B134+@sum(B211..BE211)	sales tax per capita (t+1 year)
-----POP-----			
(6)	B211	B180*B195	population
(5)	B180	econometrically calculated	coefficient sales tax rev/population
(see Table 6 for system of equations)			
-----REMPPC-----			
(6)	AB211	AB180*AB195	resident employment per capita
(5)	AB180	econometrically calculated	coefficient sales tax rev/res emp per cap
(6)	AB195	C105-B105	difference in resident employment between base and t+1 years
(3)	B105	B69/B79	resident employment per capita
(2)	B69	Input Value	resident employment (base year)
(3)	B79	Input Value	population (base year)
(3)	C105	B69+(C34-1)*(C76-B76)+C8	resident employment per capita (t+1 year)
(1)	C34	Input Value	marginal multiplier
(2)	B76	Input Value	base employment (base year)
(2)	C76	B76+(1+C28/100)+C7	base employment (t+1 year)
(1)	C28	Input Value	county base employment growth rate
(1)	C7	Input Value	change county base employment
(1)	C8	Input Value	change total employment

Explanation of Table 20 - System of equations used by the VIP model to calculate SALES TAX REVENUES PER CAPITA.

Variable Description:

Sales tax revenues are a function of population and residentiary employment per capita.

1) $STRPC = \alpha_0 + \beta_1 POP + \beta_2 REMPPC$

where α_0, β_1, and β_2 are econometrically estimated coefficients. These estimates are found in section five of the model.

Sales tax revenue depends largely on spending. Per capita income represents spending power whereas the number of businesses reflects available opportunities to spend. (Keeling)

Derivation:

Using the total derivative of the sales tax revenues function (equation 1) the model calculates the rate of change (dSTRPC) between the initial year (STRPC1) and the subsequent year (STRPC2) (equation 2).

2) $dSTRPC = \beta_1 dPOP + \beta_2 dREMPPC$

The model calculates dPOP and dREMPPC as the difference between the initial user supplied values (POP1 and REMPPC1) and the second iteration values (POP2 and REMPPC2) for each independent variable in the function (equation 3).

3) POP2 - POP1 = dPOP
INCPC2 - INCPC1 = dINCPC

where dPOP and dREMPPC are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dSTRPC or the rate of change between the initial year (STRPC1) and the second iteration (STRPC2) for the dependent variable, sales tax revenues (equation 2). This addition takes place in section three of the model. The total rate of change (dSTRPC), for the sales tax revenues function, is added to the initial values (STRPC1) resulting in the projected sales tax revenues value (STRPC2) in the second iteration (equation 4).

4) STRPC2 = dSTRPC + STRPC1

Future values for the subsequent year (STRPC3) are calculated in the same manner, except the STRPC2 values are used in place of the user supplied initial values (STRPC1).

Table 21 - System of equations used by the VIP model to calculate OTHER TAX REVENUES PER CAPITA. y = f(IPC and SLSPC)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION-----			
(3)	B135	B55/B79	other tax per capita (base year)
(2)	B55	Input Value	other tax revenue
(3)	B79	Input Value	population (base year)
-----SECOND ITERATION-----			
(3)	C135	B135+@sum(B212..BE212)	other tax per capita (t+1 year)
-----IPC-----			
(6)	AC212	AC181*AC195	per capita income
(5)	AC181	econometrically calculated	coefficient other tax rev/per cap inc
(6)	AC195	C106-B106	difference in per cap inc between base and t+1 years
(3)	B106	Input Value	per capita income (base year)
(3)	C106	(B106*(1+C32/100))+C15	per capita income (t+1 year)
(1)	C32	Input Value	real per capita income growth rate
(1)	C15	Input Value	change in per capita income
-----SLSPC-----			
(6)	AG212	AG181*AG195	sale per capita
(5)	AG181	econometrically calculated	coefficient other tax/sale per capita
(6)	AG195	C110-B110	difference in sales per capita between base and t+1 years
(3)	B110	B109/B79	sales per capita (base year)
(3)	B109	Input Value	sales (base year)
(3)	B79	Input Value	population (base year)
(3)	C110	C109/C79	sales per capita (t+1 year)
(3)	C109	C54*100	sales (t+1 year)
(2)	C54	C134*C39	sales tax revenues (t+1 year)
(3)	C39	see Table 6 for system of equations	population (t+1 year)
(3)	C134	B134+@sum(B211..BE211)	sales tax per capita (t+1 year)
(see Table 20 for system of equations)			

Explanation of Table 21 - System of equations used by the VIP model to calculate OTHER TAX REVENUES PER CAPITA.

<u>Variable Descriptions</u>:

Other tax revenues are a function of per capita income and sales per capita.

1) $OTRPC = \alpha_0 + \beta_1 IPC + \beta_2 SLSPC$

where α_0, β_1 and β_2 are econometrically estimated coefficients. These estimates are found in section five of the model.

Other tax revenue is a function of per capita income and sales per capita. These variables reflect household and business activity. (Keeling)

Derivation:

Using the total derivative of the other tax revenues function (equation 1) the model calculates the rate of change (dOTRPC) between the initial year (OTRPC1) and the subsequent year (OTRPC2) (equation 2).

2) $dOTRPC = \beta_1 dIPC + \beta_2 dSLSPC$

The model calculates dIPC and dSLSPC as the difference between the initial user supplied values (IPC1 and SLSPC1) and the second iteration values (IPC2 and SLSPC2) for each independent variable in the function (equation 3).

3) $IPC2 - IPC1 = dIPC$
$SLSPC2 - SLSPC1 = dSLSPC$

where dIPC and dSLSPC are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dOTRPC or the rate of change between the initial year (OTRPC1) and the second iteration (OTRPC2) for the dependent variable, other tax revenues (equation 2). This addition takes place in section three of the model. The total rate of change (dOTRPC), for the other tax revenues function, is added to the initial values (OTRPC1) resulting in the projected other tax revenues value (OTRPC2) in the second iteration (equation 4).

4) $OTRPC2 = dOTRPC + OTRPC1$

Future values for the subsequent year (OTRPC3) are calculated in the same manner, except the OTRPC2 values are used in place of the user supplied initial values (OTRPC1).

Table 22 - System of equations used by the VIP model to calculate JAIL EXPENDITURES PER CAPITA PER CAPITA. y = f(POP, RPTPC, PPTPC, POPSQ, PTPOP, MISQC, and FAPC)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION:			
(3)	B136	@if(M136>0,M136,0)	per capita Jail Expenditure (base year)
	M136	B56/B39	
(2)	B56	Input Value	other tax (base year)
(2)	B39	B79	population
-----SECOND ITERATION:			
(3)	C136	@if(N136>0,N136,0)	Jail Expenditure per capita (t+1 year)
	N136	B136 + SUM(B213..BD213)	
-----POP			
(6)	B213	B182*B195	population
(see Table 6 for system of equations)			
-----RPTPC			
(6)	G213	G182*G195	real property taxbase
(see Table 10 for system of equations)			
-----PPTPC			
(6)	H213	H182*G195	personnel property taxbase
(see Table 11 for system of equations)			
-----POPSQ			
(6)	Q213	Q182*Q195	population^2
(see Table 6 for system of equations)			
-----PTPOP			
(6)	T213	T182*T195	town percentage
(5)	T182	econometrically calculated	coefficient jail exp/town percentage
(6)	T195	C97-B97	difference in town percentage between base and t+1 years
(3)	B97	B68/B79*100	percent population in towns (base year)
(2)	B68	Input Value	town population (base year)
(3)	B79	Input Value	population (base year)
(3)	C97	C68/C79*100	percent population in town (t+1 year)
(2)	C68	((1+C29/100)*B68)+C9	town population (t+1 year)
(1)	C29	Input Value	town population growth rate
(1)	C9	Input Value	change in town population
-----MISQC			
(6)	AN213	AN182*AN195	square miles
(5)	AN182	econometrically calculated	coefficient jail exp/square miles
(6)	AN195	C117-B117	difference in square miles per capita between base and t+1 years
(3)	B117	B116/B79	square miles in per capita (base year)
(3)	B116	Input Value	square miles in county (base year)
(3)	B79	Input Value	population (base year)
(3)	C117	C116/C79	square miles per capita (t+1 year)
(3)	C79	see Table 6 for system of equations	population (t+1 year)
(3)	C116	B116 + C6	square miles in county (t+1 year)
(3)	B116	Input Value	square miles in county (t+1 year)
(1)	C6	Input Value	change in county area
-----FAPC			
(6)	AV213	AV213*AV195*D26	total federal aid
(5)	AV213	econometrically calculated	coefficient jail exp/tot fed aid

Table 22 cont. - System of equations used by the VIP model to calculate JAIL EXPENDITURES PER CAPITA. y = f(POP, RPTPC, PPTPC, POPSQ, PTPOP, MISQC, and FAPC)

Model Section	Cell Address	Equation	Variable Description
-----SECOND ITERATION:-----			
(6)	AV195	C125-B125	difference in total federal aid between base and t+1 years
(1)	D26	Input Value	response to change in federal aid
(3)	C125	C71/C79	total federal aid (t+1 year)
(2)	C71	(B75*B74)+C25	total federal aid (t+1 year)
(1)	C25	Input Value	change in federal aid
(2)	B74	@sum(B59..B67)	predicted total aid (federal and state)
(2)	B75	B71/B73	actual federal aid (base year)
(2)	B71	Input Value	total federal aid (base year)
(2)	B73	B74	actual total aid (base year)

Explanation of Table 22 - System of equations used by the VIP model to calculate JAIL EXPENDITURES PER CAPITA

Variable Description:

Jail expenditures per capita are a function of population, real property taxbase, personnel property taxbase, population squared, percent town population, square miles per capita, and total federal aid.

1) $JEPC = \alpha_0 + \beta_1 POP + \beta_2 RPTPC + \beta_3 PPTPC + \beta_4 POPSQ + \beta_5 PTPOP + \beta_6 MISQPC + \beta_7 FAPC$

where α_0, β_1, β_2, β_3, β_4, β_5, β_6, and β_7 are econometrically estimated coefficients. These estimates are found in section five of the model.

Economies of scale, which is represented by population, positively influences jail expenditures. Real and personnel property per capita show the ability to pay and demand for services by businesses and households. Its hypothesized that total federal aid positively effects jail expenditures. Congestion represented by persons per square mile increases the need for jail expenditures. (Keeling)

Derivation:

Using the total derivative of the jail expenditures per capita function (equation 1) the model calculates the rate of change (dJEPC) between the initial year (JEPC1) and the subsequent year (JEPC2) (equation 2).

2) $dJEPC = \beta_1 dPOP + \beta_2 dRPTPC + \beta_3 dPPTPC + \beta_4 dPOPSQ + \beta_5 dPTPOP + \beta_6 dMISQPC + \beta_7 dFAPC$

The model calculates dPOP, dRPTPC, dPPTPC, dPOPSQ, dPTPOP, dMISQPC and dFAPC as the difference between the initial user supplied values (POP1, RPTPC1, PPTPC1, POPSQ1, PTPOP1, MISQPC1, and FAPC1) and the second iteration values (POP2, RPTPC2, PPTPC2, POPSQ2, PTPOP2, MISQPC2, and FAPC2) for each independent variable in the function (equation 3).

3) POP2 - POP1 = dPOP
RPTPC2 - RPTPC1 = dRPTPC
PPTPC2 - PPTPC1 = dPPTPC
POPSQ2 - POPSQ1 = dPOPSQ
PTPOP2 - PTPOP1 = dPTPOP

MISQPC2 - MISQPC1 = dMISQPC
FAPCPC2 - FAPCPC1 = dFAPCPC

where dPOP, dRPTPC, dPPTPC, dPOPSQ, dPTPOP, dMISQPC, and dFAPC are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dJEPC or the rate of change between the initial year (JEPC1) and the second iteration (JEPC2) for the dependent variable, jail expenditures per capita (equation 2). This addition takes place in section three of the model. The total rate of change (dJEPC), for the jail expenditures per capita function, is added to the initial values (JEPC1) resulting in the projected jail expenditures per capita value (JEPC2) in the second iteration (equation 4).

4) JEPC2 = dJEPC + JEPC1

Future values for the subsequent year (JEPC3) are calculated in the same manner, except the JEPC2 values are used in place of the user supplied initial values (JEPC1).

SECTION THREE

DEPENDENT VARIABLES USED BY THE VIRGINIA IMPACT PROJECTIONS MODEL

Table 5 - System of equations used by the VIP model to calculate POPULATION. y = f(LABF)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION-----			
(3)	B79	Input Value	population (base year)
-----SECOND ITERATION-----			
(3)	C79	B79+@SUM(B196..BE196)	population (t+1 year)
-----LABF-----			
(6)	C196	C165*C195	laborforce
(5)	C165	calculated econometrically	coefficient population/laborforce
(6)	C195	C80-B80	difference in laborforce between the base and t+1 years
(3)	C80	B80+@sum(B197..BE197)	laborforce (t+1 year)
(see Table 6 for system of equations)			

Explanation of Table 5 - System of equations used by the VIP model to calculate POPULATION.

Variable Descriptions:

Population is a function of laborforce.

Economic based demographic projection techniques use changes in employment to determine the total population change within an area. Economists use the interaction between labor supply and demand to predict net changes in migration. (Keeling)

Derivation:

1) $POP = \alpha_0 + \beta_1 LABF$

See Table 6 for explanation of LABF function.

Table 6 - System of equations used by the VIP model to calculate LABORFORCE. y = f(EMP, CGLAB, CGEMP, and UEMP)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION-----			
(3)	B80	Input Value	laborforce (base year)
-----SECOND ITERATION-----			
(3)	C80	B80+@sum(B197..BE197)	laborforce (t+1 year)
-----EMP-----			
(6)	Z197	Z166*Z195	employment
(5)	Z166	econometrically calculated	coefficient laborforce/employment
(6)	Z195	C103-B103	difference in employment between the base and t+1 years
(3)	C103	C69+C76	employment (t+1 year)
(3)	B103	B69+B76	employment (base year)
(2)	C69	B69+(C34-1)*(C76-B76)+C8	residentiary employment (t+1 year)
(2)	B69	Input Value	residentiary employment (base year)
(2)	B76	Input Value	base employment (base year)
(2)	C76	B76*(1+C28/100)+C7	base employment (t+1 year)
(1)	C34	Input Value	marginal multiplier
(1)	C8	Input Value	change in total employment
(1)	C28	Input Value	county base employment growth rate
(1)	C7	Input Value	change county base employment
-----CGLAB-----			
(6)	AX197	AX166*AX195	contiguous laborforce
(5)	AX166	econometrically calculated	coefficient laborforce/contiguous laborforce
(6)	AX195	C127-B127	difference in contiguous laborforce between base and t+1 years
(3)	B127	Input Value	contiguous laborforce (base year)
(3)	C127	((1+C30/100)*B127)+C11	contiguous laborforce (t+1 year)
(1)	C30	Input Value	contiguous laborforce growth rate
(1)	C11	Input Value	change in contiguous laborforce
-----CGEMP-----			
(6)	AY197	AY166*AY195	contiguous employment
(5)	AY166	econometrically calculated	coefficient laborforce/contiguous employment
(6)	AY195	C128-B128	difference in contiguous employment between base and t+1 years
(3)	B128	Input Value	contiguous employment (base year)
(3)	C128	((1+C27/100)*B128)+C10	contiguous employment (t+1 year)
(1)	C27	Input Value	contiguous employment growth rate
(1)	C10	Input Value	change in contiguous employment
-----UEMP-----			
(6)	BB197	BB195*BB166	number unemployed
(5)	BB166	econometrically calculated	coefficient laborforce/number unemployed
(6)	BB195	C131-B131	difference in number unemployed between base and t+1 years

Table 6 cont. - System of equations used by the VIP model to calculate LABORFORCE. y = f(EMP, CGLAB, CGEMP, and UEMP)

Model Section	Cell Address	Equation	Variable Description
-----SECOND ITERATION-----			
(3)	B131	Input Value	number unemployed (base year)
(3)	C131	C33	number unemployed (t+1 year)
(1)	C33	B131*(1+C28/100)-.25*(C7*C34+C8)	number unemployed
(1)	C28	Input Value	county base employment growth rate
(1)	C34	Input Value	marginal multiplier
(1)	C7	Input Value	change in county base employment
(1)	C8	Input Value	change in total employment

Explanation of Table 6 - System of equations used by the VIP model to calculate LABORFORCE.

Variable Descriptions:

Laborforce is a function of employment, contiguous laborforce, contiguous employment and the number of unemployed.

1) $LABF = \alpha_0 + \beta_1 EMP + \beta_2 CGEMP + \beta_3 CGLAB + \beta_4 UEMP$

where α_0, β_1, β_2, β_3, and β_4 are econometrically estimated coefficients. These estimates are found in section five of the model.

Laborforce, unemployment and total employment functions are identities. Laborforce is a function of local and non local employment and unemployment. The unemployment rate can cause fluctuations within the labor market. (Keeling)

Derivation:

Using the total derivative of the laborforce function (equation 1) the model calculates the rate of change (dLABF) between the initial year (LABF1) and the subsequent year (LABF2) (equation 2).

2) $dLABF = \beta_1 dEMP + \beta_2 dCGEMP + \beta_3 dCGLAB + \beta_4 dUEMP$

The model calculates dEMP, dCGEMP, dCHLAB, and dUEMP as the difference between the initial user supplied values (EMP1, CGEMP1, CGLAB1, and UEMP1) and the second iteration values (EMP2, CGEMP2, CGLAB2, and UEMP2) for each independent variable in the function (equation 3).

3) EMP2 - EMP1 = dEMP
CGEMP2 - CGEMP1 = dCGEMP
CGLAB2 - CGLAB1 = dCGLAB
UEMP2 - UEMP1 = dUEMP

where dEMP, dCGEMP, dCGLAB, and dUEMP are the partial derivatives for each independent variable

The model estimates the independent variables for the second iteration based on user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dLABF or the rate of change between the initial year (LABF1) and the second iteration (LABF2) for the dependent variable, laborforce (equation 2). This addition takes place in section three of the model. The total rate of change (dLABF), for the laborforce function, is added to the initial values (LABF1) resulting in the projected laborforce value (LABF2) in the second iteration (equation 4).

4) LABF2 = dLABF + LABF1

Future values for the subsequent year (LABF3) are calculated in the same manner, except the LABF2 values are used in place of the user supplied initial values (LABF1).

Table 7 - System of equations used by the VIP model to calculate OUTCOMMUTERS. y = f(EMP, CGLAB, CGEMP, and UEMP)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION-----			
(3)	B81	Input Value	number of outcommuters (base year)
-----SECOND ITERATION-----			
(3)	C81	B81+@sum(B198..BE198)	number of outcommuters (t+1 year)
-----EMP-----			
(6)	Z198	Z167*Z195	employment
(5)	Z167	econometrically calculated	coefficient outcommuters/employment
(6)	Z195	C103-B103	difference in employment between base and t+1 years
(3)	C103	C69+C76	employment (t+1 year)
(3)	B103	B69+B76	employment (base year)
(2)	C69	B69+(C34-1)*(C76-B76)+C8	residentiary employment (t+1 year)
(2)	B69	Input Value	residentiary employment (base year)
(2)	B76	Input Value	base employment (base year)
(2)	C76	B76*(1+C28/100)+C7	base employment (t+1 year)
(1)	C34	Input Value	marginal multiplier
(1)	C8	Input Value	change in total employment
(1)	C28	Input Value	county base employment growth rate
(1)	C7	Input Value	change county base employment
-----CGLAB-----			
(6)	AX198	AX167*AX195	contiguous laborforce
(5)	AX167	econometrically calculated	coefficient outcommuters/contiguous laborforce
(6)	AX195	C127-B127	difference in contiguous laborforce between base and t+1 years
(3)	B127	Input Value	contiguous laborforce (base year)
(3)	C127	((1+C30/100)*B127)+C11	contiguous laborforce (t+1 year)
(1)	C30	Input Value	contiguous laborforce growth rate
(1)	C11	Input Value	change in contiguous laborforce
-----CGEMP-----			
(6)	AY198	AY167*AY195	contiguous employment
(5)	AY167	econometrically calculated	coefficient outcommuters/contiguous employment
(6)	AY195	C128-B128	difference in contiguous employment between base and t+1 years
(3)	B128	Input Value	contiguous employment (base year)
(3)	C128	((1+C27/100)*B128)+C10	contiguous employment (t+1 year)
(1)	C27	Input Value	contiguous employment growth rate
(1)	C10	Input Value	change in contiguous employment
-----UEMP-----			
(6)	BB198	BB195*BB167	number unemployed
(5)	BB167	econometrically calculated	coefficient outcommuters/number unemployed
(6)	BB195	C131-B131	difference in number unemployed between base and t+1 years

Table 7 cont. - System of equations used by the VIP model to calculate OUTCOMMUTERS. y = f(EMP, CGLAB, CGEMP, and UEMP)

Model Section	Cell Address	Equation	Variable Description
-----SECOND ITERATION-----			
(3)	B131	Input Value	number unemployed (base year)
(3)	C131	C33	number unemployed (t+1 year)
(1)	C33	B131*(1+C28/100)-.25*(C7*C34+C8)	number unemployed
(1)	C28	Input Value	county base employment growth rate
(1)	C34	Input Value	marginal multiplier
(1)	C7	Input Value	change in county base employment
(1)	C8	Input Value	change in total employment

Explanation of Table 7 - System of equations used by the VIP model to calculate OUTCOMMUTERS.

Variable Descriptions:

Outcommuters are a function of employment, contiguous laborforce, contiguous employment, and the number of unemployed.

1) $OUT = \alpha_0 + \beta_1 EMP + \beta_2 CGLAB + \beta_3 CGEMP + \beta_4 UEMP$

where α_0, β_1, β_2, β_3, and β_4 are econometrically estimated coefficients. These estimates are found in section five of the model.

Consumers desire a certain quality of services. Decisions on where to reside and work are represented by incommuters and outcommuters. Tiebolt hypothesized that the choice of where to live is an appraisal of services available in a locality. Service quality and accessibility represent measures of the costs and benefits of the decision to reside or commute. Miles of road is a proxy for accessibility. (Keeling)

Derivation:

Using the total derivative of the outcommuters function (equation 1) the model calculates the rate of change (dOUT) between the initial year (OUT1) and the subsequent year (OUT2) (equation 2).

2) $dOUT = \beta_1 dEMP + \beta_2 dCGLAB + \beta_3 dCGEMP + \beta_4 dUEMP$

The model calculates dEMP, dCGLAB, dCGEMP, and dUEMP as the difference between the initial user supplied values (EMP1, CGLAB1, CGEMP1, and UEMP1) and the second iteration values (EMP2, CGLAB2, CGEMP2, and UEMP2) for each independent variable in the function (equation 3).

3) EMP2 - EMP1 = dEMP
CGLAB2 - CGLAB1 = dCGLAB
CGEMP2 - CHEMP1 = dCGEMP
UEMP2 - UEMP1 = dUEMP

where dEMP, dCGLAB, dCGEMP, and dUEMP are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dOUT or the rate of change between the initial year (OUT1) and the second iteration (OUT2) for the dependent variable, outcommuters (equation 2). This addition takes place in section three of the model. The total rate of change (dOUT), for the outcommuters function, is added to the initial values (OUT1) resulting in the projected outcommuters value (OUT2) in the second iteration (equation 4).

4) OUT2 = dOUT + OUT1

Future values for the subsequent year (OUT3) are calculated in the same manner, except the OUT2 values are used in place of the user supplied initial values (OUT1).

Table 8 - System of equations used by the VIP model to calculate INCOMMUTERS. y = f(EMP, CGLAB, CGEMP, and UEMP)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION-----			
(3)	B82	Input Value	number of incommuters (base year)
-----SECOND ITERATION-----			
(3)	C82	B82+@SUM(B199..BE199)	
-----EMP-----			
(6)	Z199	Z168*Z195	employment
(5)	Z168	econometrically calculated	coefficient incommuters/employment
(6)	Z195	C103-B103	difference in employment between base and t+1 years
(3)	C103	C69+C76	employment (t+1 year)
(3)	B103	B69+B76	employment (base year)
(2)	C69	B69+(C34-1)*(C76-B76)+C8	residentiary employment (t+1 year)
(2)	B69	Input Value	residentiary employment (base year)
(2)	B76	Input Value	base employment (base year)
(2)	C76	B76*(1+C28/100)+C7	base employment (t+1 year)
(1)	C34	Input Value	marginal multiplier
(1)	C8	Input Value	change in total employment
(1)	C28	Input Value	county base employment growth rate
(1)	C7	Input Value	change county base employment
-----CGLAB-----			
(6)	AX199	AX168*AX195	contiguous laborforce
(5)	AX168	econometrically calculated	coefficient incommuters/contiguous laborforce
(6)	AX195	C127-B127	difference in contiguous laborforce between base and t+1 years
(3)	B127	Input Value	contiguous laborforce (base year)
(3)	C127	((1+C30/100)*B127)+C11	contiguous laborforce (t+1 year)
(1)	C30	Input Value	contiguous laborforce growth rate
(1)	C11	Input Value	change in contiguous laborforce
-----CGEMP-----			
(6)	AY199	AY168*AY195	contiguous employment
(5)	AY168	econometrically calculated	coefficient incommuters/contiguous employment
(6)	AY195	C128-B128	difference in contiguous employment between base and t+1 years
(3)	B128	Input Value	contiguous employment (base year)
(3)	C128	((1+C27/100)*B128)+C10	contiguous employment (t+1 year)
(1)	C27	Input Value	contiguous employment growth rate
(1)	C10	Input Value	change in contiguous employment
-----UEMP-----			
(6)	BB199	BB195*BB168	number unemployed
(5)	BB168	econometrically calculated	coefficient incommuters/number unemployed
(6)	BB195	C131-B131	difference in number unemployed between base and t+1 years
(3)	B131	Input Value	number unemployed (base year)

Table 8 cont. - System of equations used by the VIP model to calculate INCOMMUTERS. y = f(EMP, CGLAB, CGEMP, and UEMP)

Model Section	Cell Address	Equation	Variable Description
-----SECOND ITERATION-----			
(3)	C131	C33	number unemployed (t+1 year)
(1)	C33	B131*(1+C28/100)-.25*(C7*C34+C8)	number unemployed
(1)	C28	Input Value	county base employment growth rate
(1)	C34	Input Value	marginal multiplier
(1)	C7	Input Value	change in county base employment
(1)	C8	Input Value	change in total employment

Explanation of Table 8 - System of equations used by the VIP model to calculate INCOMMUTERS.

Variable Descriptions:

Incommuters are a function of employment, contiguous laborforce, contiguous employment, and the number of unemployed.

1) $INC = \alpha_0 + \beta_1 EMP + \beta_2 CGLAB + \beta_3 CGEMP + \beta_4 UEMP$

where α_0, β_1, β_2, β_3, and β_4 are econometrically estimated coefficients. These estimates are found in section five of the model.

Consumers desire a certain quality of services. Decisions on where to reside and work are represented by incommuters and outcommuters. Tiebolt hypothesized that the choice of where to live is an appraisal of services available in a locality. Service quality and accessibility represent measures of the costs and benefits of the decision to reside or commute. Miles of road is a proxy for accessibility. (Keeling)

Derivation:

Using the total derivative of the incommuters function (equation 1) the model calculates the rate of change (dINC) between the initial year (INC1) and the subsequent year (INC2) (equation 2).

2) $dINC = \beta_1 dEMP1 + \beta_2 dCGLAB1 + \beta_3 dCGEMP1 + \beta_4 dUEMP1$

The model calculates dEMP, dCGLAB, dCGEMP, and dUEMP as the difference between the initial user supplied values (EMP1, CGLAB1, CGEMP1, and UEMP1) and the second iteration values (EMP2, CGLAB2, CGEMP2, and UEMP2) for each independent variable in the function (equation 3).

3) EMP2 - EMP1 = dEMP
CGLAB2 - CGLAB1 = dCGLAB
CGEMP2 - CHEMP1 = dCGEMP
UEMP2 - UEMP1 = dUEMP

where dEMP, dCGLAB, dCGEMP, and dUEMP are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dINC or the rate of change between the initial year (INC1) and the second iteration (INC2) for the dependent variable, incommuters (equation 2). This addition takes place in section three of the model. The total rate of change (dINC), for the incommuters function, is added to the initial values (INC1) resulting in the projected incommuters value (INC2) in the second iteration (equation 4).

4) INC2 = dINC + INC1

Future values for the subsequent year (INC3) are calculated in the same manner, except the INC2 values are used in place of the user supplied initial values (INC1).

Table 9 - System of equations used by the VIP model to calculate ENROLLMENT. y = f(LABF, OUT, INC, and INCPC)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION-----			
(3)	B83	Input Value	number of enrollment (base year)
-----SECOND ITERATION-----			
(3)	C83	B83+@sum(B200..BE200)	enrollment (t+1 year)
-----LABF-----			
(6)	C200	(C169+((B194-1980)*C193)*C165)*C195	laborforce
(5)	C169	econometrically calculated	coefficient enrollment/laborforce
	B194		
	C193		
(5)	C165	econometrically calculated	coefficient population/laborforce
(6)	C195	C80-B80	difference in laborforce between base and t+1 years
(3)	B80	Input Value	laborforce (base year)
(3)	C80	B80+@sum(B198..BE197)	laborforce (t+1 year)
(see Table 6 for system of equations)			
-----OUT-----			
(6)	D200	D169*D195	outcommuters
(5)	D169	econometrically calculated	coefficient enrollment/outcommuters
(6)	D195	C81-B81	difference in outcommuters between base and t+1 years
(3)	B81	Input Value	outcommuters (base year)
(3)	C81	B81+@sum(B198..BE198)	outcommuters (t+1 year)
(see Table 7 for system of equations)			
-----INC-----			
(6)	E200	E169*E195	incommuters
(5)	E169	econometrically calculated	coefficient enrollment/incommuters
(6)	E195	C82-B82	difference in incommuters between base and t+1 years
(3)	B82	Input Value	incommuters (base year)
(3)	C82	B82+@sum(B199..BE199)	incommuters (t+1 year)
(see Table 8 for system of equations)			
-----INCPC-----			
(6)	AI200	AI195*AI169	incommuters per capita
(6)	AI169	econometrically calculated	coefficient enrollment/incomm per capita
(5)	AI195	C112-B112	difference in incommuters per capita between base and t+1 years
(3)	B112	B82/B79	incommuters per capita (base year)
(3)	B82	Input Value	incommuters (base year)
(3)	B79	Input Value	population (base year)
(3)	C112	C82/C79	incommuters per capita (t+1 year)
(3)	C82	B82+@sum(B199..BE199)	incommuters (t+1 year)
(see Table 8 for system of equations)			
(3)	C79	B79+@sum(B196..BE196)	population (t+1 year)
(see Table 5 for system of equations)			

Explanation of Table 9 - System of equations used by the VIP model to calculate ENROLLMENT.

Explanation of Table 9 - System of equations used by the VIP model to calculate ENROLLMENT.

Variable Descriptions:

Enrollment are a function of laborforce, outcommuters, incommuters, and incommuters per capita.

1) $ENRL = \alpha_0 + \beta_1 LABF + \beta_2 OUT + \beta_3 INC + \beta b_4 INCPC$

where α_0, β_1, β_2, β_3, and β_4 are econometrically estimated coefficients. These estimates are found in section five of the model.

Enrollment is a function of laborforce rather than population. Laborforce is the age group eligible for school age children therefore it measures enrollment more accurately. (Keeling)

Derivation:

Using the total derivative of the enrollment function (equation 1) the model calculates the rate of change (dENRL) between the initial year (ENRL1) and the subsequent year (ENRL2) (equation 2).

2) $dENRL = \beta_1 dLABF + \beta_2 dOUT + \beta_3 dINC + \beta_4 dINCPC$

The model calculates dLABF, dOUT, dINC, and dINCPC as the difference between the initial user supplied values (LABF1, OUT1, INC1, and INCPC1) and the second iteration values (LABF2, OUT2, INC2, and INCPC2) for each independent variable in the function (equation 3).

3) LABF2 - LABF1 = dLABF
OUT2 - OUT1 = dOUT
INC2 - CHEMP1 = dINC
INCPC2 - INCPC1 = dINCPC

where dLABF, dOUT, dINC, and dINCPC are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dENRL or the rate of change between the initial year (ENRL1) and the second iteration (ENRL2) for the dependent variable, enrollment (equation 2). This addition takes place in section three of the model. The total rate of change (dENRL), for the enrollment function, is added to the initial values (ENRL1) resulting in the projected enrollment value (ENRL2) in the second iteration (equation 4).

4) ENRL2 = dENRL + ENRL1

Future values for the subsequent year (ENRL3) are calculated in the same manner, except the ENRL2 values are used in place of the user supplied initial values (ENRL1).

Table 10 - System of equations used by the VIP model to calculate REAL PROPERTY TAXBASE PER CAPITA. y = f(IPC, BUSPC, and OUTPC)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION-----			
(3)	B84	B44/B79	real property taxbase per capita (base year)
(2)	B44	Input Value	real property taxbase
(3)	B79	Input Value	population (base year)
-----SECOND ITERATION-----			
(3)	C84	B84+@sum(B201..BE201)	real property taxbase (t+1 year)
-----IPC-----			
(6)	AC201	AC170*AC195	per capita income
(5)	AC170	econometrically calculated	coefficient rp taxbase/per cap inc
(6)	AC195	C106-B106	difference in per capita income between base and t+1 years
(3)	B106	Input Value	per capita income (base year)
(3)	C106	(B106*(1+C32/100))+C15	per capita income (t+1 year)
(1)	C32	Input Value	real per capita income growth rate
(1)	C15	Input Value	change in per capita income
-----BUSPC-----			
(6)	AE201	AE170*AE195	businesses per capita
(5)	AE170	econometrically calculated	coefficient rp taxbase/bus per cap
(6)	AE195	C108-B108	difference in number of businesses per cap between base and t+1 years
(3)	B108	B70/B79	number of businesses per cap (base year)
(2)	B70	Input Value	number of businesses (base year)
(3)	B79	Input Value	population
(3)	C108	C70/C79	number of businesses per capita (t+1 year)
(2)	C70	B70+((C79-B79)*.014151)+C20	number of businesses (t+1 year)
(1)	C20	Input Value	change in percent non-white
(3)	C79	see Table 6 for system of equations	
-----OUTPC-----			
(6)	AH201	AH170*AH195	outcommuters per capita
(5)	AH170	econometrically calculated	coefficient rp taxbase/outcom per cap
(6)	AH195	C111-B111	difference in outcomm per cap between base and t+1 years
(3)	B111	B81/B79	outcommuters per cap (base year)
(3)	B81	Input Value	outcommuters (base year)
(3)	B79	Input Value	population (base year)
(3)	C111	C81/C79	outcommuters per capita (t+1 year)
(3)	C81	see Table 7 for system of equations	outcommuters (t+1 year)
(3)	C79	see Table 6 for system of equations	population (t+1 year)

Explanation of Table 10 - System of equations used by the VIP model to calculate REAL PROPERTY TAXBASE PER CAPITA.

Real property taxbase per capita are a function of per capita income, businesses per capita, and outcommuters per capita

1) $RPTPC = \alpha_0 + \beta_1 IPC + \beta_2 BUSPC + \beta_3 OUTPC$

where α_0, β_1, β_2, and β_3 are econometrically estimated coefficients. These estimates are found in section five of the model.

Real property taxbase consists of both property owned by businesses and households. The model uses real tax base rather than revenue amounts because the political aspects surrounding tax rates are difficult to predict. Businesses per capita and per capita income are included to represent these types of ownerships. Per capita income is considered non linear. Outcommuters is included to test the relationship between persons who commute and the amount of real property owned. (Keeling)

Using the total derivative of the real property taxbase per capita function (equation 1) the model calculates the rate of change (dRPTPC) between the initial year (RPTPC1) and the subsequent year (RPTPC2) (equation 2).

2) $dRPTPC = \beta_1 dIPC + \beta_2 dBUSPC + \beta_3 dOUTPC$

The model calculates dIPC, dBUSPC, and dOUTPC as the difference between the initial user supplied values (IPC1, BUSPC1, and OUTPC1) and the second iteration values (IPC2, BUSPC2, SLSPC2, and OUTPC2) for each independent variable in the function (equation 3).

3) IPC2 - IPC1 = dIPC
BUSPC2 - BUSPC1 = dBUSPC
OUTPC2 - OUTPC1 = dOUTPC

where dIPC, dBUSPC, and dOUTPC are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dRPTPC or the rate of change between the initial year (RPTPC1) and the second iteration (RPTPC2) for the dependent variable, real property taxbase per capita (equation 2). This addition takes place in section three of the model. The total rate of change (dRPTPC), for the real property taxbase per capita function, is added to the initial values (RPTPC1) resulting in the projected real property taxbase per capita value (RPTPC2) in the second iteration (equation 4).

4) RPTPC2 = dRPTPC + RPTPC1

Future values for the subsequent year (RPTPC3) are calculated in the same manner, except the RPTPC2 values are used in place of the user supplied initial values (RPTPC1).

Table 11 - System of equations used by the VIP model to calculate PERSONNEL PROPERTY TAXBASE PER CAPITA.
y = f(IPC and OUTPC)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION-----			
(3)	B85	B45/B79	personnel property taxbase per capita (base year)
(2)	B45	Input Value	personnel property taxbase
(3)	B79	Input Value	population (base year)
-----SECOND ITERATION-----			
(3)	C85	B85+@sum(B202..BE202)	personnel property taxbase (t+1 year)
-----IPC-----			
(6)	AC202	AC171*AC195	per capita income
(5)	AC171	econometrically calculated	coefficient rp taxbase/per cap inc
(6)	AC195	C106-B106	difference in per capita income between base and t+1 years
(3)	B106	Input Value	per capita income (base year)
(3)	C106	(B106*(1+C32/100))+C15	per capita income (t+1 year)
(1)	C32	Input Value	real per capita income growth rate
(1)	C15	Input Value	change in per capita income
-----OUTPC-----			
(6)	AH202	AH171*AH195	outcommuters per capita
(5)	AH171	econometrically calculated	coefficient rp taxbase/outcommuters
(6)	AH195	C111-B111	difference in outcommuters per capita between base and t+1 years
(3)	B111	B81/B79	outcommuters per capita (base year)
(3)	B81	Input Value	outcommuters (base year)
(3)	B79	Input Value	population (base year)
(3)	C111	C81/C79	outcommuters per capita (t+1 year)
(3)	C81	see Table 7 for system of equations	outcommuters (t+1 year)
(3)	C79	see Table 6 for system of equations	population (t+1 year)

Explanation of Table 11 - System of equations used by the VIP model to calculate PERSONNEL PROPERTY TAXBASE PER CAPITA.

Variable Description:

Real property taxbase per capita is a function of per capita income and outcommuters per capita

1) $PPTPC = \alpha_0 + \beta_1 IPC + \beta_2 OUTPC$

where α_0, β_1, and β_2 are econometrically estimated coefficients. These estimates are found in section five of the model.

Personnel property taxbase consists of property owned by households which is represented by per capita income. Outcommuters represent additional affluence not represented by per capita income. The model uses Personnel property taxbase rather than actual amounts because the political aspects surrounding tax rates is difficult to predict. (Keeling)

Derivation:

Using the total derivative of the real property taxbase per capita function (equation 1) the model calculates the rate of change (dPPTPC) between the initial year (PPTPC1) and the subsequent year (PPTPC2) (equation 2).

2) $dPPTPC = \beta_1 dIPC + \beta_2 dIPCSQ + \beta_3 dOUTPC$

The model calculates dIPC, dIPCSQ, and dOUTPC as the difference between the initial user supplied values (IPC1, IPCSQ1, and OUTPC1) and the second iteration values (IPC2, IPCSQ2, and OUTPC2) for each independent variable in the function (equation 3).

3) IPC2 - IPC1 = dIPC
IPCSQ2 - IPCSQ1 = dIPCSQ
OUTPC2 - OUTPC1 = dOUTPC

where dIPC, dIPCSQ, and dOUTPC are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dPPTPC or the rate of change between the initial year (PPTPC1) and the second iteration (PPTPC2) for the dependent variable, real property taxbase per capita (equation 2). This addition takes place in section three of the model. The total rate of change (dPPTPC), for the real property taxbase per capita function, is added to the initial values (PPTPC1) resulting in the projected real property taxbase per capita value (PPTPC2) in the second iteration (equation 4).

4) PPTPC2 = dPPTPC + PPTPC1

Future values for the subsequent year (PPTPC3) are calculated in the same manner, except the PPTPC2 values are used in place of the user supplied initial values (PPTPC1).

Table 12 - System of equations used by the VIP model to calculate PUBLIC WORKS EXPENDITURES PER CAPITA. y = f(RPTPC, PPTPC, PCHPOP, MISQPC, and FAPC)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION:-----			
(2)	B46	Input Value	Total Public Works Expenditure (base year)
(3)	B86		per capita Public Works Expenditure (base year)
(3)	B86	@if(M86>0,M86,0)	
	M86	B46/B79	
(3)	B79	Input Value	population
-----SECOND ITERATION:-----			
(3)	C86	@if(N86>0,N86,0)	per capita Public Works Expenditure (t+1 year)
	N86	B86+@sum(B203..BE203)	
-----RPTPC-----			
(6)	G203	G172*G195	real property taxbase per capita
(see Table 10 for system of equations)			
-----PPTPC-----			
(6)	H203	H172*H195	personnel property taxbase per capita
(see Table 11 for system of equations)			
-----PCHPOP-----			
(6)	S203	S172*S195	percent change in population
(5)	S172	econometrically calculated	coefficient public works/percent change population
(6)	S195	C96-B96	difference in percent change population between base and t+1 years
(3)	B96	Input Value	percent change in population (base year)
(3)	C96	(C79-B79)/B79*100	percent change in population (t+1 year)
(3)	B79	Input Value	population per capita (base year)
(3)	C79	see Table 6 for system of equations	population per capita (t+1 year)
-----MISQPC-----			
(6)	AM203	AM172*AM195	square miles
(5)	AM172	econometrically calculated	coefficient public works/square miles
(6)	AM195	C116-B116	difference in square miles between base and t+1 years
(3)	B116	Input Value	square miles in a county (base year)
(3)	C116	B116+C6	square miles in a county (t+1 year)
(1)	C6	Input Value	change in county area
-----FAPC-----			
(6)	AV203	AV172*AV195*D26	total federal aid per capita
(5)	AV172	econometrically calculated	coefficient public works/tot fed aid
(6)	AV195	C125-B125	difference in total federal aid between base and t+1 years
(1)	D26	Input Value	response to change in federal aid
(3)	C125	C71/C79	total federal aid per capita
(2)	C71	(B75*B74)+C25	total federal aid (t+1 year)

Table 12 cont. - System of equations used by the VIP model to calculate PUBLIC WORKS EXPENDITURES PER CAPITA. y = f(RPTPC, PPTPC, PCHPOP, MISQPC, and FAPC)

Model Section	Cell Address	Equation	Variable Description
-----SECOND ITERATION:			
(2)	C25	Input Value	change in federal aid
(2)	B74	@sum(B59..B67)	predicted total aid (federal and state)
(2)	B75	B71/B73	
(2)	B71	Input Value	total federal aid (base year)
(2)	B73	B74	actual federal aid (base year)

Explanation of Table 12 - System of equations used by the VIP model to calculate PUBLIC WORK EXPENDITURES PER CAPITA.

Variable Descriptions:

Public work expenditures per capita are a function of real property taxbase per capita, personnel property taxbase per capita, percent change population, square miles in a county, and total federal aid per capita.

1) $PWEPC = \alpha_0 + \beta_1 RPTPC + \beta_2 PPTPC + \beta_3 PCHPOP + \beta_4 MISQPC + \beta_5 FAPC$

where α_0, β_1, β_2, β_3, β_4, and β_5 are econometrically estimated coefficients. These estimates are found in section five of the model.

Changes in population are expected to negatively effect public works expenditures. This relationship is hypothesized because public works are characterized by the inability to vary their cost structures and population changes are difficult to respond to immediately. County area is expected to negatively effect public works expenditures based on the hypothesis that because to increased costs less populated areas provide less public works. Real property and Personnel property per capita indicate a demand for public works therefore a positive relationship is expected. Federal grants and matching funds are often available for public work improvements therefore total federal aid is expected to have a positive relationship. (Keeling)

Derivation:

Using the total derivative of the public work expenditures per capita function (equation 1) the model calculates the rate of change (dPWEPC) between the initial year (PWEPC1) and the subsequent year (PWEPC2) (equation 2).

2) $dPWEPC = \beta_1 dRPTPC + \beta_2 dPPTPC + \beta_3 dPCHPOP + \beta_4 dMISQPC + \beta_5 dFAPC$

The model calculates dRPTPC, dPPTPC, dPCHPOP, dMISQPC, and dFAPC as the difference between the initial user supplied values (RPTPC1, PPTPC1, PCHPOP1, MISQPC1, and FAPC1) and the second iteration values (RPTPC2, PPTPC2, PCHPOP2, MISQPC2, and FAPC2) for each independent variable in the function (equation 3).

3) RPTPC2 - RPTPC1 = dRPTPC
PPTPC2 - PPTPC1 = dPPTPC
PCHPOP2 - PCHPOP1 = dPCHPOP
MISQPC2 - MISQPC1 = dMISQPC
FAPC2 - FAPC1 = dFAPC

where dRPTPC, dPPTPC, dPCHPOP, dMISQPC, and dFAPC are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dPWEPC or the rate of change between the initial year (PWEPC1) and the second iteration (PWEPC2) for the dependent variable, public work expenditures per capita (equation 2). This addition takes place in section three of the model. The total rate of change (dPWEPC), for the public work expenditures per capita function, is added to the initial values (PWEPC1) resulting in the projected public work expenditures per capita value (PWEPC2) in the second iteration (equation 4).

4) PWEPC2 = dPWEPC + PWEPC1

Future values for the subsequent year (PWEPC3) are calculated in the same manner, except the PWEPC2 values are used in place of the user supplied initial values (PWEPC1).

Table 13 - System of equations used by the VIP model to calculate COURT EXPENDITURES PER CAPITA PER CAPITA. y = f(POP, POPSQ, PTPOP, SCPC and CPC)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION:-----			
(2)	B47		Total Court Expenditure (base year)
(3)	B87		per capita Total Court Expenditure (base year)
(3)	B87	@if(M87>0,M87,0)	
	M87	B47/B79	
(3)	B79	Input Value	population per capita
-----SECOND ITERATION:-----			
(3)	C87	@if(N87>0,N87,0)	per capita Court Expenditures (t+1 year)
	N87	B87+@sum(B204..BE204)	
-----POP-----			
(6)	B204	B173*B195	population per capita
(see Table 6 for system of equations)			
-----POPSQ-----			
(6)	$B204^2$		$population^2$
(see Table 6 for system of equations)			
-----PTPOP-----			
(6)	S204	T173*T195	town percentage
(5)	T173	econometrically calculated	coefficient court expenditure/town percentage
(6)	T195	C97-B97	percent population in town
(3)	B97	B68/B79*100	percent pop in towns (base year)
(2)	B68	Input Value	town population (base year)
(3)	B79	Input Value	population (base year)
(3)	C97	C68/C79*100	percent population in town (t+1 year)
(2)	C68	((1+C29/100)*B68)+C9	town population
(3)	C79	B79 + @sum(B196+BE196)	population per capita (t+1 year)
(1)	C29	Input Value	town population growth rate
(1)	C9	Input Value	change in town population
-----SCPC-----			
(6)	AO204	AO173*AO195	solved crimes per capita
(5)	AO173	econometrically calculated	coefficient court expenditures/solved crimes per capita
(6)	AO195	C118-B118	difference in solved crimes per capita between base and t+1 years
(3)	B118	Input Value	solved crimes per capita (base year)
(3)	C118	B118+C23	solved crimes per capita (t+1 year)
(1)	C23	Input Value	change solved crimes per capita
(6)	AP204	AP173*AP195	crimes per capita
(5)	AP173	econometrically calculated	coefficient court expenditures/crimes per capita
(6)	AP195	C119-B119	difference in crimes per capita between base and t+1 years
(3)	B119	Input Value	crime per capita (base year)
(3)	C119	B119+C22	crime per capita (t+1 year)
(1)	C22	Input Value	change in crime per capita

Explanation of Table 13 - System of equations used by the VIP model to calculate COURT EXPENDITURES PER CAPITA.

Variable Descriptions:

Court expenditures per capita are a function of population, population squared, town percent, solved crimes, and crime per capita.

1) $CREPC = \alpha_0 + \beta_1 POP + \beta_2 POPSQ + \beta_3 PTPOP + \beta_4 SCPC + \beta_5 CPC$

where α_0, β_1, β_2, β_3, β_4, and β_5 are econometrically estimated coefficients. These estimates are found in section five of the model.

Population represents the relationship between economies of size and court expenditures. Solved crimes decreases the need for courts. (Johnson, Swallow, and Deaton) Crime positively effects court expenditures. Court cost structures are negatively related to percent changes in population. Towns provide judicial services thus reduce the need for court expenditures. (Keeling)

Derivation:

Using the total derivative of the court expenditures per capita function (equation 1) the model calculates the rate of change (dCREPC) between the initial year (CREPC1) and the subsequent year (CREPC2) (equation 2).

2) $dCREPC = \beta_1 dPOP + \beta_2 dPOPSQ + \beta_3 dPTPOP + \beta_4 dSCPC + \beta_5 CPC$

The model calculates dPOP, dPOPSQ, dPTPOP, dSCPC, and dCPC as the difference between the initial user supplied values (POP1, POPSQ1, PTPOP1, SCPC1, and CPC1) and the second iteration values (POP2, POPSQ2, PTPOP2, SCPC2, and CPC2) for each independent variable in the function (equation 3).

3) POP2 - POP1 = dPOP
POPSQ2 - POPSQ1 = dPOPSQ
PTPOP2 - PTPOP1 = dPTPOP
SCPC2 - SCPC1 = dSCPC
CPC2 - CPC1 = dCPC

where dPOP, dPOPSQ, dPTPOP, dSCPC, and dCPC are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dCREPC or the rate of change between the initial year (CREPC1) and the second iteration (CREPC2) for the dependent variable, court expenditures per capita (equation 2). This addition takes place in section three of the model. The total rate of change (dCREPC), for the court expenditures per capita function, is added to the initial values (CREPC1) resulting in the projected court expenditures per capita value (CREPC2) in the second iteration (equation 4).

4) CREPC2 = dCREPC + CREPC1

Future values for the subsequent year (CREPC3) are calculated in the same manner, except the CREPC2 values are used in place of the user supplied initial values (CREPC1).

Table 14 - System of equations used by the VIP model to calculate POLICE EXPENDITURES PER CAPITA. y = f(POP, PPTPC, POPSQ, PTPOP, IPC, INCPC, SCPC, and SMSA)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION:-----			
(2)	B48		Total Police Expenditures (base year)
(3)	B88		per capita Police Expenditures (base year)
(3)	B88	@if(M88>0,M88,0)	
	M88	B48/B79	
(3)	B79	Input Value	population per capita (base year)
-----SECOND ITERATION:-----			
(3)	C88	@if(N88>0,N88,0)	
	N88	B88+@sum(B205..BE205)	
-----POP-----			
(6)	B205	B174*B195	population
(see Table 6 for system of equations)			
-----PPTPC-----			
(6)	H205	H174*H195	personnel property taxbase per capita
(see Table 11 for system of equations)			
-----POPSQ-----			
(6)	Q205	$B205^2$	population ^{2}
(see Table 6 for system of equations)			
-----PTPOP-----			
(6)	T205	T174*T195	town percentage
(5)	T174	econometrically calculated	coefficient police expenditure/town percentage
(6)	T195	C97-B97	difference in percent population in town between base and t+1 years
(3)	B97	B68/B79*100	percent population in town (base year)
(2)	B68	Input Value	town population (base year)
(3)	B79	Input Value	population (base year)
(3)	C97	C68/C79*100	percent population in town (t+1 year)
(2)	C68	((1+C29/100)*B68)+C9	town population (t+1 year)
(3)	C79	B79 + @sum(B196..BE196)	population (t+1 year)
(1)	C29	Input Value	town population growth rate
(1)	C9	Input Value	change town population
-----IPC-----			
(6)	AC205	AC174*AC195	per capita income
(5)	AC174	econometrically calculated	coefficient police expenditures/per capita income
(6)	AC195	C106-B106	difference in per capita income between base and t+1 years
(3)	B106	Input Value	per capita income (base year)
(3)	C106	(B106*(1+C32/100))+C15	per capita income (t+1 year)
(1)	C32	Input Value	real per capita income growth rate
(1)	C15	Input Value	change in per capita income

Table 14 cont. - VIP model to calculate POLICE EXPENDITURES PER CAPITA. y = f(POP, PPTPC, POPSQ, PTPOP, IPC, INCPC, SCPC, and SMSA)

Model Section	Cell Address	Equation	Variable Description
SECOND ITERATION:			
INCPC			
(6)	AI205	AI173*AI195	incommuters per capita
(see Table 8 for system of equations)			
SCPC			
(6)	AO205	AO174*AO195	solved crime per capita
(5)	AO174	econometrically calculated	coefficient police exp/solved crime per capita
(6)	AO195	C118-B118	difference in solved crimes per capita between base and t+1 years
(3)	B116	Input Value	square miles in a county (base year)
(3)	C116	B116+C6	square miles in a county (t+1 year)
(1)	C6	Input Value	change in county area
SMSA			
(6)	AT206	AT174*AT195	miles to SMSA
(5)	AT175	econometrically calculated	coefficient police exp /miles to SMSA
(6)	AT195	C123-B123	difference in miles to SMSA between base and t+1 years
(3)	B123	Input Value	miles to SMSA (base year)
(3)	C123	B123	miles to SMSA (t+1 year)

Explanation of Table 14 - System of equations used by the VIP model to calculate POLICE EXPENDITURES PER CAPITA.

Variable Descriptions:

Police expenditures per capita are a function of population, personnel property taxbase per capita, population squared, town percent, per capita income, incommuters per capita, solved crimes per capita and standard metropolitan statistical area.

1) $PLEPC = \alpha_0 + \beta_1 POP + \beta_2 PPTPC + \beta_3 POPSQ + \beta_4 PTPOP + \beta_5 IPC + \beta_6 INCPC + \beta_7 SCPC + \beta_8 SMSA$

where α_0, β_1, β_2, β_3, β_4, β_5, β_6, β_7 and β_8 are econometrically estimated coefficients. These estimates are found in section five of the model.

Population represents the relationship between police expenditures and economies of scale. Degree of urbanization, which is represented by miles to a Standard Metropolitan Statistical Area (SMSA), is positively related to demand for police expenditures. Solved crimes indicate an increased quality or quantity of police thus increasing expenditures. Crime is a proxy for police demand. Ability to pay for police services is indicated by per capita income. Town population or concentration of population decreases police expenditures. Incommuters increase the need for police during daily commutes. (Keeling)

Derivation:

Using the total derivative of the police expenditures per capita function (equation 1) the model calculates the rate of change (dPLEPC) between the initial year (PLEPC1) and the subsequent year (PLEPC2) (equation 2).

2) $dPLEPC = \beta_1 dPOP + \beta_2 dPPTPC + \beta_3 dPOPSQ + \beta_4 dPTPOP + \beta_5 dIPC + \beta_6 dINCPC + \beta_7 dSCPC + \beta_8 dSMSA$

The model calculates dPOP, dPPTPC, dPOPSQ, dPTPOP, dIPC, dINCPC, dSCPC, and dSMSA as the difference between the initial user supplied values (POP1, PPTPC1, POPSQ1, PTPOP1, IPC1, INCPC1, SCPC1, and SMSA1) and the second iteration values (POP2, PPTPC2, POPSQ2, PTPOP2, IPC2, INCPC2, SCPC2, and SMSA2) for each independent variable in the function (equation 3).

3) POP2 - POP1 = dPOP
PPTPC2 - PPTPC1 = dPPTPC
POPSQ2 - POPSQ1 = dPOPSQ
PTPOP2 - PTPOP1 = dPTPOP
IPC2 - IPC1 = dIPC
INCPC2 - INCPC1 = dINCPC
SCPC2 - SCPC1 = dSCPC
SMSA2 - SMSA1 = dSMSA

where dPOP, dPPTPC, dPOPSQ, dPTPOP, dIPC, dINCPC, dSCPC, and dSMSA are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dPLEPC or the rate of change between the initial year (PLEPC1) and the second iteration (PLEPC2) for the dependent variable, police expenditures per capita (equation 2). This addition takes place in section three of the model. The total rate of change (dPLEPC), for the police expenditures per capita function, is added to the initial values (PLEPC1) resulting in the projected police expenditures per capita value (PLEPC2) in the second iteration (equation 4).

4) PLEPC2 = dPLEPC + PLEPC1

Future values for the subsequent year (PLEPC3) are calculated in the same manner, except the PLEPC2 values are used in place of the user supplied initial values (PLEPC1).

Table 46 - System of equations used by the VIP model to calculate PERCENT POPULATION IN TOWNS.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B97	B68/B79*100	percent population in towns (base year)
(2)	B68	Input Value	town population (base year)
(3)	B79	Input Value	population (base year)
-----Second Iteration-----			
(3)	C97	C68/C79*100	percent population in towns (t+1 year)
(2)	C68	((1+C29/100)*B68)+C9	town population (t+1 year)
(1)	C29	Input Value	town population growth rate
(1)	C9	Input Value	change in town population

Explanation of Table 46 - System of equations used by the VIP model to calculate PERCENT POPULATION IN TOWNS.

The model calculates PTPOP as TPOP1 divided by POP1. The model calculates PTPOP2 in a Similar manner using TPOP2 and POP2 in the calculations. Both POP2 and TPOP2 are estimated in the model (see Tables 5 and 34 respectively).

Table 47 - System of equations used by the VIP model to calculate PERCENT POPULATION IN TOWNS SQUARED.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B98	B97*B97	percent population in towns squared (base year)
(3)	B97	see Table 46	percent population in towns (base year)
-----Second Iteration-----			
(3)	C98	C97*C97	percent population in towns squared (t+1 year)
(3)	C97	see Table 46	percent population in towns (t+1 year)

Table 48 - System of equations used by the VIP model to calculate UNEMPLOYMENT RATE.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B99	B131/B80*100	unemployment rate (base year)
(3)	B131	Input Value	number of unemployed
(3)	B80	Input Value	laborforce (base year)
-----Second Iteration-----			
(3)	C99	C131/C80*100	unemployment rate (t+1 year)
(3)	C131	C33	number unemployed (t+1 year)
(1)	C33	Input Value	number unemployed
(3)	C80	see Table 6	laborforce (t+1 year)

Explanation of Table 48 - System of equations used by the VIP model to calculate UNEMPLOYMENT RATE.

The model calculates UR1 as the number of unemployed by laborforce. Each of these values are supplied by the user. The model calculates UR2 in a Similar manner using estimates of the number of unemployed and laborforce. The number of unemployed is estimated by the user. See Table 6 for the estimation procedure used to calculate laborforce.

Table 49 - System of equations used by the VIP model to calculate GRADUATES PER 100 POPULATION.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B100	Input Value	graduates per 100 population (base year)
-----Second Iteration-----			
(3)	C100	B100+C16	graduates per 100 population (t+1 year)
(1)	C16	Input Value	change in grads per 100 pop

Explanation of Table 49 - System of equations used by the VIP model to calculate GRADUATES PER 100 POPULATION.

Users supply the value of G100 for the first iteration (G1001). The model estimates G1002 as G1001 plus a user supplied estimate of the change in graduates per 100 population (CHG100).

Table 50 - System of equations used by the VIP model to calculate PERCENT NON WHITE POPULATION.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B101	Input Value	percent non white population (base year)
-----Second Iteration-----			
(3)	C101	B101+C20	percent non white population (t+1 year)
(1)	C20	Input Value	change in percent non white population

Explanation of Table 50 - System of equations used by the VIP model to calculate PERCENT NON WHITE POPULATION.

Users supply the value of PNW for the first iteration (PNW1). The model estimates PNW2 as the sum of PNW1 and a user supplied estimate of the change in percent non white population (CHPNW).

Table 51 - System of equations used by the VIP model to calculate MORTALITY.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B102	Input Value	mortality (base year)
-----Second Iteration-----			
(3)	C102	B102+C19	mortality (t+1 year)
(1)	C19	Input Value	change in mortality rate

Explanation of Table 51 - System of equations used by the VIP model to calculate MORTALITY.

Users supply the value of MOR for the first iteration (MOR1). The model estimates MOR2 as the sum of MOR1 and a user supplied estimate of the change in percent non white population (CHMOR).

Table 52 - System of equations used by the VIP model to calculate EMPLOYMENT.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B103	B69+B76	employment (base year)
(2)	B69	see Table 54	residentiary employment (base year)
(2)	B76	see Table 42	base employment (base year)
-----Second Iteration-----			
(3)	C103	C69+C76	employment (t+1 year)
(2)	C69	see Table 54	residentiary employment (t+1 year)
(2)	B76	see Table 42	base employment (t+1 year)

Estimation of Table 52 - System of equations used by the VIP model to calculate EMPLOYMENT.

The model calculates EMP1 as the sum of RE1 and BEMP1. EMP2 is calculated in a Similar manner using estimates of RE2 and BEMP2. See Tables 54 and 42 for the estimation procedure.

Table 53 - System of equations used by the VIP model to calculate EMPLOYMENT PER CAPITA.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B104	B103/B79	employment per capita (base year)
(3)	B103	see Table 52	employment
(3)	B79	Input Value	population (base year)
-----Second Iteration-----			
(3)	C104	C103/C79	employment per capita (t+1 year)
(3)	C103	see Table 52	employment (t+1 year)
(3)	C79	see Table 5	population (t+1 year)

Explanation of Table 53 - System of equations used by the VIP model to calculate EMPLOYMENT PER CAPITA.

The model estimates EMPPC1 as EMP1 divided by POP1. EMPPC2 is estimated in a Similar manner. See Tables 5 and 9 for estimation procedures used to calculate POP2 and EMP2.

Table 54 - System of equations used by the VIP model to calculate RESIDENTIARY EMPLOYMENT PER CAPITA.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B105	B69/B79	residentiary employment per capita (base year)
(2)	B69	see Table 54	residentiary employment (base year)
(3)	B79	Input Value	population (base year)
-----Second Iteration-----			
(3)	C105	C69/C79	residentiary employment per capita (t+1 year)
(2)	C69	see Table 54	residentiary employment (t+1 year)
(3)	C79	see Table 5	population (t+1 year)

Explanation of Table 54 - System of equations used by the VIP model to calculate RESIDENTIARY EMPLOYMENT PER CAPITA.

The model estimates REPC1 as RE1 divided by POP1. REPC2 is estimated in a Similar manner. See Tables 5 and 35 for estimation procedures used to calculate POP2 and RE2.

Table 55 - System of equations used by the VIP model to calculate PER CAPITA INCOME.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B106	Input Value	per capita income (base year)
-----Second Iteration-----			
(3)	C106	(B106*(1+C32/100))+C15	per capita income (t+1 year)
(1)	C32	Input Value	real per capita income growth rate
(1)	C15	Input Value	change in per capita income

Explanation of Table 55 - System of equations used by the VIP model to calculate PER CAPITA INCOME.

Users supply the model with IPC values for the first year (IPC1). The model calculates IPC2 as the product of IPC1 and the change in town population (RIPCGR) plus change in town population (CHIPC).

Table 56 - System of equations used by the VIP model to calculate PER CAPITA INCOME SQUARED.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B107	B106*B106	per capita income squared (base year)
(3)	B106	see Table 55	per capita income (base year)
-----Second Iteration-----			
(3)	C107	C106*C106	per capita income squared (t+1 year)
(3)	C106	see Table 56	per capita income squared (t+1 year)

Table 57 - System of equations used by the VIP model to calculate NUMBER OF BUSINESSES PER CAPITA.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B108	B70/B79	number of businesses (base year)
(2)	B70	Input Value	number of businesses (base year)
(3)	B79	Input Value	population (base year)
-----Second Iteration-----			
(3)	C108	C70/C79	number of businesses (t+1 year)
(2)	C70	Input Value	number of businesses (t+1 year)
(3)	C79	see Table 5	population (t+1 year)

Explanation of Table 57 - System of equations used by the VIP model to calculate NUMBER OF BUSINESSES PER CAPITA.

The model estimates BUSPC1 as BUS1 divided by POP1. BUSPC2 is estimated in a Similar manner. See Tables 5 and 36 for estimation procedures used to calculate POP2 and BUS2.

Table 58 - System of equations used by the VIP model to calculate SALES.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B109	B54*100	sales
(2)	B54	Input Value	sales tax revenue (base year)
-----Second Iteration-----			
(3)	C109	C54*100	sales (t+1 year)
(2)	C54	C134*C39	sales tax revenue (t+1 year)
(3)	C134	see Table 51	sales per capita (t+1 year)
(2)	C39	see Table 5	population (t+1 year)

Explanation of Table 58 - System of equations used by the VIP model to calculate SALES.

Sales are determined through multiplying sales tax revenue by 100. This is base on a 1 percent sales tax, therefore the product of sales tax revenue multiplied by 100 equals sales.

Table 59 - System of equations used by the VIP model to calculate SALES PER CAPITA.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B110	B109/B79	sales per capita (base year)
(3)	B109	see Table 58	sales (base year)
(3)	B79	see Table 5	population (base year)
-----Second Iteration-----			
(3)	C110	C109/C79	sales per capita (t+1 year)
(3)	C109	see Table 58	sales (t+1 year)
(3)	C79	see Table 5	population (t+1 year)

Explanation of Table 59 - System of equations used by the VIP model to calculate SALES PER CAPITA.

The model estimates SLSPC1 as SLS1 divided by POP1. SLSPC2 is estimated in a Similar manner. See tables 5 and 58 for estimation procedures used to calculate POP2 and SLS2.

Table 60 - System of equations used by the VIP model to calculate OUTCOMMUTERS PER CAPITA.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B111	B81/B79	outcommuters per capita (base year)
(3)	B81	see Table 7	outcommuters (base year)
(3)	B79	see Table 5	population (base year)
-----Second Iteration-----			
(3)	C111	C81/C79	outcommuters per capita (t+1 year)
(3)	C81	see Table 7	outcommuters (t+1 year)
(3)	C79	see Table 5	population (t+1 year)

Explanation of Table 60 - System of equations used by the VIP model to calculate OUTCOMMUTERS PER CAPITA.

The model estimates OUTPC1 as OUT1 divided by POP1. OUTPC2 is estimated in a Similar manner. See Tables 5 and 7 for estimation procedures used to calculate POP2 and OUT2.

Table 61 - System of equations used by the VIP model to calculate INCOMMUTERS PER CAPITA.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B112	B82/B79	incommuters per capita (base year)
(3)	B82	see Table 8	incommuters (base year)
(3)	B79	see Table 5	population (base year)
-----Second Iteration-----			
(3)	C112	C82/C79	incommuters per capita (t+1 year)
(3)	C82	see Table 8	incommuters (t+1 year)
(3)	C79	see Table 5	population (t+1 year)

Explanation of Table 61 - System of equations used by the VIP model to calculate INCOMMUTERS PER CAPITA.

The model estimates INPC1 as IN1 divided by POP1. INCPC2 is estimated in a Similar manner. See Tables 5 and 8 for estimation procedures used to calculate POP2 and INC2.

Table 62 - System of equations used by the VIP model to calculate ENROLLMENT SQUARED.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B113	B83*B83	enrollment squared (base year)
(3)	B83	see Table 9	enrollment (base year)
-----Second Iteration-----			
(3)	C113	C83*C83	enrollment squared (t+1 year)
(3)	C83	see Table 9	enrollment (t+1 year)

Table 63 - System of equations used by the VIP model to calculate PERCENT CHANGE IN ENROLLMENT.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B114	Input Value	percent change enrollment (base year)
-----Second Iteration-----			
(3)	C114	(C83-B83)/B83*100	percent change enrollment (t+1 year)
(3)	C83	see Table 9	enrollment (t+1 year)
(3)	B83	see Table 9	enrollment (base year)

Explanation of Table 63 - System of equations used by the VIP model to calculate PERCENT CHANGE ENROLLMENT.

Users supply the model with PCHENRL values for the first year (PCHENRL1). The model calculates PCHENRL2 as the difference between ENRL2 and ENRL1 divided by the ENRL1. See Table 9 for an explanation of enrollment estimations.

Table 64 - System of equations used by the VIP model to calculate INSTRUCTOR PERSONNEL/1000.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B115	Input Value	instructor (base year)
-----Second Iteration-----			
(3)	C115	B115+C17	instructor (t+1 year)
(1)	C17	Input Value	change in teacher:pupil ratio

Explanation of Table 64 - System of equations used by the VIP model to calculate INSTRUCTOR PERSONNEL/1000.

Users supply the value of IP1000 for the first iteration (IP10001). The model estimates IP10002 as IP10001 plus a user supplied estimate of the change in instructor personnel per 1000 (CHIP1000).

Table 65 - System of equations used by the VIP model to calculate SQUARE MILES PER CAPITA.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B116	Input Value	square miles in county (base year)
-----Second Iteration-----			
(3)	C116	B116+C6	square miles in county (t+1 year)
(1)	C6	Input Value	change in county area

Explanation of Table 65 - System of equations used by the VIP model to calculate SQUARE MILES PER CAPITA.

Users supply the value of MISQPC for the first iteration (MISQPC1). The model estimates MISQPC2 as MISQPC1 plus a user supplied estimate of the change in county area (CHCA).

Table 66 - System of equations used by the VIP model to calculate SQUARE MILES PER CAPITA PER CAPITA.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B117	B116/B79	square miles in county per capita (base year)
(3)	B116	see Table 65	square miles in county (base year)
(3)	B79	Input Value	population (base year)
-----Second Iteration-----			
(3)	C117	C116/C79	square miles in county per capita (t+1 year)
(3)	C116	see Table 65	square miles in county (t+1 year)
(3)	C79	see Table 5	population (t+1 year)

Explanation of Table 66 - System of equations used by the VIP model to calculate SQUARE MILES PER CAPITA PER CAPITA.

Users supply the value of MISQPC for the first iteration (MISQPC1). The model estimates MISQPC2 as MISQPC1 plus a user supplied estimate of the change in county area (CHCA).

Table 67 - System of equations used by the VIP model to calculate SOLVED CRIMES PER CAPITA.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B118	Input Value	solved crimes per capita (base year)
-----Second Iteration-----			
(3)	C118	B118+C23	solved crimes per capita (t+1 year)
(1)	C23	Input Value	change in solved crimes per capita (t+1 year)

Explanation of Table 67 - System of equations used by the VIP model to calculate SOLVED CRIMES PER CAPITA.

Users supply the value of SCPC for the first iteration (SCPC1). The model estimates SCPC2 as SCPC1 plus a user supplied estimate of the change in crime (CHSC).

Table 68 - System of equations used by the VIP model to calculate CRIME PER CAPITA.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B119	Input Value	crimes per capita (base year)
-----Second Iteration-----			
(3)	C119	B119+C22	crimes per capita (t+1 year)
(1)	C22	Input Value	change in crimes per capita (t+1 year)

Explanation of Table 68 - System of equations used by the VIP model to calculate CRIME PER CAPITA.

Users supply the value of CPC for the first iteration (CPC1). The model estimates CPC2 as CPC1 plus a user supplied estimate of the change in crime (CHC).

Table 69 - System of equations used by the VIP model to calculate FIRE PROTECTION RATING.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B120	Input Value	fire protection rating (base year)
-----Second Iteration-----			
(3)	C120	B120+C21	fire protection rating (t+1 year)
(1)	C21	Input Value	change in fire protection rating (t+1 year)

Explanation of Table 69 - System of equations used by the VIP model to calculate FIRE PROTECTION RATING.

Users supply the value of FPR for the first iteration (FPR1). The model estimates FPR2 as FPR1 plus a user supplied estimate of the change in crime (CHFPR).

Table 70 - System of equations used by the VIP model to calculate PROFESSIONAL:VOLUNTEER FIREMEN RATIO.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B121	Input Value	professional:volunteer firemen ratio (base year)
-----Second Iteration-----			
(3)	C121	B121+C24	professional:volunteer firemen ratio (t+1 year)
(1)	C24	Input Value	change in professional:volunteer firemen ratio (t+1 year)

Explanation of Table 70 - System of equations used by the VIP model to calculate PROFESSIONAL:VOLUNTEER FIREMEN RATIO.

Users supply the value of RVPF for the first iteration (RVPF1). The model estimates RVPF2 as RVPF1 plus a user supplied estimate of the change in professional:volunteer firemen ratio (CHRVPF).

Table 71 - System of equations used by the VIP model to calculate DEVELOPMENT GROUP.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B122	Input Value	development group (base year)
-----Second Iteration-----			
(3)	C122	B122	development group (t+1 year)

Explanation of Table 71 - System of equations used by the VIP model to calculate DEVELOPMENT GROUP.

Dummy variable indicating the county has an organized development group. Value is one if the area has a development group and zero otherwise.

Table 72 - System of equations used by the VIP model to calculate MILES TO SMSA.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B123	Input Value	miles to SMSA (base year)
-----Second Iteration-----			
(3)	C123	B123	miles to SMSA (t+1 year)

Explanation of Table 72 - System of equations used by the VIP model to calculate MILES TO SMSA.

SMSA measures the distance from the center of the county to a Standard Metropolitan Statistical Area. Users supply the model with a value.

Table 73 - System of equations used by the VIP model to calculate TOTAL LOCAL GOVERNMENT EXPENDITURES PER CAPITA.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B124	(B58+B50+B56+B48+B57 +B51+B47+B53+B46)/B79	total local government expenditures per capita (base year)
(2)	B58	Input Value	fire protection expenditure (base year)
(2)	B50	Input Value	parks and recreation expenditure (base year)
(2)	B56	Input Value	correction and detention expenditures (base year)
(2)	B48	Input Value	police expenditures (base year)
(2)	B57	Input Value	health expenditures (base year)
(2)	B51	Input Value	welfare expenditure (base year)
(2)	B47	Input Value	court expenditure (base year)
(2)	B53	Input Value	development expenditure (base year)
(2)	B46	Input Value	public works expenditures (base year)
(3)	B79	Input Value	population (base year)
-----Second Iteration-----			
(3)	C124	(C58+C50+C56+C48+C57 +C51+C47+C53+C46)/C79	total local government expenditures per capita (t+1 year)
(2)	C58	C138*C39	fire protection expenditure (t+1 year)
(3)	C138	see Table 24	fire expenditures per capita (t+1 year)
(2)	C39	see Table 5	population (t+1 year)
(2)	C50	C90*C39	parks and recreation expenditures (t+1 year)
(3)	C90	see Table 16	recreation expenditures per capita (t+1 year)
(2)	C56	C136*C39	correction and detention expenditures (t+1 year)
(3)	C136	see Table 22	jail expenditures per capita (t+1 year)
(2)	C48	C88*C39	police expenditures (t+1 year)
(3)	C88	see Table 14	police expenditures per capita (t+1 year)
(2)	C57	C137*C39	health expenditures (t+1 year)
(3)	C137	see Table 23	health expenditures per capita (t+1 year)
(2)	C51	C91*C39	welfare expenditure (t+1 year)
(3)	C91	see Table 17	welfare expenditures per capita (t+1 year)
(2)	C47	C87*C39	court expenditure (t+1 year)
(3)	C87	see Table 13	court expenditures per capita (t+1 year)
(2)	C53	C93*C39	development expenditure (t+1 year)
(3)	C93	see Table 19	development expenditures per capita (t+1 year)
(2)	C46	C86*C39	public works expenditures (t+1 year)
(3)	C86	see Table 12	public work expenditures per capita (t+1 year)
(3)	C79	see Table 5	population (t+1 year)

Explanation of Table 73 - System of equations used by the VIP model to calculate TOTAL LOCAL GOVERNMENT EXPENDITURES PER CAPITA.

This variable is the sum of the per capita expenditure values of the county excluding education and administration. Users supply these figures for the first iteration. The model uses estimates of these variables for the second iteration. See the tables listed above for an explanation of the estimation procedures. Because these estimates are terms of per capita units population is multiplied to obtain an amount base on total units.

Table 74 - System of equations used by the VIP model to calculate TOTAL FEDERAL AID PER CAPITA.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B125	B71/B79	total federal aid per capita (base year)
(2)	B71	see Table 37	total federal aid (base year)
(3)	B79	Input Value	population (base year)
-----Second Iteration-----			
(3)	C125	C71/C79	total federal aid per capita (t+1 year)
(2)	C71	see Table 37	total federal aid (t+1 year)
(3)	C79	see Table 5	population (t+1 year)

Explanation of Table 74 - System of equations used by the VIP model to calculate TOTAL FEDERAL AID PER CAPITA.

The model estimates FAPC1 as FA1 divided by POP1. Both FAPC1 and POP1 are user supplied values. FACPC2 is estimated in a similar manner except FAPC2 and POP2 estimates are used in the model. The model estimates FAPC2 and POP2 (see Tables 37 and 5).

Table 75 - System of equations used by the VIP model to calculate PUBLIC SAFETY EXPENDITURE PER CAPITA.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B126	@IF(M126>0,M126,0)	public safety expenditure per capita (base year)
	M126	(B48+B58+B56)/B79	
(2)	B48	Input Value	police expenditures (base year)
(2)	B58	Input Value	fire protection expenditure (base year)
(2)	B56	Input Value	correction and detention expenditures (base year)
(3)	B79	Input Value	population (base year)
-----Second Iteration-----			
(3)	C126	@IF(N126>0,N126,0)	public safety expenditure per capita (t+1 year)
	N126	(C48+C58+C56)/C79	
(2)	C48	C88*C39	police expenditures (t+1 year)
(3)	C88	see Table 14	police expenditures per capita (t+1 year)
(2)	C58	C138*C39	fire protection expenditure (t+1 year)
(3)	C138	see Table 24	fire expenditures per capita (t+1 year)
(2)	C56	C136*C39	correction and detention expenditures (t+1 year)
(3)	C136	see Table 22	jail expenditures per capita (t+1 year)
(3)	C79	see Table 5	population (t+1 year)

Explanation of Table 75 - System of equations used by the VIP model to calculate PUBLIC SAFETY EXPENDITURES PER CAPITA.

Public safety expenditures per capita are calculated by summing all safety related expenditures (police, fire, and jail) and dividing by population. Users supply these figures for the first iteration. The model calculates PSEPC2 using estimates of PLEPC2, FEPC2, and FEPC2. These estimates are explained in Tables 14, 24, and 22 respectively.

Table 76 - System of equations used by the VIP model to calculate CONTIGUOUS LABORFORCE.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B127	Input Value	contiguous laborforce (base year)
-----Second Iteration-----			
(3)	C127	((1+C30/100)*B127)+C11	contiguous laborforce (t+1 year)
(1)	C30	Input Value	contiguous laborforce growth rate
(1)	C11	Input Value	change in contiguous laborforce

Explanation of Table 76 - System of equations used by the VIP model to calculate CONTIGUOUS LABORFORCE.

Users supply the model with CGLAB values for the first year (CGLAB1). The model calculates CGLAB2 as the product of CGLAB1 and the change in contiguous laborforce (CGLABGR) plus change in contiguous laborforce (CHCGLAB).

Table 77 - System of equations used by the VIP model to calculate CONTIGUOUS EMPLOYMENT.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B128	Input Value	contiguous employment (base year)
-----Second Iteration-----			
(3)	C128	((1+C27/100)*B128)+C10	contiguous employment (t+1 year)
(1)	C27	Input Value	contiguous employment growth rate
(1)	C10	Input Value	change in contiguous employment

Explanation of Table 77 - System of equations used by the VIP model to calculate CONTIGUOUS EMPLOYMENT.

Users supply the model with CGEMP values for the first year (CGEMP1). The model calculates CGEMP2 as the product of CGEMP1 and the change in contiguous employment (CGEMPGR) plus change in contiguous employment (CHCGEMP).

Table 78 - System of equations used by the VIP model to calculate NUMBER OF BUSINESSES.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B130	B70	number of businesses (base year)
(2)	B70	see Table 36	number of businesses (base year)
-----Second Iteration-----			
(3)	C130	C70	number of businesses (t+1 year)
(2)	C70	see Table 36	number of businesses (t+1 year)

Explanation of Table 78 - System of equations used by the VIP model to calculate NUMBER OF BUSINESSES.

See Table 36 for an explanation of the equations used to calculate BUSPC1 AND BUSPC2.

Table 79 - System of equations used by the VIP model to calculate NUMBER OF UNEMPLOYED.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B131	Input Value	number of unemployed (base year)
-----Second Iteration-----			
(3)	C131	C33	number of unemployed (t+1 year)
(1)	C33	Input Value	number of unemployed

Explanation of Table 79 - System of equations used by the VIP model to calculate NUMBER OF UNEMPLOYED.

Users supply the model with UEMP values for the first year (UEMP1). The model uses the user supplied estimate of the number of unemployed as an estimate of UEMP2. This number is found in section 1 of the model.

Table 80 - System of equations used by the VIP model to calculate COST CONSTANT SERVICE.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B147	B153/B79	constant cost service (base year)
(3)	B79	see Table 5	population
(4)	B153	see Table 83	total expenditures
-----Second Iteration-----			
(3)	C147	B147+@SUM(N150..Q150)	constant cost service (t+1 year)
	N150	@SUM(B203..B208,B213..B215) + B210 + (B209*B83/B79) - B206 - B208	
(6)	B204	B173*B195	population delta
(see Table 5 for system of equations)			
(6)	B205	B174*B195	population delta
(see Table 5 for system of equations)			
(6)	B207	B176*B195	population delta
(see Table 5 for system of equations)			
(6)	B211	B180*B195	population delta
(see Table 5 for system of equations)			
(6)	B213	B182*B195	population delta
(see Table 5 for system of equations)			
(3)	B83	see Table 9	enrollment
(3)	B79	see Table 5	population
	O150	@SUM(F203..F208,F213..F215) + F210 + (F209*B83/B79) - F206 - F208	
(6)	F209	F178*F195	enrollment delta
(see Table 9 for system of equations)			
(3)	B83	see Table 9	enrollment delta
(3)	B79	see Table 5	population
	P150	@SUM(Q203..Q208,Q213..Q215) + Q210 + (Q209*B83/B79) - Q206 - Q208	
(6)	Q207	Q176*Q195	population^2 delta
(see Table 6 for system of equations)			
(6)	Q213	Q213*Q195	population^2 delta
(see Table 6 for system of equations)			
(3)	B83	see Table 9	enrollment
(3)	B79	see Table 5	population
	Q150	@SUM(AJ203..AJ208,AJ213..AJ215) + AJ210 + (AJ209*B83/B79) - AJ206 - AJ208	
(6)	AJ209	AJ178*AJ195	enrollment delta
(see Table 9 for system of equations)			

Explination of Table 80 - System of equations used by the VIP model to calculate COST CONSTANT SERVICE.

Cost of constant service indicates the per capita cost of the area's total expenditure package if the only adjustments allowed with only adjustments made in population. This variable shows the cost of providing a constant quantity and quality of service for the population. (Keeling et al)

Table 81 - System of equations used by the VIP model to calculate TOTAL EXPENSES PER CAPITA

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B148	B153/B79	total expense per capita (base year)
(3)	B79	see Table 5	population (base year)
(4)	B153	see Table 83	total expenditures (base year)
-----Second Iteration-----			
(3)	C148	C153/C79	total expense per capita (t+1 year)
(3)	C79	see Table 5	population (t+1 year)
(4)	B153	see Table 83	total expenditures (t+1 year)

Explination of Table 81 - System of equations used by the VIP model to calculate TOTAL EXPENSES PER CAPITA.

This variables is the sum of all expenditure categories.

Table 82 - System of equations used by the VIP model to calculate QUANTITY/QUALITY CHANGE.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B149	(B148-B147)/B147*100	quantity/quality change (base year)
(3)	B148	see Table 81	total expense per capita (base year)
(3)	B147	see Table 80	cost constant service (base year)
-----Second Iteration-----			
(3)	C149	(C148-C147)/C147*100	quantity/quality change (t+1 year)
(3)	C148	see Table 81	total expense per capita (t+1 year)
(3)	C147	see Table 80	cost constant service (t+1 year)

Explination of Table 82 - System of equations used by the VIP model to calculate QUANTITY/QUALITY CHANGE.

This variable represents the change in quality or quantity of a service received by the residents of the area. (keeling et al)

SECTION FIVE

SUMMARY VARIABLES USED BY THE VIRGINIA IMPACT PROJECTION MODEL

Table 83 - System of equations used by the VIP model to calculate TOTAL EXPENDITURES.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(4)	B153	@SUM(B46..B53)+@SUM(B56..B58)	total expenditures (base year)
(2)	B46..B53	Input Values	expenditures (base year)
(2)	B56..B58	Input Values	expenditures (base year)
-----Second Iteration-----			
(4)	C153	@SUM(C46..C53)+@SUM(C56..C58)	total expenditures (t+1 year)
-----PWE-----			
(2)	C46	C86*C39	public works expenditures (t+1 year)
(3)	C86	see Table 12	public works expenditures per capita
(2)	C39	see Table 5	population (t+1 year)
-----CRE-----			
(2)	C47	C87*C39	court expenditures (t+1 year)
(3)	C87	see Table 13	court expenditures per capita
(2)	C39	see Table 5	population (t+1 year)
-----PLE-----			
(2)	C48	C88*C39	police expenditures (t+1 year)
(3)	C88	see Table 14	police expenditures per capita
(2)	C39	see Table 5	population (t+1 year)
-----ADE-----			
(2)	C49	C89*C39	administration expenditures (t+1 year)
(3)	C89	see Table 15	administration expenditures per capita
(2)	C39	see Table 5	population (t+1 year)
-----RCE-----			
(2)	C50	C90*C39	recreation expenditures (t+1 year)
(3)	C90	see Table 16	recreation expenditures per capita
(2)	C39	see Table 5	population (t+1 year)
-----WE-----			
(2)	C51	C91*C39	welfare expenditures (t+1 year)
(3)	C91	see Table 17	welfare expenditures per capita
(2)	C39	see Table 5	population (t+1 year)
-----EDE-----			
(2)	C52	C92*C39	educational expenditures (t+1 year)
(3)	C92	see Table 18	educational expenditures per capita
(2)	C39	see Table 5	population (t+1 year)
-----DE-----			
(2)	C53	C93*C39	development expenditures (t+1 year)
(3)	C93	see Table 19	development expenditures per capita
(2)	C39	see Table 5	population (t+1 year)
-----JE-----			
(2)	C56	C136*C39	jail expenditures (t+1 year)
(3)	C136	see Table 22	jail expenditures per capita
(2)	C39	see Table 5	population (t+1 year)
-----MHE-----			
(2)	C57	C137*C39	mental health and health expenditures (t+1 year)
(3)	C137	see Table 23	mental health and health expenditures per capita
(2)	C39	see Table 5	population (t+1 year)

Table 83 cont. - System of equations used by the VIP model to calculate TOTAL EXPENDITURES.

Model Section	Cell Address	Equation	Variable Description
-----Second Iteration-----			
-----FE-----			
(2)	C58	C138*C39	fire expenditures (t+1 year)
(3)	C138	see Table 24	fire expenditures per capita
(2)	C39	see Table 5	population (t+1 year)

Explination of Table 83 - System of equations used by the VIP model to calculate TOTAL EXPENDITURES.

Total dollar value of all expenditures.

Table 84 - System of equations used by the VIP model to calculate TOTAL NON LOCAL AID.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(4)	B154	B73	total non local aid (base year)
(2)	B73	see Table 39	
-----Second Iteration-----			
(4)	C154	C73	total non local aid (t+1 year)
(2)	C73	see Table 39	

Explination of Table 84 - System of equations used by the VIP model to calculate TOTAL NON LOCAL AID.

Total dollar value of all non local aid.

Table 85 - System of equations used by the VIP model to calculate SALES TAX REVENUES.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(4)	B155	B54	sales tax revenues (base year)
(2)	B54	Input Value	sales tax revenue
-----Second Iteration-----			
(4)	C155	C54	sales tax revenues (t+1 year)
(2)	C54	C134*C39	sales tax revenues
(3)	C134	see Table 20	sales tax revenues per capita
(2)	C39	see Table 5	population

Explination of Table 85 - System of equations used by the VIP model to calculate SALES TAX REVENUES.

Same as Table 20.

Table 86 - System of equations used by the VIP model to calculate OTHER TAX REVENUES.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(4)	B156	B55	other tax revenues (base year)
(2)	B55	Input Value	other tax revenue
-----Second Iteration-----			
(4)	C156	C55	other tax revenues (t+1 year)
(2)	C554	C135*C39	other tax revenues
(3)	C135	see Table 21	other tax revenues per capita
(2)	C39	see Table 5	population

Explination of Table 86 - System of equations used by the VIP model to calculate OTHER TAX REVENUES.

Same a Table 21.

Table 87 - System of equations used by the VIP model to calculate LOCAL TAX BURDEN.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(4)	B157	B153-B154-B155-B156	local tax burden (base year)
(4)	B153	see Table 83	total expenditures (base year)
(4)	B154	see Table 84	total non local aid (base year)
(4)	B155	see Table 85	sales tax revenues (base year)
(4)	B156	see Table 86	other tax revenues (base year)
-----Second Iteration-----			
(4)	C157	C153-C154-C155-C156	local tax burden (t+1 year)
(4)	C153	see Table 83	total expenditures (t+1 year)
(4)	C154	see Table 84	total non local aid (t+1 year)
(4)	C155	see Table 85	sales tax revenues (t+1 year)
(4)	C156	see Table 86	other tax revenues (t+1 year)

Explination of Table 87 - System of equations used by the VIP model to calculate LOCAL TAX BURDEN.

Represents the dollar amount that must be supplied by an area.

Table 88 - System of equations used by the VIP model to calculate PROPERTY TAX BASE.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(4)	B158	B44+B45	property tax base (base year)
(2)	B44	Input Value	real propery taxbase
(2)	B45	Input Value	personal property tax
-----Second Iteration-----			
(4)	C158	C44+C45	property tax base (t+1 year)
(2)	C44	C84*C39	real property tax (t+1 year)
(3)	C84	see Table 10	real property tax per capita
(2)	C39	see Table 5	population (t+1 year)

Explination of Table 88 - System of equations used by the VIP model to calculate PROPERTY TAX BASE.

Equals the value of taxable real and personal property in the area.

Table 89 - System of equations used by the VIP model to calculate PROXY OF TAX BURDEN.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(4)	B159	B157/B158*100	proxy of tax burden (base year)
(4)	B157	see Table 87	local tax burden
(4)	B158	see Table 88	property tax base
-----Second Iteration-----			
(4)	C159	C157/C158*100	proxy of tax burden (t+1 year)
(4)	C157	see Table 87	local tax burden
(4)	C158	see Table 88	property tax base

Explination of Table 89 - System of equations used by the VIP model to calculate PROXY OF TAX BURDEN.

This variable allows users to compare expected tax burden for with and without scenerios.

Table 90 - System of equations used by the VIP model to calculate BOTTOM LINE (CASH FLOW).

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(4)	B160	AB157-AB158*B159/100	bottom line cash flow (base year)
	AB157	see Table 87	local tax burden with shock
	AB158	see Table 88	property tax base with shock
(4)	B159	see Table 89	proxy of tax burden
-----Second Iteration-----			
(4)	C160	AC157-AC158*C159/100	bottom line cash flow (t+1 year)
	AC157	see Table 87	local tax burden without shock
	AC158	see Table 88	property tax base without shock
(4)	C159	see Table 89	proxy of tax burden

Explination of Table 90 - System of equations used by the VIP model to calculate BOTTOM LINE (CASH FLOW).

Table 91 - System of equations used by the VIP model to calculate BOTTOM LINE (CONSTANT QUALITY).

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(4)	B160	AB157-AB158*B159/100	
		+ (B148-B147-AB148+AB147)*AB39	bottom line cash flow (base year)
	AB157	see Table 87	local tax burden with shock
	AB158	see Table 88	property tax base with shock
(4)	B159	see Table 89	proxy of tax burden
(3)	B148	see Table 81	total expense per capita
(3)	B147	see Table 82	quantity/quality change
	AB148	see Table 81	total expense per capita with shock
		see Table 82	quantity/quality change
	AB39	see Table 5	population with shock
-----Second Iteration-----			
(4)	C160	AC157-AC158*C159/100	bottom line cash flow (t+1 year)
		+ (C148-C147-AC148+AC147)*AC39	bottom line cash flow (base year)
	AC157	see Table 87	local tax burden without shock
	AC158	see Table 88	property tax base without shock
(4)	C159	see Table 89	proxy of tax burden
	AC157	see Table 87	local tax burden without shock
	AC158	see Table 88	property tax base without shock
(4)	C159	see Table 89	proxy of tax burden
(3)	C148	see Table 81	total expense per capita
(3)	C147	see Table 82	quantity/quality change
	AC148	see Table 81	total expense per capita without shock
		see Table 82	quantity/quality change
	AC39	see Table 5	population without shock

Explination of Table 91 - System of equations used by the VIP model to calculate BOTTOM LINE (CONSTANT QUALITY).

References

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Keeling, John R. A Fiscal Impact Model for Virginia Localities. Virginia Polytechnic Institute, Department of Agricultural Economics. Unpublished PhD. dissertation.

Keeling, John R., T.G. Johnson, and J. Wagner. "Virginia Impact Projections (VIP) Model Technical Manual." Revised December 1986.

Table 23 - System of equations used by the VIP model to calculate **MENTAL HEALTH AID PER CAPITA.** y = f(IPC and FAPC)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION:-----			
(3)	B137	@if(M137>0,M137,0)	per capita Mental Health aid (base year)
	M137	B57/B39	
(2)	B57	Input Value	health expenditures (base year)
(2)	B39	B79	population
-----SECOND ITERATION:-----			
(3)	C137	@if(N137>0,N137,0)	mental health and health expenditure
	N137	B137 + @SUM(B214.. BD214)	
-----IPC-----			
(6)	AC214	AC183*AC195	per capita income
(5)	AC183	econometrically calculated	coefficient mental health exp/per capita income
(6)	AC195	C106-B106	difference in per capita income between base and t+1 years
(3)	B106	Input Value	per capita income (base year)
(3)	C106	B106*(1+C32/100))+C15	per capita income (t+1 year)
(1)	C32	Input Value	real per capita income growth rate
(1)	C15	Input Value	change in per capita income
-----FAPC-----			
(6)	AV214	AV214*AV195*D26	total federal aid
(5)	AV213	econometrically calculated	coefficient mental health exp/tot fed aid
(6)	AV195	C125-B125	difference in total federal aid between base and t+1 years
(1)	D26	Input Value	response to change in federal aid
(3)	C125	C71/C79	total federal aid (t+1 year)
(2)	C71	(B75*B74)+C25	total federal aid (t+1 year)
(1)	C25	Input Value	change in federal aid
(2)	B74	@sum(B59..B67)	predicted total aid (federal and state)
(2)	B75	B71/B73	actual federal aid (base year)
(2)	B71	Input Value	total federal aid (base year)
(2)	B73	B74	actual total aid (base year)

Explanation of Table 23 - System of equations used by the VIP model to calculate **MENTAL HEALTH AND HEALTH AID PER CAPITA.**

Variable Description:

Mental health and health aid are a function of per capita income and total federal aid.

1) $MHEPC = \alpha_0 + \beta_1 IPC + \beta_2 FAPC$

where α_0, β_1, and β_2 are econometrically estimated coefficients. These estimates are found in section five of the model.

Per capita income indicates the ability to support mental health and health expenditures. Federal aid indicates the level of need for mental health and health expenditures. (Keeling)

<u>Derivation</u>:

Using the total derivative of the mental health and health aid function (equation 1) the model calculates the rate of change (dMHEPC) between the initial year (MHEPC1) and the subsequent year (MHEPC2) (equation 2).

2) $dMHEPC = \beta_1 dIPC + \beta_2 dFAPC$

The model calculates dIPC and dFAPC as the difference between the initial user supplied values (IPC1 and FAPC1) and the second iteration values (IPC2 and FAPC2) for each independent variable in the function (equation 3).

3) $IPC2 - IPC1 = dIPC$
$FAPC2 - FAPC1 = dFAPC$

where dIPC and dFAPC are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dMHEPC or the rate of change between the initial year (MHEPC1) and the second iteration (MHEPC2) for the dependent variable, mental health and health aid (equation 2). This addition takes place in section three of the model. The total rate of change (dMHEPC), for the mental health and health aid function, is added to the initial values (MHEPC1) resulting in the projected mental health and health aid value (MHEPC2) in the second iteration (equation 4).

4) $MHEPC2 = dMHEPC + MHEPC1$

Future values for the subsequent year (MHEPC3) are calculated in the same manner, except the MHEPC2 values are used in place of the user supplied initial values (MHEPC1).

Table 24 - System of equations used by the VIP model to calculate FIRE EXPENDITURES PER CAPITA. y = f(RPTPC, PTPOP, IPC, CPC, and FPR).

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION:			
(3)	B138	@if(M138>0,M138,0)	Fire Expense Per Capita (base year)
	M138	B58/B39	
(2)	B58	Input Value	fire protection expenditure
(2)	B39	B79	population
-----SECOND ITERATION:			
(3)	C138	@IF(N138>0,N138,0)	fire expense per capita (t+1 years)
	N138	B138 + @SUM(B215..BD215)	
-----RPTPC			
(6)	G215	G184*G195	real property taxbase
(see Table 10 for system of equations)			
-----PTPOP			
(6)	T215	T184*T195	town percent
(5)	T184	econometrically calculated	coefficient fire expenditure/town percentage
(6)	T195	C97-B97	difference in percent population in town between base and t+1
(3)	B97	B68/B79/100	percent pop in towns (base year)
(2)	B68	Input Value	town population (base year)
(3)	B79	Input Value	population (base year)
(3)	C97	C68/C79*100	percent population in town (t+1 year)
(2)	C68	((1+C29/100)*B68)+C9	town population
(1)	C29	Input Value	town population growth rate
(1)	C9	Input Value	change in town population
-----IPC			
(6)	AC215	AC184*AC195	per capita income
(5)	AC183	econometrically calculated	coefficient fire exp/per capita income
(6)	AC195	C106-B106	difference in per capita income between base and t+1 years
(3)	B106	Input Value	per capita income (base year)
(3)	C106	(B106*(1+C32/100))+C15	per capita income (t+1 year)
(1)	C32	Input Value	real per capita income growth rate
(1)	C15	Input Value	change in per capita income
-----CPC			
(6)	AP215	AP184*AP195	crime
(5)	AP184	econometrically calculated	coefficient fire exp/crime
(6)	AP195	C119-B119	difference crime per capita between base and t+1 years
(3)	B119	Input Value	crime per capita (base year)
(3)	C119	B119+C22	crime per capita (t+1 year)
(1)	C22	Input Value	change in crime per capita

Table 24 cont. - System of equations used by the VIP model to calculate FIRE EXPENDITURES PER CAPITA. y = f(RPTPC, PTPOP, IPC, CPC, and FPR).

Model Section	Cell Address	Equation	Variable Description
-----SECOND ITERATION:			
-----FPR			
(6)	AQ215	AQ184*AQ195	fire protection rate
(5)	AQ184	econometrically calculated	coefficient fire exp/fire protection
(6)	AQ195	C120-B120	difference fire protection rating between base and t+1 years
(3)	B120	Input Value	fire protection rating (base year)
(3)	C120	B120+C21	fire protection rating (t+1 year)
(1)	C21	Input Value	change in fire protection rating

Explanation of Table 24 - System of equations used by the VIP model to calculate FIRE EXPENDITURES PER CAPITA.

Variable Descriptions:

Fire expense per capita are a function of real property taxbase per capita, percent town population, per capita income, crime, and fire protection rating.

1) $FEPC = \alpha_0 + \beta_1 RPTPC + \beta_2 PTPOP + \beta_3 IPC + \beta_4 CPC + \beta_5 FPR$

where α_0, β_1, β_2, β_3, β_4, and $\beta_5$are econometrically estimated coefficients. These estimates are found in section five of the model.

Fire protection is positively related to the level of arson activity. Crime is a proxy for arson activity. Low fire protection ratings, an insurance industry measure, is correlated with higher quality services thus higher expenditure levels. Real property per capita indicates the level of property protection. Ability to pay is indicated by per capita income. Similar to crime prevention, percent town population decreases expenditures. (Keeling)

Derivation:

Using the total derivative of the fire expense per capita function (equation 1) the model calculates the rate of change (dFEPC) between the initial year (FEPC1) and the subsequent year (FEPC2) (equation 2).

2) $dFEPC = \beta_1 dRPTPC + \beta_2 dPTPOP + \beta_3 dIPC + \beta_4 dCPC + \beta_5 dFPR$

The model calculates dRPTPC, dPTPOP, dIPC, dCPC, and dFPR as the difference between the initial user supplied values (RPTPC1, PTPOP1, IPC1, PC1, and FPR1) and the second iteration values (RPTPC2, PTPOP2, IPC2, INCPC2, CPC2, and FPR2) for each independent variable in the function (equation 3).

3) RPTPC2 - RPTPC1 = dRPTPC
PTPOP2 - PTPOP1 = dPTPOP
IPC2 - IPC1 = dIPC
CPC2 - CPC1 = dCPC
FPR2 - FPR1 = dFPR

where dRPTPC, dPTPOP, dIPC, dCPC, and dFPR are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dFEPC or the rate of change between the initial year (FEPC1) and the second iteration (FEPC2) for the dependent variable, fire expense per capita (equation 2). This addition takes place in section three of the model. The total rate of change (dFEPC), for the fire expense per capita function, is added to the initial values (FEPC1) resulting in the projected fire expense per capita value (FEPC2) in the second iteration (equation 4).

4) FEPC2 = dFEPC + FEPC1

Future values for the subsequent year (FEPC3) are calculated in the same manner, except the FEPC2 values are used in place of the user supplied initial values (FEPC1).

Table 25 - System of equations used by the VIP model to calculate NON LOCAL PUBLIC WORK AID PER CAPITA. y = f(PPTPC, PWEPC, and IPC)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION:-----			
(3)	B139	@if(M139>0,M139,0)	non local public work aid per capita (base year)
	M139	B59/B39	
(2)	B59	Input Value	non local public work aid
(2)	B39	B79	population
-----SECOND ITERATION:-----			
(3)	C139	@if(N139>0,N139,0)	non local public work aid per capita (t+1 year)
	N139	B139+@SUM(B216..BD216)	
-----PPTPC-----			
(6)	H216	H185*H195	personnel property taxbase
(see Table 11 for system of equations)			
-----PWEPC-----			
(6)	I216	I185*I195	public work expense
(see Table 12 for system of equations)			
-----IPC-----			
(6)	AC216	AC185*AC195	per capita income
(5)	AC185	econometrically calculated	coefficient nl public work aid per capita/per capita income
(6)	AC195	C106-B106	difference in per capita income between base and t+1 years
(3)	C106	B106*(1+C32/100))+C15	per capita income (t+1 year)
(3)	B106	Input Value	per capita income (base year)
(1)	C32	Input Value	real per capita income growth rate
(1)	C15	Input Value	change in per capita income

Explanation of Table 25 - System of equations used by the VIP model to calculate NON LOCAL PUBLIC WORK AID PER CAPITA.

Variable Descriptions:

Non local public work aid are a function of personnel property taxbase, public work expense, and per capita income.

1) $NLPWAPC = \alpha_0 + \beta_1 PPTPC + \beta_2 PWEPC + \beta_3 IPC$

where α_0, β_1, β_2, and β_3 are econometrically estimated coefficients. These estimates are found in section five of the model.

Aid for public works is expected to increase with the number of sales because businesses demand a high number of public work services. Public work expenditures is also expected to increase aid. Political power represented by per capita income and Personnel property per capita is hypothesized to be positively related to public work aid. (Keeling)

Derivation:

Using the total derivative of the non local public work aid function (equation 1) the model calculates the rate of change (dNLPWAPC) between the initial year (NLPWAPC1) and the subsequent year (NLPWAPC2) (equation 2).

2) $dNLPWAPC = \beta_1 dPPTPC + \beta_2 dPWEPC + \beta_3 dIPC$

The model calculates dPPTPC, dPWEPC, and dIPC as the difference between the initial user supplied values (PPTPC1, PWEPC1, and IPC1) and the second iteration values (PPTPC2, PWEPC2, and IPC2) for each independent variable in the function (equation 3).

3) PPTPC2 - PPTPC1 = dPPTPC
PWEPC2 - PWEPC1 = dPWEPC
IPC2 - IPC1 = dIPC

where dPPTPC, dPWEPC, and dIPC are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dNLPWAPC or the rate of change between the initial year (NLPWAPC1) and the second iteration (NLPWAPC2) for the dependent variable, non local public work aid (equation 2). This addition takes place in section three of the model. The total rate of change (dNLPWAPC), for the non local public work aid function, is added to the initial values (NLPWAPC1) resulting in the projected non local public work aid value (NLPWAPC2) in the second iteration (equation 4).

4) NLPWAPC2 = dNLPWAPC + NLPWAPC1

Future values for the subsequent year (NLPWAPC3) are calculated in the same manner, except the NLPWAPC2 values are used in place of the user supplied initial values (NLPWAPC1).

Table 26 - System of equations used by the VIP model to calculate NON LOCAL COURT AID PER CAPITA. y = f(PPTPC, CREPC, and JEPC)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION:			
(3)	B140	@if(M140>0,M140,0)	Non Local Court Aid (base year)
	M140	B60/B39	
(2)	B60	Input Value	non local court aid (base year)
(2)	B39	B79	population
-----SECOND ITERATION:			
(3)	C140	@if(N140>0,N140,0)	non local court aid (t+1 year)
	N140	B140 + SUM(B217..BD217)	
-----PPTPC			
(6)	H217	H186*H195	personnel property taxbase
(see Table 11 for system of equations)			
-----CREPC			
(6)	J217	J186*J195	court expense
(see Table 13 for system of equations)			
-----JEPC			
(6)	K217	K186*K195	jail expense
(see Table 22 for system of equations)			

Explanation of Table 26 - System of equations used by the VIP model to calculate NON LOCAL COURT AID PER CAPITA.

Variable Descriptions:

Non local court aid are a function of personnel property taxbase per capita, court expenses, jail expenses.

1) $NLCRAPC = \alpha_0 + \beta_1 PPTPC + \beta_2 CREPC + \beta_3 JEPC$

where α_0, β_1, β_2, and β_3 are econometrically estimated coefficients. These estimates are found in section five of the model.

Court expenditures may have a positive influence on non local court aid. Successful police work lowers the need for court aid. Political influence increases court aid. This relationship is indicated by Personnel property levels. (Keeling)

Derivation:

Using the total derivative of the non local court aid function (equation 1) the model calculates the rate of change (dNLCRAPC) between the initial year (NLCRAPC1) and the subsequent year (NLCRAPC2) (equation 2).

2) $dNLCRAPC = \beta_1 dPPTPC + \beta_2 dCREPC + \beta_3 dJEPC$

The model calculates dPPTPC, dCREPC, and dJEPC as the difference between the initial user supplied values (PPTPC1, CREPC1, and JEPC1) and the second iteration values (PPTPC2, CREPC2, and JEPC2) for each independent variable in the function (equation 3).

3) PPTPC2 - PPTPC1 = dPPTPC
CREPC2 - CREPC1 = dCREPC
JEPC2 - JEPC1 = dJEPC

where dPPTPC, dCREPC, and dJEPC are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dNLCRAPC or the rate of change between the initial year (NLCRAPC1) and the second iteration (NLCRAPC2) for the dependent variable, non local court aid (equation 2). This addition takes place in section three of the model. The total rate of change (dNLCRAPC), for the non local court aid function, is added to the initial values (NLCRAPC1) resulting in the projected non local court aid value (NLCRAPC2) in the second iteration (equation 4).

4) NLCRAPC2 = dNLCRAPC + NLCRAPC1

Future values for the subsequent year (NLCRAPC3) are calculated in the same manner, except the NLCRAPC2 values are used in place of the user supplied initial values (NLCRAPC1).

Table 27 - System of equations used by the VIP model to calculate NON LOCAL PUBLIC SAFETY AID PER CAPITA. y = f(POP, PPTPC, PCHPOP, PUEMP, and PSEPC)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION:			
(3)	B141	@if(M141>0,M141,0)	Non Local Public Safety Aid per capita (base year)
	M141	B61/B39	
(2)	B61	Input Value	Non Local Public Safety Aid (base year)
-----SECOND ITERATION:			
(3)	C131	@if(N141>0,N141,0)	Non Local Public Safety Aid per capita (t+1 year)
	N141	B141 + @SUM(B218..BE218)	
-----POP			
(6)	B217	B187*B195	population
(see Table 6 for system of equations)			
-----PPTPC			
(6)	H217	H187*H195	personnel property taxbase
(see Table 11 for system of equations)			
-----PCHPOP			
(6)	S217	S187*S195	percent change population
(5)	S187	econometrically calculated	coefficient nl public safety aid per capita/percent change population
(6)	S195	C96-B96	difference in percent change population between base and t+1 years
(3)	B96	Input Value	percent change in population (base year)
(3)	C96	(C79-B79)/B79*100	percent change in population (t+1 year)
(3)	B79	Input Value	population
(3)	C79	see Table 6 for system of equations	population (t+1 year)
-----PUEMP			
(6)	V217	V187*V195	percent unemployment
(5)	V187	econometrically calculated	coefficient nl public safety/percent unemployment
(6)	V195	C99-B99	difference in unemployment rate between base and t+1 years
(3)	B99	B131/B80*100	unemployment rate (base year)
(3)	B131	Input Value	number unemployed (base year)
(3)	B80	Input Value	laborforce (base year)
(3)	C99	C131/C80*100	unemployment rate (t+1 year)
(3)	C131	C33	number of unemployed
(1)	C33	B131*(1+C28/100)-.25*(C7*C34+C8)	number unemployed
(1)	C28	Input Value	county base employment growth rate
(1)	C7	Input Value	change county base employment
(1)	C34	Input Value	marginal multiplier
(1)	C8	Input Value	change total employment
-----PSEPC			
(6)	AW217	AW187*AW195	public safety expenses
(3)	C126	@IF(N126>0,N126,0)	

Explanation of Table 27 - System of equations used by the VIP model to calculate NON LOCAL PUBLIC SAFETY AID PER CAPITA.

Variable Descriptions:

Non local public safety aid are a function of population, personnel property taxbase per capita, percent change population, percent change in population, unemployment rate, and public safety expense.

1) $NLPSPC = \alpha_0 + \beta_1 POP + \beta_2 PPTPC + \beta_3 PCHPOP + \beta_4 UR + \beta_5 PSEPC$

where α_0, β_1, β_2, β_3, β_4, and β_5 are econometrically estimated coefficients. These estimates are found in section five of the model.

Personnel property levels and public safety expenditures increase aid. High growth rates, indicated by percent change in population, are hypothesized to positively influence aid levels. Community need, proxied by unemployment rates, is expected to have a positive influence on aid. (Keeling)

Derivation:

Using the total derivative of the non local public safety aid function (equation 1) the model calculates the rate of change (dNLPSPC) between the initial year (NLPSPC1) and the subsequent year (NLPSPC2) (equation 2).

2) $dNLPSPC = \beta_1 dPOP + \beta_2 dPPTPC + \beta_3 dPCHPOP + \beta_4 dUR + \beta_5 PSEPC$

The model calculates dPOP, dPPTPC, dPCHPOP, dUR, and dPSEPC as the difference between the initial user supplied values (POP1, PPTPC1, PCHPOP1, UR1, and PSEPC1) and the second iteration values (POP2, PPTPC2, PCHPOP2, UR2, and PSEPC2) for each independent variable in the function (equation 3).

3) POP2 - POP1 = dPOP
PPTPC2 - PPTPC1 = dPPTPC
PCHPOP2 - PCHPOP1 = dPCHPOP
UR2 - UR1 = dUR
PSEPC2 - PSEPC1 = dPSEPC

where dPOP, dPPTPC, dPCHPOP, dUR, and dPSEPC are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dNLPSPC or the rate of change between the initial year (NLPSPC1) and the second iteration (NLPSPC2) for the dependent variable, non local public safety aid (equation 2). This addition takes place in section three of the model. The total rate of change (dNLPSPC), for the non local public safety aid function, is added to the initial values (NLPSPC1) resulting in the projected non local public safety aid value (NLPSPC2) in the second iteration (equation 4).

4) NLPSPC2 = dNLPSPC + NLPSPC1

Future values for the subsequent year (NLPSPC3) are calculated in the same manner, except the NLPSPC2 values are used in place of the user supplied initial values (NLPSPC1).

Table 28 - System of equations used by the VIP model to calculate NON LOCAL ADMINISTRATION AID PER CAPITA. y = f(RPTPC, ADEPC, PCHPOP, PTPOP, and IPC)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION:-----			
(3)	B142	@if(M142>0,M142,0)	Non Local Administration Expense (base year)
	M142	B62/B39	
-----SECOND ITERATION:-----			
(3)	C142	@if(N142>0,N142,0)	Non Local Administration Expense (t+1 year)
	N142	B142 + @SUM(B219..BD219)	
-----RPTPC-----			
(6)	G219	G188*G195	real property taxbase
(see Table 11 for system of equations)			
-----ADEPC-----			
(6)	L219	L188*L195	administration expense
(see Table 15 for system of equations)			
-----PCHPOP-----			
(6)	S219	S188*S195	percent change population
(5)	S188	econometrically calculated	coefficient nl administration/percent change population
(6)	S195	C96-B96	difference in percent change in population between base and t+1 years
(3)	B96	Input Value	percent change in population (base year)
(3)	C96	(C79-B79)/B79*100	percent change in population (t+1 year)
(3)	B79	Input Value	population
(3)	C79	see Table 6 for system of equations	population (t+1 year)
-----PTPOP-----			
(6)	T219	T188*T195	town percent
(5)	T188	econometrically calculated	coefficient nl administration exp/town percent
(6)	T195	C97-B97	difference in percent population in town between base and t+1 years
(3)	B97	B68/B79*100	percent population in town (base year)
(2)	B68	Input Value	town population (base year)
(3)	B79	Input Value	population (base year)
(3)	C97	C68/C79*100	percent population in town (t+1 year)
(2)	C68	((1+C29/100)*B68)+C9	town population
(1)	C29	Input Value	town population growth rate
(1)	C9	Input Value	change in town population
-----IPC-----			
(6)	AC219	AC188*AC195	per capita income
(5)	AC188	econometrically calculated	coefficient nl administration/per capita income
(6)	AC195	C106-B106	difference in per capita income between base and t+1 years
(3)	C106	B106*(1+C32/100))+C15	per capita income (t+1 year)
(3)	B106	Input Value	per capita income (base year)
(1)	C32	Input Value	real per capita income growth rate
(1)	C15	Input Value	change in per capita income

Explanation of Table 28 - System of equations used by the VIP model to calculate NON LOCAL ADMINISTRATION AID PER CAPITA.

Variable Descriptions:

Non local administration aid per capita are a function of real property taxbase per capita, administration expenses, percent change in population, percent town population, per capita income, sales per capita.

1) $NLADAPC = \alpha_0 + \beta_1 RPTPC + \beta_2 ADMEPC + \beta_3 PCHPOP + \beta_4 PTPOP + \beta_5 IPC$

where α_0, β_1, β_2, β_3, β_4, and β_5 are econometrically estimated coefficients. These estimates are found in section five of the model.

Political influences is expected to have a positive relationship with non local aid to administration. Therefore Personnel property per capita and per capita income have a positive relationship. A lagged response is expected for aid therefore percent change in population was included. Percent change in town population may have a negative response because towns generally decrease the need for aid at the county level. Business activity are thought to effect administration aid. (Keeling)

Derivation:

Using the total derivative of the non local administration aid per capita function (equation 1) the model calculates the rate of change (dNLADAPC) between the initial year (NLADAPC1) and the subsequent year (NLADAPC2) (equation 2).

2) $dNLADAPC = \beta_1 dRPTPC + \beta_2 dADMEPC + \beta_3 dPCHPOP + \beta_4 dPTPOP + \beta_5 dIPC$

The model calculates dRPTPC, dADMEPC, dPCHPOP, dPTPOP, and dIPC as the difference between the initial user supplied values (RPTPC1, ADMEPC1, PCHPOP1, PTPOP1, and IPC1) and the second iteration values (RPTPC2, ADMEPC2, PCHPOP2, PTPOP2, and IPC2) for each independent variable in the function (equation 3).

3) RPTPC2 - RPTPC1 = dRPTPC
ADMEPC2 - ADMEPC1 = dADMEPC
PCHPOP2 - PCHPOP1 = dPCHPOP
PTPOP2 - PTPOP1 = dPTPOP
IPC2 - IPC1 = dIPC

where dRPTPC, dADMEPC, dPCHPOP, dPTPOP, and dIPC are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dNLADAPC or the rate of change between the initial year (NLADAPC1) and the second iteration (NLADAPC2) for the dependent variable, non local administration aid per capita (equation 2). This addition takes place in section three of the model. The total rate of change (dNLADAPC), for the non local administration aid per capita function, is added to the initial values (NLADAPC1) resulting in the projected non local administration aid per capita value (NLADAPC2) in the second iteration (equation 4).

4) NLADAPC2 = dNLADAPC + NLADAPC1

Future values for the subsequent year (NLADAPC3) are calculated in the same manner, except the NLADAPC2 values are used in place of the user supplied initial values (NLADAPC1).

Table 29 - System of equations used by the VIP model to calculate NON LOCAL RECREATION AID PER CAPITA.
y = f(PPTPC, RCEPC, IPC, and MISQC)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION:-----			
(3)	B143	@if(M143>0,M143,0)	Non Local Recreation per capita (base year)
	M143	B63/B39	
(2)	B63	Input Value	Non Local Recreation (base year)
(2)	B39	B79	population
-----SECOND ITERATION:-----			
(3)	C143	@if(N143>0,N143,0)	Non Local Recreation per capita (t+1 year)
	N143	B143+@SUM(B220..BD220)	
-----PPTPC-----			
(6)	H220	H189*H195	personnel property taxbase
(see Table 11 for system of equations)			
-----RCEPC-----			
(6)	M220	M189*M195	recreation expense
(see Table 16 for system of equations)			
-----IPC-----			
(6)	AC220	AC220*AC195	per capita income
(5)	AC220	econometrically calculated	coefficient nl recreation/per capita income
(6)	AC195	C106-B106	difference in per capita income between base and t+1 years
(3)	C106	B106*(1+C32/100))+C15	per capita income (t+1 year)
(3)	B106	Input Value	per capita income (base year)
(1)	C32	Input Value	real per capita income growth rate
(1)	C15	Input Value	change in per capita income
-----MISQC-----			
(6)	AN220	AN189*AN195	square miles
(5)	AN189	econometrically calculated	coefficient nl recreation/square miles
(6)	AN195	C117-B117	difference in square miles per capita between base and t+1 years
(3)	B117	B116/B79	square miles per capita
(3)	B116	Input Value	square miles in county (base year)
(3)	B79	Input Value	population (base year)
(3)	C116	B116 + C6	square miles in county (t+1 year)
(1)	C6	Input Value	change in county area

Explanation of Table 29 - System of equations used by the VIP model to calculate NON LOCAL RECREATION AID PER CAPITA.

Variable Descriptions:

Non local recreation aid are a function of personnel property taxbase per capita, recreation expense, per capita income, and square miles in a county.

1) $NLRCPC = \alpha_0 + \beta_1 PPTPC + \beta_2 RECEPC + \beta_3 IPC + \beta_4 MISQC$

where α_0, β_1, β_2, β_3, and β_4 are econometrically estimated coefficients. These estimates are found in section five of the model.

Political influence, represented by Personnel property per capita and per capita income, is thought to increase recreational aid. Recreational expenditures increase aid levels. Recreational opportunities occur in densely populated areas therefore aid is need in these areas. (Keeling)

<u>Derivation</u>:

Using the total derivative of the non local recreation aid function (equation 1) the model calculates the rate of change (dNLRCPC) between the initial year (NLRCPC1) and the subsequent year (NLRCPC2) (equation 2).

2) $dNLRCPC = \beta_1 dPPTPC + \beta_2 dRECEPC + \beta_3 dIPC + \beta_4 dMISQC$

The model calculates dPPTPC, dRECEPC, dIPC, and dMISQC as the difference between the initial user supplied values (PPTPC1, RECEPC1, IPC1, and MISQC1) and the second iteration values (PPTPC2, RECEPC2, IPC2, and MISQC2) for each independent variable in the function (equation 3).

3) PPTPC2 - PPTPC1 = dPPTPC
RECEPC2 - RECEPC1 = dRECEPC
IPC2 - IPC1 = dIPC
MISQC2 - MISQC1 = dMISQC

where dPPTPC, dRECEPC, dIPC, and dMISQC are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dNLRCPC or the rate of change between the initial year (NLRCPC1) and the second iteration (NLRCPC2) for the dependent variable, non local recreation aid (equation 2). This addition takes place in section three of the model. The total rate of change (dNLRCPC), for the non local recreation aid function, is added to the initial values (NLRCPC1) resulting in the projected non local recreation aid value (NLRCPC2) in the second iteration (equation 4).

4) NLRCPC2 = dNLRCPC + NLRCPC1

Future values for the subsequent year (NLRCPC3) are calculated in the same manner, except the NLRCPC2 values are used in place of the user supplied initial values (NLRCPC1).

Table 30 - System of equations used by the VIP model to calculate NON LOCAL HEALTH AND WELFARE AID PER CAPITA. y = f(WEPC and IPC)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION:			
(3)	B144	@if(M144>0,M144,0)	Non Local Welfare Aid per capita (base year)
	M144	B64/B39	
(2)	B64	Input Value	Non Local Welfare Aid
(2)	B39	B79	population
-----SECOND ITERATION:			
(3)	C144	@if(N144>0,N144,0)	Non Local Welfare Aid per capita (t+1 year)
	N144	B144+@SUM(B221..BD221)	
-----WEPC			
(6)	N221	N190*N195	health welfare expense
(see Table 17 for system of equations)			
-----IPC			
(6)	AC221	AC190*AC195	per capita income
(5)	AC190	econometrically calculated	coefficient nl welfare aid/per capita income
(6)	AC195	C106-B106	difference in per capita income between base and t+1 years
(3)	B106	Input Value	per capita income (base year)
(3)	C106	(B106*(1+C32/100))+C15	per capita income (t+1 year)
(1)	C32	Input Value	real per capita income growth rate
(1)	C15	Input Value	change in per capita income

Explanation of Table 30 - System of equations used by the VIP model to calculate NON LOCAL HEALTH AND WELFARE AID PER CAPITA.

Variable Descriptions:

Non local recreation aid are a function of health welfare expense and per capita income.

1) $NLHWPC = \alpha_0 + \beta_1 WELEPC + \beta_2 IPC$

where α_0, β_1 and β_2 are econometrically estimated coefficients. These estimates are found in section five of the model.

Political power, represented by per capita income, positively impacts non local aid to health and welfare aid. Welfare expenditures also positively influence aid levels. (Keeling)

Derivation:

Using the total derivative of the non local recreation aid function (equation 1) the model calculates the rate of change (dNLHWPC) between the initial year (NLHWPC1) and the subsequent year (NLHWPC2) (equation 2).

2) $dNLHWPC = \beta_1 dWELEPC + \beta_2 dIPC$

The model calculates dWELEPC and dIPC as the difference between the initial user supplied values (WELEPC1 and IPC1) and the second iteration values (WELEPC2 and IPC2) for each independent variable in the function (equation 3).

3) WELEPC2 - WELEPC1 = dWELEPC
IPC2 - IPC1 = dIPC

where dWELEPC and dIPC are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dNLHWPC or the rate of change between the initial year (NLHWPC1) and the second iteration (NLHWPC2) for the dependent variable, non local recreation aid (equation 2). This addition takes place in section three of the model. The total rate of change (dNLHWPC), for the non local recreation aid function, is added to the initial values (NLHWPC1) resulting in the projected non local recreation aid value (NLHWPC2) in the second iteration (equation 4).

4) NLHWPC2 = dNLHWPC + NLHWPC1

Future values for the subsequent year (NLHWPC3) are calculated in the same manner, except the NLHWPC2 values are used in place of the user supplied initial values (NLHWPC1).

Table 31 - System of equations used by the VIP model to calculate **NON LOCAL EDUCATION AID PER PUPIL.** y = f(RPTPC, EDEPC, IPC, and PCHENRL)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION:-----			
(3)	B145	@if(M145>0,M145,0)	Non Local Education Aid per pupil (base year)
	M145	B65/B42	
(2)	B65	Input Value	Non Local Aid
(2)	B43	B83	enrollment
-----SECOND ITERATION:-----			
(3)	C145	@if(N145>0,N145,0)	Non Local Education Aid per pupil (t+1 year)
	N145	B145+@SUM(B222..BD222)	
-----RPTPC-----			
(6)	G222	G191*G195	real property taxbase
(see Table 10 for system of equations)			
-----EDEPC-----			
(6)	O222	O191*O195	educational expense
(see Table 18 for system of equations)			
-----IPC-----			
(6)	AC222	AC191*AC195	per capita income
(5)	AC191	econometrically calculated	coefficient nl education aid/per capita income
(6)	AC195	C106-B106	difference in per capita income between base and t+1 years
(3)	C106	(B106*(1+C32/100))+C15	per capita income (t+1 year)
(3)	B106	Input Value	per capita income (base year)
(1)	C32	Input Value	real per capita income growth rate
(1)	C15	Input Value	change in per capita income
-----PCHENRL-----			
(6)	AK222	AK191*AK195	percent change enrollment
(5)	AK191	econometrically calculated	coefficient nl education aid/percent change enrollment
(6)	AK195	C114-B114	difference in percent change in enrollment between base and t+1 years
(3)	B114	Input Value	percent change in enrollment (base year)
(3)	C114	(C83-B83)/B83*100	percent change in enrollment (t+1 year)
(3)	B83	Input Value	enrollment (base year)
(3)	C83	B83+@sum(B200..BE200)	enrollment (t+1 year)
(see Table 9 for system of equations)			

Explanation of Table 31 - System of equations used by the VIP model to calculate **NON LOCAL EDUCATION AID PER PUPIL.**

<u>Variable Descriptions</u>:

Non local education aid are a function of real property taxbase per capita, educational expense, per capita income, and percent change in enrollment.

1) $NLEDAPC = \alpha_0 + \beta_1 RPTPC + \beta_2 EDEPC + \beta_3 IPC + \beta_4 PCHENRL$

where α_0, β_1, β_2, β_3, and $\beta_4$are econometrically estimated coefficients. These estimates are found in section five of the model.

Education aid is influenced by political power represented by real property per capita and per capita aid. Expenditures per pupil is also expected to have a positive relationship with educational aid. (Keeling)

Derivation:

Using the total derivative of the non local education aid function (equation 1) the model calculates the rate of change (dNLEDAPC) between the initial year (NLEDAPC1) and the subsequent year (NLEDAPC2) (equation 2).

2) $dNLEDAPC = \beta_1 dRPTPC + \beta_2 dEDEPC + \beta_3 dIPC + \beta_4 dPCHENRL$

The model calculates dRPTPC, dEDEPC, dIPC, and dPCHENRL as the difference between the initial user supplied values (RPTPC1, EDEPC1, IPC1, and PCHENRL1) and the second iteration values (RPTPC2, EDEPC2, IPC2, and PCHENRL2) for each independent variable in the function (equation 3).

3) RPTPC2 - RPTPC1 = dRPTPC
EDEPC2 - EDEPC1 = dEDEPC
IPC2 - IPC1 = dIPC
PCHENRL2 - PCHENRL1 = dPCHENRL

where dRPTPC, dEDEPC, dIPC, and dPCHENRL are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dNLEDAPC or the rate of change between the initial year (NLEDAPC1) and the second iteration (NLEDAPC2) for the dependent variable, non local education aid (equation 2). This addition takes place in section three of the model. The total rate of change (dNLEDAPC), for the non local education aid function, is added to the initial values (NLEDAPC1) resulting in the projected non local education aid value (NLEDAPC2) in the second iteration (equation 4).

4) NLEDAPC2 = dNLEDAPC + NLEDAPC1

Future values for the subsequent year (NLEDAPC3) are calculated in the same manner, except the NLEDAPC2 values are used in place of the user supplied initial values (NLEDAPC1).

Table 32 - System of equations used by the VIP model to calculate NON LOCAL DEVELOPMENT AID PER CAPITA.
y = f(DEPC, PCHPOP, G100, IPC, and DG)

Model Section	Cell Address	Equation	Variable Description
-----FIRST ITERATION:-----			
(3)	B146	@if(M146>0,M146,0)	Non Local Development Aid per capita (base year)
	M146	B66/B39	
(2)	B66	Input Value	non Local Development Aid (base year)
(2)	B39	B79	population
-----SECOND ITERATION:-----			
(3)	C146	@if(N146>0,N146,0)	Non Local Development Aid per capita (t+1 year)
	N146	B146 + @SUM(B223..BD223)	
-----DEPC-----			
(6)	P223	P192*P195	development expense
(see Table 19 for system of equations)			
-----PCHPOP-----			
(6)	S223	S192*S195	percent change population
(5)	S192	econometrically calculated	coefficient nl development/percent change population
(6)	S195	C96-B96	difference in percent change population between base and t+1 years
(3)	B96	Input Value	percent change in population (base year)
(3)	C96	(C79-B79)/B79*100	percent change in population (t+1 year)
(3)	B79	Input Value	population
(3)	C79	see Table 6 for system of equations	population (t+1 year)
-----G100-----			
(6)	W223	W192*W195	graduates per 100 population
(5)	W192	econometrically calculated	coefficient nl development/graduates per 100 population
(6)	W195	C100-B100	difference in graduates per 100 population between base and t+1 years
(3)	B100	Input Value	graduates per 100 population (base year)
(3)	C100	B100+C16	graduates per 100 population (t+1 year)
-----IPC-----			
(6)	AC223	AC192*AC195	per capita income
(5)	AC192	econometrically calculated	coefficient nl development/per capita income
(6)	AC195	C106-B106	difference in per capita income between base and t+1 years
(3)	B106	Input Value	per capita income (base year)
(3)	C106	(B106*(1+C32/100))+C15	per capita income (t+1 year)
(1)	C32	Input Value	real per capita income growth rate
(1)	C15	Input Value	change in per capita income

Table 32 cont. - System of equations used by the VIP model to calculate NON LOCAL DEVELOPMENT AID PER CAPITA. y = f(DEPC, PCHPOP, G100, IPC, and DG)

Model Section	Cell Address	Equation	Variable Description
-----SECOND ITERATION:-----			
-----DG-----			
(6)	AS223	AS192*AS195	development group
(5)	AS192	econometrically calculated	coefficient nl development/development group
(6)	AS195	C122-B122	difference in development group between base and t+1 years
(3)	B122	Input Value	development group (base year)
(3)	C122	B122	development group (t+1 year)

Explanation of Table 32 - System of equations used by the VIP model to calculate NON LOCAL DEVELOPMENT AID PER CAPITA.

Variable Description:

Non local development aid are a function of development expense, percent change in population, graduates per 100, per capita income, and development group.

1) $NLDAPC = \alpha_0 + \beta_1 DEPC + \beta_2 PCHPOP + \beta_3 G100 + \beta_4 IPC + \beta_5 DG$

where α_0, β_1, β_2, β_3, β_4, and β_5 are econometrically estimated coefficients. These estimates are found in section five of the model.

An educated populace is hypothesized to have a positive influence on the demand for non local aid for development. Development groups may also influence non local aid in a positive manner. Development aid is hypothesized to positively relate to expenditures. Growing areas demand more aid for development since development concentrates in growing areas. Political affluence, represented by per capita income, is expected to positively influence aid. Businesses also positively influence the need for aid. (Keeling)

Derivation:

Using the total derivative of the non local development aid function (equation 1) the model calculates the rate of change (dNLDAPC) between the initial year (NLDAPC1) and the subsequent year (NLDAPC2) (equation 2).

2) $dNLDAPC = \beta_1 dDEPC + \beta_2 dPCHPOP + \beta_3 dG100 + \beta_4 dIPC + \beta_5 dDG$

The model calculates dDEPC, dPCHPOP, dG100, dIPC, and dDG as the difference between the initial user supplied values (DEPC1, PCHPOP1, G1001, IPC1, and DG1) and the second iteration values (DEPC2, PCHPOP2, G1002, IPC2, and DG2) for each independent variable in the function (equation 3).

3) DEPC2 - DEPC1 = dDEPC
PCHPOP2 - PCHPOP1 = dPCHPOP
G1002 - G1001 = dG100
IPC2 - IPC1 = dIPC
DG2 - DG1 = dDG

where dDEPC, dPCHPOP, dG100, dIPC, and dDG are the partial derivatives for each independent variable. This calculation takes place in row 195 of the model.

The model estimates the independent variables for the second iteration based on the user supplied information on the rates of growth and change for the given variable. These variables are supplied by the user in section one of the model.

The partial derivatives and econometrically estimated coefficients are multiplied together in section six. These values are added together resulting in dNLDAPC or the rate of change between the initial year (NLDAPC1) and the second iteration (NLDAPC2) for the dependent variable, non local development aid (equation 2). This addition takes place in section three of the model. The total rate of change (dNLDAPC), for the non local development aid function, is added to the initial values (NLDAPC1) resulting in the projected non local development aid value (NLDAPC2) in the second iteration (equation 4).

4) NLDAPC2 = dNLDAPC + NLDAPC1

Future values for the subsequent year (NLDAPC3) are calculated in the same manner, except the NLDAPC2 values are used in place of the user supplied initial values (NLDAPC1).

SECTION FOUR

INDEPENDENT VARIABLES USED BY THE VIRGINIA IMPACT PROJECTION MODEL

Table 33 - System of equations used by the VIP model to calculate NON LOCAL MISCELLANEOUS AID.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(2)	B67	Input Value	non local aid misc (base year)
-----Second Iteration-----			
(2)	C67	B67/B39*C39	non local aid misc (t+1 year)
(1)	B39	B79	population (base year)
(1)	C39	C79	population (t+1 year)
(3)	C79	see Table 5	

Explanation of Table 33 - System of equation used by the VIP model to calculate NON LOCAL MISCELLANEOUS AID.

Users supply the model with NLMISC values for the first year (NLMISC1). The model calculates NLMISC2 as the product of per capita value of NLMISC1 and POP2. See Table 5 for estimation of POP2.

Table 34 - System of equations used by the VIP model to calculate TOWN POPULATION.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(2)	B68	Input Value	town population (base year)
-----Second Iteration-----			
(2)	C68	((1+C29/100)*B68)+C9	town population (t+1 year)
(1)	C29	Input Value	town population growth rate
(1)	C9	Input Value	change in town population

Explanation of Table 34 - System of equations used by the VIP model to calculate TOWN POPULATION.

Users supply the model with TPOP values for the first year (TPOP1). The model calculates TPOP2 as the product of TPOP1 and the change in town population (TPOPGR) plus change in town population (CHTPOP).

Table 35 - System of equations used by the VIP model to calculate RESIDENTIARY EMPLOYMENT.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(2)	B69	Input Value	residentiary employment (base year)
-----Second Iteration-----			
(2)	C69	B69+(C34-1)*(C76-B76)+C8	residentiary employment (t+1 year)
(1)	C34	Input Value	marginal multiplier
(2)	B76	Input Value	base employment (base year)
(2)	C76	B76+(1+C28/100)+C7	base employment (t+1 year)
(1)	C7	Input Value	change county base employment
(1)	C8	Input Value	change total employment

Explanation of Table 35 - System of equations used by the VIP model to calculate RESIDENTIARY EMPLOYMENT.

Users supply the model with RE values for the first year (RE1). The model calculates RE2 as the sum of RE1, predicted amount of RE resulting from a change in the base employment level (BEMP) and the change in total employment. The model uses a marginal multiplier to calculate the amount of the RE resulting from a change in the base employment level (BEMP).

Table 36 - System of equations used by the VIP model to calculate NUMBER OF BUSINESSES.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(2)	B70	Input Value	number of businesses (base year)
-----Second Iteration-----			
(2)	C70	B70+((C79-B79)*0.014151)+C20	number of businesses (t+1 year)
(3)	B79	Input Value	population (base year)
(3)	C79	see Table 6	population (t+1 year)
(1)	C20	Input Value	change in percent non white population

Explanation of Table 36 - System of equations used by the VIP model to calculate NUMBER OF BUSINESSES.

Users supply the model with BUS values for the first year (BUS1). The model calculates BUS2 as the sum of BUS1, predicted amount of BUS resulting from a change in the population (POP) level and the change in percent non white population (CHPNW). The model uses a marginal multiplier to calculate the amount of the BUS resulting from a change in the population level (POP). See Table 5 for the calculation of population values.

Table 37 - System of equations used by the VIP model to calculate TOTAL FEDERAL AID.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(2)	B71	Input Value	total federal aid (base year)
-----Second Iteration-----			
(2)	C71	(B75*B74)+C25	total federal aid (t+1 year)
(2)	B75	B71/B73	actual ratio federal aid:total aid (base year)
(2)	B71	Input Value	total federal aid (base year)
(2)	B73	B74	actual total aid federal and state (base year)
(2)	B74	@sum(B59..BE67)	predicted total aid federal and state (base year)
(2)	B59-B66	(see Tables 25-32)	non local aid
(2)	B67	Input Value	non local aid misc
(1)	C25	Input Value	change in federal aid

Explanation of Table 37 - System of equations used by the VIP model to calculate TOTAL FEDERAL AID.

Users supply the model with FA values for the first year (FA1). The model calculates FA2 as the product of the total predicted federal aid and the ratio of federal aid:total aid (federal and state). Both figures are derived using the user supplied values for the initial years. The model predicts total federal aid based on initial values of non local aid (see Tables 37 and 39). Finally a user predicted value of the change in federal aid is added to the product resulting in the second iteration value.

Table 38 - System of equations used by the VIP model to calculate TOTAL STATE AID.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(2)	B72	B74-B71	total state aid (base year)
(2)	B74	@sum(B59..BE67)	predicted total aid federal and state (base year)
(2)	B59-B66	(see Tables 25-32)	non local aid
(2)	B67	Input Value	non local aid misc
(2)	B71	Input Value	total federal aid
-----Second Iteration-----			
(2)	C72	C74-C71	total state aid (t+1 year)
(2)	C74	@sum(C59..CE67)	predicted total aid federal and state (t+1 year)
(2)	C59-C66	(see Tables 25-32)	non local aid
(2)	C67	B67/B39*C39	non local aid misc (t+1 year)
(2)	B67	Input Value	non local aid misc (base year)
(2)	B39	see Table 5	population (base year)
(2)	C39	see Table 5	population (t+1 year)
(2)	C71	see Table 37	total federal aid (t+1 year)

Explanation of Table 38 - System of equations used by the VIP model to calculate TOTAL STATE AID.

The model calculates SA for the initial iteration (SA1) as the difference between total aid (PTA1) and total federal aid (FA1). The model calculates SA2 in the same manner. Both iterations use predicted values for total aid.

Table 39 - System of equations used by the VIP model to calculate ACTUAL TOTAL AID (federal and state).

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(2)	B73	B74	actual total aid federal and state(base year)
(2)	B74	@sum(B59..B67)	predicted total aid federal and state (base year)
(2)	B59-B66	(see Tables 25-32)	non local aid
(2)	B67	Input Value	non local aid misc
-----Second Iteration-----			
(2)	C73	C74+C25	actual total aid federal and state (t+1 year)
(2)	C74	@sum(C59..CE67)	predicted total aid federal and state (t+1 year)
(2)	C59-C66	(see Tables 25-32)	non local aid
(2)	C67	B67/B39*C39	non local aid misc (t+1 year)
(2)	B67	Input Value	non local aid misc (base year)
(2)	B39	see Table 5	population (base year)
(2)	C39	see Table 5	population (t+1 year)
(1)	C25	Input Value	change in federal aid

Explanation of Table 39 - System of equations used by the VIP model to calculate ACTUAL TOTAL AID (federal and state).

The model estimates ATA1 as the sum of all non local aid (see Tables 25-32). The model calculates ATA2 in the same manner: non local aid estimates (for the second iteration) plus change in federal aid.

Table 40 - System of equations used by the VIP model to calculate PREDICTED TOTAL AID (federal and state).

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(2)	B74	@sum(B59..B67)	predicted total aid federal and state (base year)
(2)	B59-B66	(see Tables 25-32)	non local aid
(2)	B67	Input Value	non local aid misc
-----Second Iteration-----			
(2)	C74	@sum(C59..CE67)	predicted total aid federal and state (t+1 year)
(2)	C59-C66	(see Tables 25-32)	non local aid
(2)	C67	B67/B39*C39	non local aid misc (t+1 year)
(2)	B67	Input Value	non local aid misc (base year)
(2)	B39	see Table 5	population (base year)
(2)	C39	see Table 5	population (t+1 year)

Explanation of Table 40 - System of equations used by the VIP model to calculate PREDICTED TOTAL AID (federal and state).

PTA and ATA values are estimated in the same manner. The model substitutes PTA values for ATA values.

Table 41 - System of equations used by the VIP model to calculate ACTUAL RATIO OF FEDERAL/TOTAL AID.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(2)	B75	B71/B73	actual ratio of federal/total aid (base year)
(2)	B71	Input Value	total federal aid
(2)	B73	B74	actual total aid federal and state (base year)
(2)	B74	@sum(B59..B67)	predicted total aid federal and state (base year)
(2)	B59-B66	(see Tables 25-32)	non local aid
(2)	B67	Input Value	non local aid misc
-----Second Iteration-----			
(2)	C75	C71/C73	actual ratio of federal/total aid (t+1 year)
(2)	C71	(B75*B74)+C25	total federal aid (t+1 year)
(2)	B75	B71/B73	actual ratio federal aid:total aid (base year)
(2)	B71	Input Value	total federal aid (base year)
(2)	B73	B74	actual total aid federal and state (base year)
(2)	B74	@sum(B59..BE67)	predicted total aid federal and state (base year)
(2)	B59-B66	(see Tables 25-32)	non local aid
(2)	B67	Input Value	non local aid misc
(1)	C25	Input Value	change in federal aid
(2)	C73	C74+C25	actual total aid federal and state

Explanation of Table 41 - System of equations used by the VIP model to calculate ACTUAL RATIO OF FEDERAL/TOTAL AID.

The model calculates RTF as the ratio of FA and ATA. See Tables 37 and 39 for estimating FA and ATA respectively.

Table 42 - System of equations used by the VIP model to calculate BASE EMPLOYMENT.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(2)	B76	Input Value	base employment (base year)
-----Second Iteration-----			
(2)	C76	B76+(1+C28/100)+C7	base employment (t+1 year)
(1)	C28	Input Value	county base employment growth rate
(1)	C7	Input Value	change in county base employment

Explanation of Table 42 - System of equations used by the VIP model to calculate BASE EMPLOYMENT.

Users supply the model with BEMP values for the first year (BEMP1). The model calculates BEMP2 as the sum of BEMP1, county base employment growth rate (CBEMPGR), and change in county base employment.

Table 43 - System of equations used by the VIP model to calculate POPULATION SQUARED.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B94	B79*B79	population squared (base year)
(3)	B79	see Table 6	
-----Second Iteration-----			
(3)	C94	C79*C79	population squared (t+1 year)
(3)	C79	see Table 6	

Table 44 - System of equations used by the VIP model to calculate POPULATION DENSITY.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B95	B79/B116	population density (base year)
(3)	B79	see Table 6	population (base year)
(3)	B116	Input Value	square miles in county (base year)
-----Second Iteration-----			
(3)	C95	C79/C116	population density (t+1 year)
(3)	C79	see Table 6	population (t+1 year)
(3)	C116	B116+C6	square miles in county (t+1 year)
(1)	C6	Input Value	change in county area

Explanation of Table 44 - System of equations used by the VIP model to calculate PERCENT CHANGE IN POPULATION.

The model calculates POPD1 as population (POP1) divided by square miles in a county. The model estimates POPD in a Similar manner plus any in county area.

Table 45 - System of equations used by the VIP model to calculate PERCENT CHANGE IN POPULATION.

Model Section	Cell Address	Equation	Variable Description
-----First Iteration-----			
(3)	B96	Input Value	percent change in population (base year)
-----Second Iteration-----			
(3)	C96	(C79-B79)/B79*100	percent change in population (t+1 year)
(3)	C79	see Table 6	population (t+1 year)
(3)	B79	Input Value	population (base year)

Explanation of Table 45 - System of equations used by the VIP model to calculate PERCENT CHANGE IN POPULATION

Users supply the model with PCHPOP values for the first year (PCHPOP1). The model calculates PCHPOP2 as the difference between POP2 and POP1 divided by the POP1. See Table 5 for an explanation of the population estimations.