SOFTWARE REVIEW

EDITOR'S NOTE: *This is the first of what we hope will be numerous software reviews in Regional Science Perspectives. It is our objective to review software designed for classroom use in courses devoted to regional science. For each review, we would like to publish an overview of the program written by its author. This would be followed by a brief review of the program's classroom application by an instructor who is willing to volunteer his or her time and course(s) as a test bed. If you are interested in contributing software to this endeavor or if you would like to serve as a reviewer, please contact the editor of RSP.*

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WINNEMAC: AN INTERACTIVE POLICY SIMULATION GAME

Daniel A. Seiver

Introduction

Winnemac is a simple policy simulation model of a hypothetical state in the United States. It has been designed chiefly as an interactive teaching tool for undergraduates in regional economics and regional policy courses. The sections below describe the structure of the policy model, its operation, and its availability. Appendix I* contains instructions for the player. A printout of a successful game is included in Appendix II.*

Economic Structure

Winnemac's economic structure has been kept as simple as possible. All variables are in real terms. There is not an explicit regional capital stock or financial sector. The structure is largely recursive and linear to simplify programming and solution.

The economy has four sectors: farming, manufacturing, services, and government. The small farm sector's income and output are determined by stochastic variation around an unchanging mean, while the farm labor force shrinks at a constant 1 percent per year as labor productivity increases.

The employment of the large manufacturing sector is determined by local and export demand, a measure of relative labor costs, and a time trend:

$$(1)\quad MEMP_t = A_m + B_m{*}USINC_t + C_m{*}YD_t - D_m{*}\,[MWAGE_t / USWAGE_t] - E_m{*}t + MOTHER_t$$

where

$MEMP_t$ = manufacturing employment in period t;
A_m, B_m, C_m, D_m, E_m = guesstimated parameters;
$USINC_t$ = U.S. disposable income in period t;
YD_t = local disposable income in period t;

*These are available on request from the author: Daniel A. Seiver, Miami University, School of Business Administration, Department of Economics, 208 Laws Hall, Oxford, Ohio 45056.

$MWAGE_t$ = local manufacturing wage rate; and
$USWAGE_t$ = U.S. manufacturing wage rate.

An increase in either U.S. or local incomes increases output and thus employment in manufacturing. The sizes of A_m, B_m, and C_m were chosen so that the elasticities in the relevant ranges are reasonable; a 10 percent increase in local disposable income generates about a 1 percent increase in employment. A 10 percent increase in U.S. income generates about a 10 percent increase in MEMP. The time trend destroys about 10,000 jobs per year (of 1.6 million) as a result of a loss of world competitiveness. The relative labor cost term captures one of the factors causing Sunbelt migration. If MWAGE rises 10 percent relative to USWAGE, MEMP will drop about 10,000 jobs. The special factors (MOTHER) are discussed below.

Services employment (SEMP) is determined in a similar fashion:

(2) $SEMP_t = A_s + B_s{*}USINC_t + C_s{*}YD_t - E_s{*}t + SOTHER_t + GEMP_t$

where

A_s, B_s, C_s, E_s = guesstimated parameters;
$SOTHER_t$ = other special factors; and
$GEMP_t$ = government employment.

The service sector mainly serves the local market. B_s is 1/4 the size of B_m, and C_s is five times as large as C_m. The time trend creates 1,000 jobs per year, as the area evolves toward a service economy. The special factors are discussed below, and GEMP is calculated in equation (9).

The wage rates in manufacturing (MWAGE) and services (SWAGE) are functions of U.S. wage rates and the lagged rate of unemployment:

(3) $MWAGE_t = A_{mw} + B_{mw}{*}USWAGE_t - C_{mw}{*}U_{t-1}$

(4) $SWAGE_t = A_{sw} + B_{sw}{*}USWAGE_t - C_{sw}{*}U_{t-1} + D_{sw}{*}ESPEND_t$

where

A_{xx}, B_{xx}, C_{xx}, D_{xx} = guesstimated parameters;
$USWAGE_t$ = U.S. wage rate in period t; and
$ESPEND_t$ = lagged spending on education.

C_{mw} is twice as large as C_{sw}, reflecting the greater cyclical sensitivity of manufacturing wage rates in recent years. USWAGE has a

time trend growth rate of 2 percent per year, and B_{mw} and B_{sw} are set at 1.02 and 1.01, respectively.

The only wedges between total personal income, Y_t, and disposable income, YD_t, are federal and state income taxes:

(5) $Y_t = FINC_t + MINC_t + SINC_t$

(6) $YD_t = (.85 - PTAX_t)*Y_t$

where

$PTAX_t$ = personal income tax rate (policy variable);
$FINC_t$ = farm income;
$MINC_t$ = manufacturing income, $MEMP_t*MWAGE_t$; and
$SINC_t$ = services income, $SEMP_t*SWAGE_t$.

YD_t, $MEMP_t$, and $SEMP_t$ can be determined simultaneously, because all other variables are predetermined or exogenous.

Population grows as a result of natural increase (0.8 percent per year) and net migration (NETMIG), which is determined as follows:

(7) $NETMIG_t = A_{nm} + B_{nm}*(TEMP_t - TEMP_{t-1})$

$+ C_{nm}* (MWAGE_t / USWAGE_t)$

where

A_{nm}, B_{nm}, C_{nm} = guesstimated parameters; and
$TEMP_t$ = total employment in year t.

Migrants are attracted, on net, by rising levels of employment and higher relative wages. A fixed proportion of the population participates in the labor force (LF), and the unemployment rate (U) is simply the excess labor supply:

(8) $U_t = (LF_t - TEMP_t) / LF_t$

The Government Sector

The Winnemac player is elected governor of the state in 1984 and must manage the economy described by equations (1) through (8) to the year 2000 if possible, facing elections every four years. The main tools available to stimulate growth in Winnemac are fiscal policy tools. Each year the player must submit a budget to the legislature that specifies

the level of spending in four categories: education (EDUC), transportation (TRANS), social welfare (WELF), and general government (GENGOV). A tax rate for personal income (PTAX) and corporate income (CTAX) also must be specified.

Each spending category creates some government employment:

$$(9)\quad GEMP_t = E_w{*}WELF_t + E_e{*}EDUC_t + E_t{*}TRANS_t + E_g{*}GENGOV_t$$

where

E_x = employment intensities of state spending of type x.

E_g is 2 1/2 times as large as E_t and E_e, which are twice as large as E_w. An increase of $100 million in spending on GENGOV (initially $1 billion) will generate 2,000 new jobs in general government, which includes law enforcement and general administration.

Political constraints are associated with each type of government spending. If per capita social welfare spending is cut, there are welfare riots in the cities, which cost political points; if per capita general government spending is cut, a crime wave sweeps Winnemac, which also costs political points. If education or transportation spending is cut, there is a five to seven year lagged effect on the quality of the labor force (reflected in ESPEND in equation (4), and SOTHER in equation (2)) or the infrastructure (MOTHER in equation (1)). These lagged effects also can operate in a positive direction; higher education and transportation spending improve the quality of the labor force and infrastructure. Increasing social welfare spending directly increases local income.

This spending must be funded mainly by personal and corporate taxes, although federal revenue sharing provides about 40 percent of total revenues initially. Reducing taxes earns political points and stimulates economic activity, in the case of PTAX, but revenues fall, just as in the real world. Resultant budget deficits can be closed by across-the-board spending cuts, with the costs noted above, or one time corporate tax surcharges, which speeds industry migration to the Sunbelt. Unbalanced budgets cost political points. Raising PTAX or CTAX costs political points, slows economic activity in the case of PTAX, and eventually causes job losses in the case of CTAX. Tax increases do close budget gaps, however. Although the link between corporate taxes and job losses is debatable, the game is much too easy if corporate taxes can be raised without economic consequences.

The budget proposals submitted to the legislature are not adopted automatically. The legislature will not allow spending to change by more than 10 percent in one year for the large categories and 50 percent per

year for the small categories. CTAX and PTAX are not permitted to change by more than 1 percentage point per year, with initial starting values of .10 and .08, respectively.

Political Points and Elections

Values for the policy variables, combined with equations (1) through (9), enable us to solve all the variables in the system. Each year a political point score is calculated based on the following formulas: points are gained for reductions in the unemployment rate, increases in employment, and reductions in taxes, all relative to the previous year and the initial year in office. Changes in the opposite direction cost political points. Government spending adds or subtracts points as noted above, and credit is given for running a budget surplus, which can be carried forward indefinitely.

Total points determine the probability of reelection in 1988 and subsequent years. Poor point totals always cost the incumbent the election, and high totals always win. Between the high and low totals there is a positive but imperfect correlation between score and election success. A victory entitles the incumbent to four more years, while a loss is accompanied by a suggestion to seek employment in the Sunbelt.

Undertaking Major Initiatives

After an initial familiarization period of three years, the governor is presented with six long-term policies that are supposed to improve the Winnemac economy. Any one or none can be chosen, but all initiatives remain in effect for four years. These initiatives are based partly on real world policy alternatives, with sardonic and didactic undertones.

Of the options doomed to fail, the "Buy Winnemac" program is the simplest. It costs little to implement, but neighbor states retaliate immediately. There is a net loss of jobs. Other options that fail include the construction of a high speed rail system linking Winnemac cities that is plagued by cost overruns and never completed; legalization of gambling, which usually puts an end to the governor's career; basing the MX missile system in Winnemac, which creates construction jobs, but costs political points when a Soviet airliner is shot down by a Winnemissle.

Two options that fare better are a subsidy program to attract high tech industry to Winnemac, although the job creation is expensive, and a low cost research program to find ways to burn Winnemac's high sulfur coal cleanly and cheaply. There is only a small probability that the coal

program is a success, but the payoff is 100,000 new manufacturing jobs as power costs fall.

Each of these options reflects the author's personal biases, which are based on intensive armchair empiricism. The Winnemac program is designed to facilitate the addition of new options at any time.

Strategy and Pedagogy

Winnemac is designed as a pleasurable introduction to regional economic policy making. While students are striving to be reelected and amass points, they discover the pitfalls of cutting taxes without spending reductions, the political difficulties of either spending cuts or tax increases, and the relative powerlessness of regional policy makers in the face of national business cycles. A U.S. recession occurs on average once every four years, with a significant negative impact on employment and incomes in Winnemac; the manufacturing sector is the most cyclically sensitive. These recessions can be neither predicted nor controlled.

Nonetheless, some strategies are better than others. Rapid tax cutting can stimulate the economy in the short run and earn political points, but budget deficits or spending reductions can mortgage Winnemac's future. Raising taxes is politically costly, but governors soon discover that cutting taxes in an election year and raising them the following year is optimal. The major initiatives represent a potpourri of tried and untried approaches to regional economic development with which the student should be familiar.

The game probably is best introduced after a groundwork in regional economics has been laid; in particular, location theory, labor migration, and regional economic growth should be covered beforehand. A course with heavy emphasis on mathematical models of regional growth and development could incorporate the model directly for use in calculating impact multipliers and perhaps in trying to estimate empirically some of the equations.

A complete game takes about 30 minutes on an IBM PC. Students playing Winnemac in a regional economics class considered it intellectually stimulating and entertaining. The game is written in Fortran and the object code fits on one single-sided diskette that will run on any IBM or compatible machine with at least 128K of memory. A diskette and documentation are available from the author for a nominal charge.

WINNEMAC: A REVIEW OF CLASSROOM APPLICATION

Roger F. Riefler

Winnemac, in the words of its author, is "designed chiefly as an interactive teaching tool for undergraduates in regional economics and regional policy courses." In reviewing this product, however, I tested it on faculty, graduate, and undergraduate students here at the University of Nebraska-Lincoln. My comments, therefore, reflect the collective thoughts of a wide variety of individuals. Before disseminating the program to others, I did play the game myself; undoubtedly my experiences biased my subsequent evaluation and, therefore, it is appropriate to begin with an analysis of my track record.

After reading the above description of the program by Professor Seiver, I waited a month before actually using the model. My motivation was to erase from memory (mine) the hints to successful playing contained in the overview. I certainly accomplished my objective; in my first seven runs of the model, I was reelected governor of Winnemac once and then only for one term. My initial experience, it subsequently turned out, was typical of first time players handed the disk and the brief three page "Instructions for the Player." Although these instructions successfully motivate the player to give the program a try and provide him/her with the necessary information to get through the program, they provide only limited information on the pitfalls and potentials facing those booting up Winnemac.

Comments from players in both my undergraduate and graduate regional economics classes indicate that they approached the game much as I did. Initial runs of the model were made with what I would call either an experimental approach (e.g., let's see what this arbitrarily chosen combination of policy variables will do) or a seat-of-the-pants, arcade-like, randomly chosen approach to policy. Such approaches almost universally are doomed to failure; this is a hard game to win!

At this point about 75 percent of the undergraduate and (shudder!) 50 percent of my graduate students gave up on the program and returned the disk (usually with some favorable general comments that proved to be only cover ups at their frustration at not winning). The remainder of the students took the tack that I (and certainly Dr. Seiver) hoped: they started to generate development strategies and more carefully track what was going on in the Winnemac economy (and in their reelection chances). Crucial to this evolution in game-playing skill was printing or, in some other fashion, storing the policy options pursued and the year-to-year results.

This minority of what I would call *motivated players* adopted one of two game playing strategies. They either would pursue policy options suggested by their course work (what I will call a regional strategy) by adopting the lessons of regional development models presented in class or they would adopt a political strategy to game playing and simply, by trial and error, narrow an appropriate setting of policy parameter values that would work in insuring reelection. In the latter case, a majority of the players had difficulty in translating their political success into material congruent with that presented in the classroom. Unfortunately the political strategy was more successful than the regional strategy in terms of both the percent of the players who mastered the game and the quickness of their mastery.

It is my assessment that Winnemac can be used to challenge the mettle of our best undergraduate and graduate students. They are the ones that will stick with the game and be willing to make it a learning experience. Other students, the majority unfortunately, will adopt what I would call an *arcade approach* to the game: they will push the required keys and try to win but, if not successful, they will retire in (short-lived) frustration. The game will remain a black box to this latter group, while the former will be willing to at least peer into the box.

Probably the most disturbing aspect of the review process to me was the fact that students who had completed at least one course in regional economics, overall, did not do better than students who were just beginning courses under my tutelage. In both groups roughly the same percent gave up on the game. The only difference, thankfully, was that students who had completed at least one course in regional economics and were willing to use the program as a learning device used the regional as opposed to the political strategy more often. Unfortunately, this did not mean they were quicker learners of a winning strategy!

Winnemac is a good program. Although one could quibble with certain parameter values and the (significant) degree of randomness in the various aspects of the program (i.e., incidence of recession, probability of organized crime, infiltration of legalized gambling, etc.), overall one gets the feeling the game is realistic. Policy makers don't have an easy time of it in the real world, and successful strategies are not easily formulated in this game.

As the author mentions, the Winnemac program is constructed in a flexible manner; parameters can be changed easily, the probabilities of random perturbations can be adjusted, and new major policy options can be added. Further, the econometric model-type structure of the model begs for empirical estimation by motivated (graduate) students. To paraphrase Dr. Seiver's concluding paragraph above, my students and colleagues found Winnemac entertaining and, those that got over

the initial frustration involved in the futility of seat of the pants strategies, found it intellectually stimulating. Several of the latter group of students are continuing to pursue the challenges offered by the game. For them and for me, utilization of the program in the classroom milieu has been a worthwhile experience.