SOCIOLOGY AND SYSTEM DYNAMICS

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This is a revised version of a paper presented at the 1983 International System Dynamics Conference, Pine Manor College, Boston, July, 1983.

The authors wish to thank Richard Bronson for his helpful comments and criticism.

ABSTRACT

The most basic problem of sociology as an empirical science is the difficulty of replicating studies within reasonable time limits and in genuinely comparable situations. It is the problem of controlled experimentation. Sociologists want to make correct predictions based on verified casual relationships, but cannot, because the nature of macro-social phenomena precludes experiments with adequate controls.

System dynamics promises a way out of this dilema. The proposed strategy involves four phases. (1) Formulating the theory as a casual loop diagram. (2) Stating the variables involved in the functioning of the system, building the model and calibrating it until it is consistent with the theory. (3) Refining and adjusting the constants until the model can reproduce known time-series of relevant data on a number of data sets. (4) Systematically varying each constant while controlling the others. The last phase is, in fact, the quasi-experimental procedure for testing the conditions under which theory will stand or fall.

An illustrative example of the proposed strategy is given, with encouraging results relative to two data sets.

1. INTRODUCTION

Ever since Durkheim and Weber, sociologists have concerned themselves with the methodology of their discipline as much as with its substantive content. Yet the classic names in sociology are remembered for their theoretical insights rather than for their contributions to method. Not that there has been no progress in method. We have seen great improvements in the techniques of empirical social research. Still, our predictions of social events are at best tentative, resting typically on a non-existent *ceteris paribus*, while our theoretical explanations remain time-specific and situation-bound, being frequently no better than those of competent journalists.

Part of the difficulty is to get valid operationalisations and reliable measurements. These, however, are matter of degree, not of substance. Generations of researchers have made great strides towards greater sophistication and robustness of our data bases. The real problem, perhaps the most basic problem of sociology as an empirical science, is that we have not yet found a way to make true replications of our studies within reasonable time limits and genuinely comparable situations. It is the problem of controlled experimentation. Until this problem is resolved, we shall continue to wallow in reams of theoretical sociology, while empirically tested sociological theory goes begging.

By way of contrast, consider social psychology. Once pioneers like Lewin and Sherit had shown the way to study social interaction and small group behaviour in controlled experimental settings, this branch has surged forwards like no other in the social sciences. Social psychology is today the most scientifically advanced field in sociology, having spawned technologies based on systematic theory and research for marketing, advertising, personnel management, education, and many other applied areas. Macro-sociology and the study of larger social systems have been left far behind.

We are in a dilemma. The nature of the phenomena that we study preclude experimental situations with elaborate controls, leaving us with research techniques that lend themselves at best only to correlational analyses and their derivatives. Moreover, our data are typically time-specific and situation-bound, making generalisations and extrapolations extremely hazardous, as economists have learned the hard way. We want to make correct predictions about events, and veritiable casual statements about the relationships between variables, but with our data and analytical techniques it cannot be done with impunity.

Computer simulation in general, and the system dynamics approach in particular, seem to hold the promise of a way out of this dilemma. A number of features of system dynamics methodology make it especially suitable for testing sociological theory. First, it is possible to handle many variable simultaneously, and study their fluctuations over time. Secondly, we can take account of multiple feedback loops in the system under investigation and study their mutual influences, again, over time. Furthermore, we do not have to stick to linear hypotheses, and can readily model any non-linear relationships posited by the theory. Another advantage is that system dynamics stresses robustness rather than precision, making it more suitable than other modelling techniques for the imprecise measures that we usually have. Finally, and perhaps crucially for many practicing sociologists, system dynamics does not require great mathematical sophistication from the user. What it does require is analytical acumen and a familiarity with computers, both of which are necessary to sociologists anyway.

Not all sociologists are unaware of system dynamics and its applications. Forrester's work on industrial and urban dynamics[1] has attracted the attention of many social scientists who specialise in organisational studies, urban planning, human ecology, demography, and similar areas. But sociologists generally have tended to dismiss this approach, probably because it did not incorporate the knowledge available to them, and in some cases flatly contradicted it. This is unfortunate, because thereby they have thrown the baby out with the bath water. It is the author's belief that there is great potential in the system dynamics methodology for sociology, once we make the effort to anchor it in social theory.

If sociologists have not adopted system dynamics of their own accord, it still may seem puzzling why there has been no concerted effort by system dynamics experts to penetrate sociology from their side. The main reason for this is, they believe that system dynamicists have tended to concern themselves primarily with decision-making problems. While there is, of course, an implicit theory in every system dynamics model, these have tended to be, by and large, intuitive, common sense type of theories based on the practical experience and specific expertise of the modelers or their clients. Using system dynamics methodology explicitly to test theory has been done only rarely, and we have not been able to find a single example of an attempt to apply it to a macro-sociological theory.

There are many sociological theories that lend themselves to system dynamics modeling. Smelser's theory of collective behaviour, for example[2], or Merton's theory of the self-fulfilling prophesy[3]. In fact, any theory that posits, either explicitly or implicitly, dynamic feedback loops of some sort should be amenable to the system dynamics approach for testing it.

2. STRATEGY

The strategy we propose has four phases. Each phase involves an iterative process of refinement and elaboration, until the output satisfies the pertinent logical and methodological conditions.

Phase I – Deduction. Select a dynamic sociological theory, preferably one of the type which Merton has called the 'middle range', so as to increase the chances of obtaining relevant data. Formulate the theory as a casual loop diagram, forcing implicit casual assumptions into the open, and correcting any lapses or contradictions in the deductive argument. Iterate this process until the theory is adequately expressed in the diagram and all casual loops are logically consistent.

Phase II – Internal Validity Testing. State the variables, endogenous as well as exogenous to the system, that are involved in its functioning over time. If serviceable operationalizations are available for these variables, so much the better. Define the levels, outline the flow diagram and write the equations. Then run the model, to see whether it behaves consistently with the theoretical predictions. Adjust the relationships between the variables in successive iterations, until the model reflects the theory as initially stated.

In our experience, this phase may involve the disaggregation or variables to express system states which had been implicitly assumed or overlooked in the verbal statement of the theory. This is all to the good, as it tightens the argument and makes it more explicit. Running the model for longer time horizons than had originally been anticipated may also reveal unexpected patterns, which may or may not fit the theory.

Phase III – External Validity Testing. Once the model can produce output that tallies with the theoretical predictions, real data must be substituted for the arbitrarily chosen initial values. The aim is to reproduce known time series to see whether the theory corresponds with reality. The more data sets there are, the better, as that increases our confidence in the theory. A really good fit will probably not be obtained at first. In that case the constants in the model which reflect the situational assumptions in the theory may be calibrated and adjusted to improve the fit.

This is the stage where our strategy provides an answer to one important requirement of the scientific method. If the model does indeed represent the theory – and this should have been established in Phase II – but cannot reproduce known time series of data, then the theory must be either revised or rejected. It is the empirical possibility of rejection that gives the successful model its external validity.

Phase IV – Boundary Testing. The final step to test the theory requires the systematic variation of each constant in turn, while controlling for all the others. This is, in fact, the quasi-experimental procedure whereby we can establish the range of conditions under which the theory holds. The flow diagram in fig. 1 summarizes the four phases of our proposed strategy.

The given strategy will now be illustrated with a social theory that seeks to explain the proliferation of norm evasions in contemporary societies. For a more detailed exposition of the theory, see Jacobsen 1979[4].

3. A THEORY OF NORM EVASIONS

When social systems have to contend with structural impediments to their mechanisms of social control, isolated cases of norm evasion tend to coalesce into a pattern. For example, social settings which make individuals anonymous or transient are structurally conducive to norm-evasive patterns of

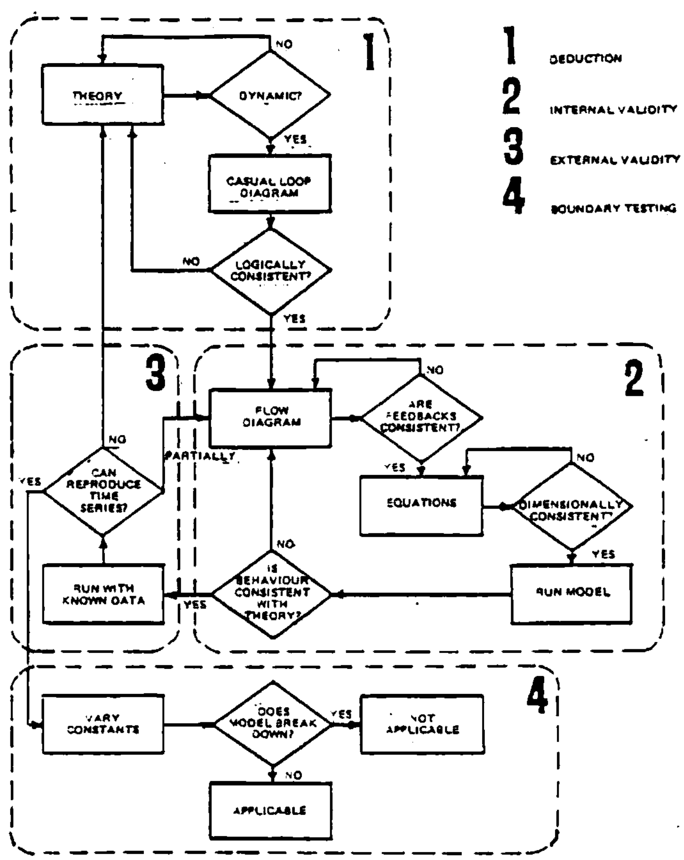

Figure 1: Strategy for Theory Testing.

behaviour. Patterned evasions[5] are widespread and frequently recurring, devious and deliberate violations of accepted norms, which elicit no perceptible reactions from their social audiences. Tax evasions and building code violations are two cases in point. A pattern develops despite the surreptitious nature of the practices, because so many people do it, and do it repeatedly.

When patterned evasions continue for some time, normative ambiguity increases. More and more people become unsure about what the norm really prescribes or prohibits, and how stringently it applies. If, under such conditions, there is also structural strain in the system, the patterned evasions acquire partial legitimacy, and will be transformed thereby into institutionalized evasions[6]. Systemic structural strain is an obvious disparity between the norms and social realities. It may be expected in times of rapid technological change, in organizations where regulations are arbitrarily imposed or changed from above, or when patterned evasions have been allowed to persist for lengthy periods. Many traffic violations are examples of institutionalized evasions, as are illegal abortions, kickbacks to strategically placed agents or executives, and similar practices.

Social systems which have, in addition to patterned evasions and institutionalized evasions, also some general beliefs and values that lend themselves to interpretation as legitimations of nonconformity, will gradually increase in permissiveness. This is an institutionalized social climate, wherein a person can violate accepted norms in public without incurring sanctions, because social audiences are normatively expected not to react to nonconforming behaviour. Some examples of beliefs and values that have the potential for fostering a permissive social climate are toleration, cultural pluralism, liberalism, and freedom of expression.

Patterned evasions, institutionalized evasions and permissiveness frequently serve adaptive and tension-releasing functions for the social systems in which they occur. Indeed it may be argued that, were it not for such facilitating functions, these phenomena would not grow and spread. But once a permissive social climate has become institutionalized, a positive feedback cycle of increasing evasions, legitimation and permissiveness is set in motion. Such a process, once started, must lead sooner or later to a crisis in social self-regulation.

But a negative feedback loop may also be activated through the manifestation of social dysfunctions that result from the decrease in predictability in social interaction. This applies especially if the dysfunctions are exacerbated by crises of some sort: political, economic, or military. In that case the system is likely to react in a spate of repressive coercion, neutralizing the beliefs and values that legitimized the permissiveness, and directly reducing the level of evasions and their legitimacy.

4. THE MODEL

To simulate this theory a model has been developed. Fig. 2 shows a casual loop diagram for this and Fig. 3 presents a flow diagram. The DYNAMO equations are given in the Appendix. The model contains three multipliers, five auxiliary variables and one extraneous variable. In addition, there is an increase rate and a decrease rate for each of the three levels. These variables shall now be briefly described.

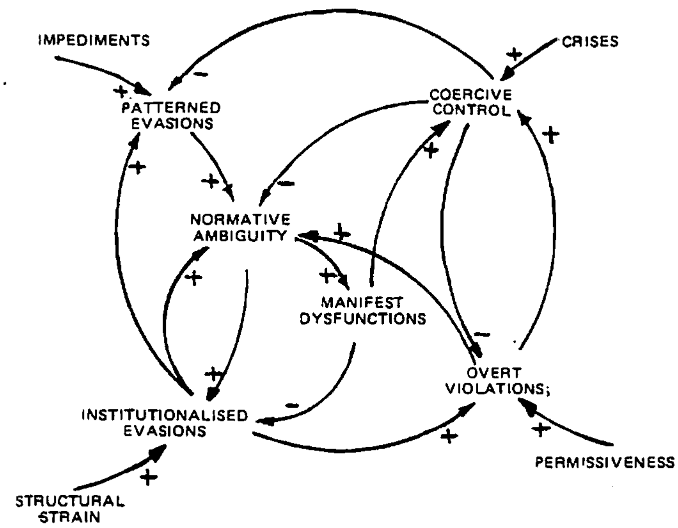

Figure 2: Casual Loop Diagram of Norm Evasions.

Levels. Patterned evasions (EVADRS) are measured by the percent of the population that evades the particular norm or norm-set under consideration. Institutionalized evasions (PERTEL) are indicated by the legitimacy attached to the evasions, and are measured by the percent of the evader's acquaintances he is willing to tell of his evasions. Overt violations (INFRIN) are estimated by the percent of the population that overtly infringes the norm or norm-set.

Constants. The increase rates of each of the levels have been modeled to depend on the social-structural conditions that are assumed in the theory, and are represented in the model by constant multipliers. The increase rate of EVADRS is propelled by the constant structural impediments (IMPEDS)

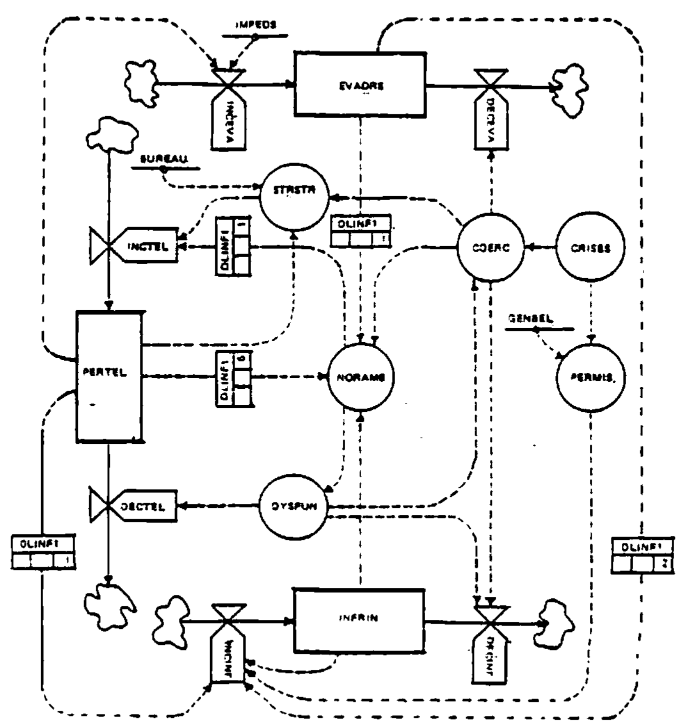

Figure 3: Flow Diagram of General Norm Evasion Model.

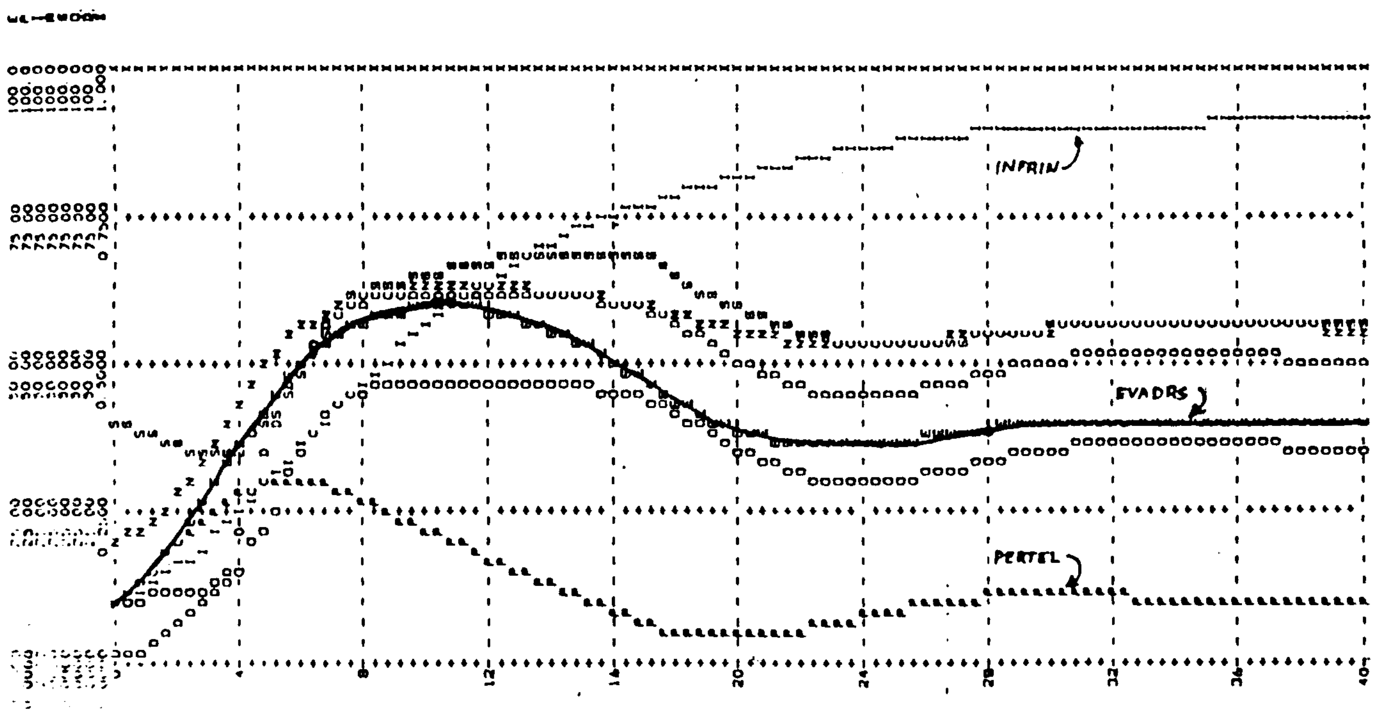

Figure 4: System Behaviour (without crises).

to social control mechanisms that exist in contemporary industrial societies. The increase of legitimacy leading to institutionalized evasions (PERTEL) depends on the amount of structural strain in the normative system due to the bureaucratic structure (BUREAU). For overt violators (INFRIN) the assumption is that it increases with the degree of permissiveness in the social climate brought about by the general beliefs (GENBEL) that legitimize non-reaction to norm violations.

Auxiliary Variables. The following five variables represent the links in the casual chain of the theory. Two of these, structural strain and permissiveness, have already been mentioned. Structural strain (STRSTR) is indicated by the percent of people who feel constrained, because of bureaucratic regulations, to evade the norms in question. The presence or absence of permissiveness (PERMIS) is modeled by a dimensionless multiplier. The most crucial outcome of patterned evasions is normative ambiguity (NORAMB), which is measured

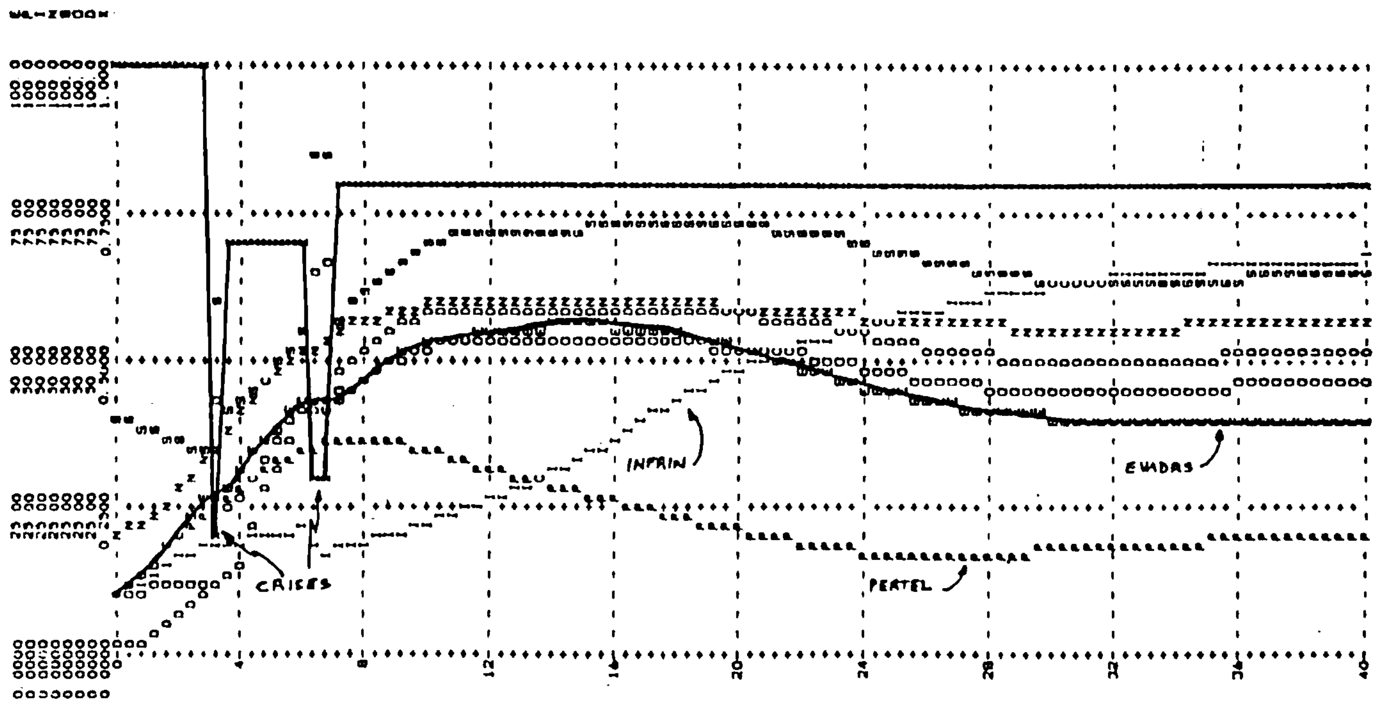

Figure 5: System Behaviour (with crises).

by the percent of people who are unsure about the norm that is being evaded. The negative effects of normative ambiguity are indicated by the percent of people who become aware of manifest dysfunctions (DYSFUN) due to lack of predictability in others' behaviour. The fifth auxiliary variable is coercive enforcement (COERC), as measured by the percent of violators who are being coerced into norm compliance.

Finally, there is one extraneous variable, CRISIS, which can be programmed to occur at given points for known time-series, or postulated to occur as the modeler sees fit. In addition, there are delays to approximate the time-lapses between the different occurrences in the system behaviour.

While there are still some inadequacies in the model, notably the absence of feedback loops to simulate change in the norms themselves, we feel that it represents the main propositions of the theory without major distortions. The system behaviour is shown in Figure 4 (without crisis) and Figure 5 (with crisis) for a period of forty years.

Year	Number of Taxable Incomes	Number of Approved Returns	Number of Evaders	Percent Evaders
1971	191.525	100,550	90,975	47.5
1972	207,091	111,622	95,469	46.1
1973	218,206	107,793	110,413	50.6
1974	229,163	118,248	110,915	48,4
1975	237,988	132,559	105,429	44.3
1976	261,107	149,614	111,493	42.7
1977	271,422	152,267	119,155	43.9
1978	279,520	160,444	119,076	42.6
1979	291,875	153,526	138,349	47.4
1980	313,887	163,221	150,666	48.0

Table 1: Number and Percentage of Income Tax Evaders in Israel, 1971-1980.

5. EXTERNAL VALIDATION

As a first attempt at external validation, data were obtained from the Income Tax Division of the Israeli Treasury on the extent of income tac evasions by self-employed persons for the period 1971-1980. The data are given in the first two columns of Table 1.

The initial value for this time-series (47.5%) was fed into the model as EVADRS, along with estimated values for PERTEL and INFRIN. Two crises were programmed, one for 1973 (the Yom Kippur war), and a second for 1977 (first change of ruling party in 29 years). After calibrating the precise timing and duration of the crises, results were obtained as shown in Figure 6.

To give some indication of the degree of fit between the real data and the model output, we computed the proportion of the variance of the real data points around their initial value, which the model can reproduce, as follows:

Proportion of real variance reproduced by model =

$$\frac{\Sigma (D_i - a)^2 - \Sigma (D_i - M_i)^2}{\Sigma (D_i - a)^2}$$

where D_i = the data at time i,
M_i = the model value at time i,
a = the initial value of the data

The result for the run shown in Figure 6 was .817, which we consider acceptable evidence of external validity.

A second set of data for external validation described the extent of illegal building in the city of Haifa. The data were obtained from the City Engineer's Reports for the years 1960-1980, and the Israel Bureau of Statistics. They are shown in Table 2.

After adjusting the constants IMPEDS and CRISIS, the proportion of variance in the data reproduced by the model was .98. All things considered, then, the results are encouraging. Even so, the model will have to be further refined and tested before we can take the external validity of the theory as established. The important innovation, however, is that this is both possible and practicable.

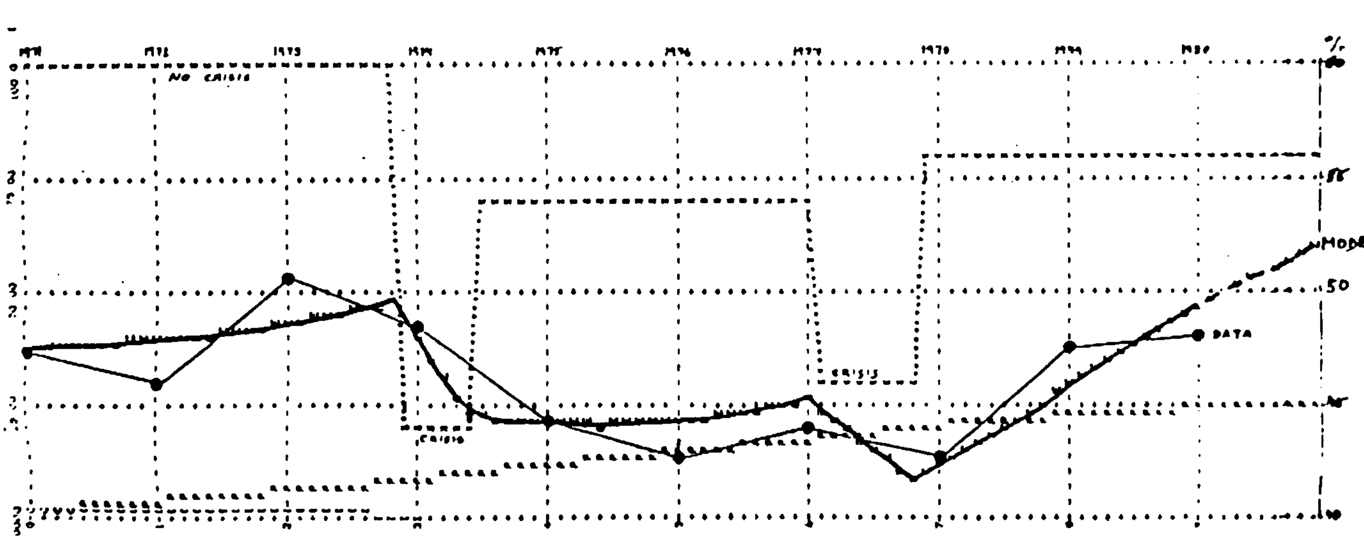

Figure 6: Plotted Output of the Tax Evasion Model (Real Data superimposed).

Year	Number of Building Permits (A)	Number of Prosecutions for Illegal Buildings (B)	Percent Evaders (B/B+A) 100
1960	980	250	20
1961	900	400	31
1962	1000	750	43
1963	940	800	46
1964	970	700	42
1965	880	950	52
1966	700	1450	67
1967	760	1170	61
1968	810	900	53
1969	830	820	50
1970	920	780	46
1971	920	750	45
1972	850	810	49
1973	(1182)*	800	40
1974	(873)	790	48
1975	(613)	813	57
1976	(458)	708	61
1977	(432)	662	61
1978	(540)	637	54
1979	(443)	713	62
1980	(393)	988	72

*From 1973 on, the figures were calculated from total sq.mtrs. per permit.

Table 2: Number and Percentage of Illegal Building Projects in Haifa, 1960-1980.

IMPEDS	1.85	1.90	2.00	2.05	2.10	2.20	2.25	
Sum of sqd. deviations	46.17	31.80	16.41	15.15	15.80	33.54	44.79	
Proportion of variance reproduced	.443	.616	.802	.817	.809	.595	.460	
BUREAU	27	30	35	40	45	50	55	60
Sum of sqd. deviations	41.49	30.98	18.78	15.15	19.00	24.83	32.22	38.61
Proportion of variance reproduced	.499	.626	.773	.817	.771	.700	.611	.534
GENBEL	.01	1	3	6	8	9		
Sum of sqd. deviations	14.40	14.40	14.40	15.47	18.26	38.78		
Proportion of variance reproduced	.826	.26	.826	.813	.800	.532		

Table 3: Sums of Squared Deviations of Model from Data, and Proportions of Variance Reproduced with Different Values for Constants.

6. BOUNDARY TESTING

To illustrate this final phase of the procedure, let us assume that external validity has been established. Each constant has now to be systematically varied, all others being controlled, to see at what point the model can no longer satisfy the criterion for external validity. Let us set this cut-off point arbitrarily at 50% reproduced variance. Table 3 presents the results of this procedure for each of the three constants in our model, as applied to the tax data.

Thus the ranges within which the theory can be said to hold for tax evasions are, for IMPEDS: 1.9 through 2.2, for BUREAU: 28 through 60, and for GENBEL: 0.01 through 9. In other words, when the multiplier effects of these constants exceeds these ranges, the theory can no longer reproduce reality satisfactorily and is therefore not applicable to tax evasions.

CONCLUSIONS

We must emphasize again that the model we have presented is by no means final, and that we are continuously working on its improvement. Our purpose in presenting it even in its tentative form has been to demonstrate the feasibility of the research strategy we have proposed. The results we have obtained so far are encouraging enough to suggest that here at last we may have found a quasi-experimental procedure for testing macro-sociological theories. An added fringe benefit is that system dynamics models developed in this manner are likely to be better grounded in social theory than some of the models that have been proposed in the past.

Appendix.

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        * GENERAL NORM EVASION MODEL -  VERSION  THREE (10.3.83)

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1.      NOTE      C O N S T A N T S
1.1     C       IMPEDS=2
1.11    NOTE       IMPEDIMENTS TO SOCIAL CONTROL (UNITS)
1.2     C       BUREAU=40
1.21    NOTE       BUREAOCRATIC STRAIN (% POP. CONSTRAINED TO EVADE)
1.3     C       GENBEL=6
1.31    NOTE       GENERALIZED BELIEFS LEGITIMIZING NONCONFORMITY (UNITS)
1.32    NOTE
2.      NOTE    . E X O G E N O U S   V A R I A B L E S
2.1     A       CRISIS.K=1
2.11    NOTE       COERCION-PRECIPITATING CRISES (NO CRISIS=1.CRISIS<1)
2.12    NOTE
3.      NOTE       L E V E L S
3.1     L       EVADRS.K=EVADRS.J+DT*(INCEVA.JK-DECEVA.JK)
3.11    NOTE       EVADERS (% POPULATION EVADING THE NORM)
3.12    N       EVADRS=10
3.2     L       PERTEL.K=PERTEL.J+DT*(INCTEL.JK-DECTEL.JK)
3.21    NOTE       LEGITIMACY LEVEL (% OTHERS ONE TELLS OF THE EVASION)
3.22    N       PERTEL=10
3.3     L       INFRIN.K=INFRIN.J+DT*(INCINF.JK-DECINF.JK)
3.31    NOTE       INFRINGED NORMS (% OF NORMS OVERTLY INFRINGED)
3.32    N       INFRIN=10
3.41    NOTE
4       NOTE       A U X I L I A R Y   V A R I A B L E S
4.01    A       DEVA1.K=DLINF1(EVADRS.K.1)
4.02    NOTE       ONE YEARS DELAY INFLUENCE OF EVADRS ON AMBIGUITY
4.03    A       DPER1.K=DLINF1(PERTEL.K..5)
4.04    NOTE       HALF A YEAR DELAY INFLUENCE OF PERTEL ON AMBIGUITY
4.05    T       TAMB1=10/20/30/37/42/45/45/45
4.06    NOTE       EVADERS EFFECT ON AMBIGUITY (% UNSURE)
4.07    T       TAMB2=0/1/3/6/10/12/10/6/3/1/0
4.08    NOTE       LEGITIMACY EFFECT ON AMBIGUITY (ADDNL % UNSURE)
4.09    T       TAMB3=.5/1/3/7/9/9.5
4.10    NOTE       INFRINGEMENT EFFECT ON AMBIGUITY (ADDNL % UNSURE)
4.11    T       TAMB4=9/9/8.5/7.5/4.5/1
4.12    NOTE       COERCION EFFECT ON AMBIGUITY (ADDNL & UNSURE)
4.13    L       OLD.K=OLD.J+DT*(INCOLD.JK)
4.131   NOTE       AUX. LEVEL OF NORAMB FOR COMPUTING PURPOSES ONLY
4.14    N       OLD=21
4.15    R       INCOLD.KL=(NORAMB.K-OLD.K)/.1
4.151   NOTE       DENOMINATOR IS DT=.1
4.2     A       NORAMB.K=TABLE(TAMB1.DEVA1.K.10.80.10)+TABLE(TAMB2.
X               DPER1.K.0.100.10)+TABLE(TAMB3.INFRIN.K.0.100.20)
X               +TABLE(TAMB4.COERC.K.0.100.20)
4.21    NOTE       NORMATIVE AMBIGUITY (% PEOPLE UNSURE ABOUT THE NORM)
4.3     A       COERC.K=YES*(1-CRISIS.K)+(NO*CRISIS.K)
4.31    NOTE       COERCIVE ENFORCEMENT (% NORMS COERCIVELY ENFORCED)
4.32    A       YES=TABLE(TCOER1.DYSFUN.K.0.100.20)
4.33    NOTE       DYSFUNCTION INFLUENCE ON COERCION WITH CRISIS
4.34    T       TCOER1=40/60/80/90/95/95
4.35    A       NO=TABLE(TCOER2.DYSFUN.K.0.100.20)
4.36    NOTE       DYSFUNCTION INFLUENCE ON COERCION WITHOUT CRISIS
4.37    T       TCOER2=10/15/25/45/65/70
4.4     A       DYSFUN.K=TABLE(TDYS2.OLD.K.0.100.20)
4.41    NOTE       OTHERS MADE AWARE OF DYSFUNCTIONS ( % )
4.42    T       TDYS2=1/1/15/60/75/80
4.43    NOTE       AMBIGUITY EFFECT ON PEOPLES AWARENESS OF DYSFUNCTIONS
4.5     A       PERMIS.K=CRISIS.K*GENBEL
4.51    NOTE       PERMISSIVENESS (DLESS  PRESENT=3.ABSENT=ZERO)
4.6     A       STRSTR.K=BUREAU-TABLE(TSTR1.PERTEL.K.0.100.20)
X               +TABLE(TSTR2.COERC.K.0.100.20)
4.61    NOTE       STRUCTURAL STRAIN (% POP CONSTRAINED TO EVADE)
4.62    T       TSTR1=0/10/15/17.5/19/20
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* GENERAL NORM EVASION MODEL -  VERSION  THREE (10 3.83)
4.63    NOTE       STRAIN  REDUCTION (% POP. RELIEVED OF STRAIN)
4.64    T       TSTR2=0/10/25/55/70/80
4.65    NOTE       ADDTNL. STRAIN (% ADDTNL CONSTRAINED TO EVADE)
4.66    NOTE
5.      NOTE       I N C R E A S E   A N D   D E C R E A S E   R A T E S
5.1     R       INCEVA.KL=TABLE(TINEVA,PERTEL.K,0,80,10)*INPEDS
5.12    NOTE       YEARLY INCREASE OF EVADERS (%EVADERS PER YEAR)
5.13    T       TINEVA=1/2.5/4/5.2/6.2/7/7.5/8/8
5.14    NOTE       LEGITIMACY EFFECT ON EVADER INCREASE (% PER YEAR)
5.2     R       DECEVA.KL=TABLE(TDCEVA,COERC.K,0,100,20)
5.21    NOTE       YEARLY DECREASE OF EVADERS (% EVADERS PER YEAR)
5.22    T       TDCEVA=0/2/6/12/16/18
5.3     R       INCTEL.KL=(TABLE(TINTEL,DNOR.K,0,100,20)
X               +TABLE(TINPST,STRSTR.K,0,100,20))/2
5.32    NOTE       YEARLY INCREASE OF LEGITIMACY (% OTHERS TOLD PER YEAR)
5.33    T       TINTEL=0/4/6/8/9/10
5.34    NOTE       AMBIGUITY EFFECT ON LEGITIMACY INCREASE (% OTHERS/YEAR)
5.35    T       TINPST=0/4/6/8/9/10
5.36    NOTE       STRUCTURAL STRAIN EFFECT ON LEGITIMATION
5.37    A       DNOR.K=DLINF1(NORAMB.K,1)
5.38    NOTE       DELAYED INFLUENCE OF NORAMB ON INCTEL
5.4     R       DECTEL.KL=TABLE(TDECTL,DYSFUN.K,0,100,20)
5.41    NOTE       YEARLY DECREASE OF LEGITIMACY (% OTHERS TOLD/YEAR)
5.42    T       TDECTL=0/2/5/10/16/24
5.43    NOTE       EFFECT OF AWARENESS ON LEGITIMACY DECREASE (% OTHERS)
5.5     R       INCINF.KL=(TABLE(TPERT,DPER2.K,0,100,20)+TABLE(TEVAD,DEVA2.K
X               ,0,100,20)+TABLE(TINFR,INFRIN.K,0,100,20))*PERMIS.K/3
5.52    NOTE       % INCREASE IN OVERTLY INFRINGED NORMS
5.521   A       DPER2.K=DLINF1(PERTEL.K,1)
5.522   NOTE       ONE YEAR DELAY INFLUENCE OF LEGITIMACY ON INFRINGEMENT
5.523   A       DEVA2.K=DLINF1(EVADRS.K,2)
5.524   NOTE       TWO YEAR DELAY INFLUENCE OF EVADERS ON INFRINGEMENT
5.53    T       TPERT=0/.2/1/2/2.8/3
5.54    NOTE       LEGITIMATION EFFECT ON INFRIN INCREASE
5.55    T       TEVAD=0/1/2.5/3.5/4/4
5.56    NOTE       DEMONSTRATION EFFECT OF EVADERS ON INFRIN INCREASE
5.57    T       TINFR=0/2/3/2/1/0
5.58    NOTE       DEMONSTRATION EFFECT OF INFRINGED NORMS ON INFRIN INCREASE
5.6     R       DECINF.KL=(TABLE(TDYS3,DYSFUN.K,0,100,20)+TABLE(TCOER3,
X               COERC.K,0,100,20))/2
5.62    NOTE       % DECREASE IN INFRINGED NORMS
5.63    T       TDYS3=0/2/5/7/8/8.5
5.64    NOTE       DYSFUN EFFECT ON INFRIN DECREASE
5.65    T       TCOER3=0/3/6.5/9/12/14
5.66    NOTE       COERCION EFFECT ON INFRINGEMENT DECREASE

        END
SPEC DT=.1/LENGTH=40/PRTPER=1/PLTPER=.4
PLOT EVADRS=E(0,100)/PERTEL=P(0,100)/INFRIN=I(0,100)/NORAMB=N(0,100)/
X STRSTR=S(0,100)/COERC=C(0,100)/DYSFUN=D(0,100)/CRISIS=X(0,1)
```

FOOTNOTE:
The variables YES and NO in the listing should read YES.K and NO.K.

REFERENCES

1. FORRESTER, Jay W., *Industrial Dynamics.* Cambridge, Mass.: The M.I.T. Press, 1961.
   – – –, *Urban Dynamics.* Cambridge, Mass.: The M.I.T. Press, 1969.
2. SMELSER, N.J., *Theory of Collective Behaviour.* New York: The Free Press, 1962.
3. MERTON, Robert K., *Social Theory and Social Structure.* Glencoe, Ill.: The Free Press, 1949: 179-195.
4. JACOBSEN, Chanoch, "Permissiveness and Norm Evasions: Definitions, Relationships, and Implications". *Sociology,* 1979: 219-233.
5. WILLIAMS, Robin M Jr., *American Society.* New York: Alfred Knopf, 3rd ed., 1970.
6. MERTON, Robert K., *Social Theory and Social Structure.* Glencoe, Ill.: The Free Press, 1949: 318ff.