Ontario University System Financing and Staffing Policies

A Quantitative Model for Policy Analysis

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ABSTRACT

This paper presents a computer based model of the Ontario university system. The emphasis is on funding, faculty staffing and faculty salaries from 1955 to 1995. Recent events in these areas are analyzed and explained as consequences of interaction between a strongly self-equilibrating social system, the universities, and a massively disequilibrating external force, the expansionary drive of the 1960's. Many past and present characteristics of the university system are seen as temporary abberations, a return to which is not possible. The effects of several proposed modifications to funding, staffing and salaries policies are explored, as are prerequisites for a return to "steady state". While a technical appendix is available which specifies and discusses the equations employed in the computer model, this paper is intended for a non-technical readership whose primary interest is the subject matter dealt with.

RESUME

Un modèle informatique du système universitaire de l'Ontario

Cet article présente un modèle informatique du système universitaire de l'Ontario. Les principales composantes en sont le financement, la composition du corps professoral et leurs échelles de traitement de 1955 à 1995. Les développements récents dans ces domains sont analysés et perçus comme les effets résultant du choc de l'essor expansionniste des années 60, source externe de déséquilibres massifs, sur le système universitaire, corps social ayant une forte tendance à s'équilibrer. Certaines caractéristiques, présentes et passées, des

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universités sont alors considérées comme des anomalies temporaires qu'il est impossible de voir se reproduire. Les conséquences de certains changements proposés dans les politiques sur le financement, la dotation en personnel et les salaires sont examinées de même que les conditions préalables à un retour à la normale. Les équations utilisées dans ce modèle sont reproduites et commentées dans une annexe technique reportée à la fin afin de rendre accessible cet article au lecteur non-spécialisé dont l'intérêt se situe rait au niveau du sujet traité.

Introduction

The major purpose of this paper is to explain the reasons why certain aspects of the Ontario university system have shown undersirable behaviour characteristics in recent years and to explore the implications which this explanation has for the behaviour of these aspects of the system in the future. A secondary purpose is to examine the potency of a number of policy options which might be expected to have some influence on that future. The aspects of system behaviour which will be discussed are the operating funding level (Provincial grants plus student fees), and the size, the age composition and salary levels of the full-time professoriat. The paper will discuss these matters at the level of aggregation of the whole Provincial university system, and over a period of interest of forty years.

The discussion will have implications for other aspects of system behaviour, for conditions at lower levels of aggregation, and for options available over shorter periods of time. Such implications lie beyond the scope of the present paper, however. This work is directed primarily to persons who are concerned with the longer term development of financing and faculty staffing aspects of the system as a whole, and secondarily to those who wish to draw inferences therefrom.

The recent history of the Ontario university system is one of rapid growth in capacity and funding level during the sixties, followed by a leveling off in both in the first half of the present decade. The expansion was carried out with surprising ease, while leveling off has caused great difficulties.

At present the university system's constant dollar operating funding level is increasing at a low rate. Expansion of the size of the full-time professoriat has not slowed proportionately. A result has been increased expenditure for faculty salaries in aggregate resulting in downwards pressure on individual faculty salary levels and on expenditure categories other than faculty salaries. Because large numbers of younger faculty were hired over a relatively short period of time, the sixties, the age composition of the professoriat is skewed. As the younger faculty bulge ages it has age-related salary expectations which put further downward pressure on other expenditure categories. Concurrently, leveling off in total faculty numbers has much reduced the inflow of junior faculty, precluding any modification of the skewed age pattern through additional hirings.

Examination of recent trends over the past two or three years in the areas of interest displays a situation which may be summarized as follows:

constant dollar operating funds	– slow growth
numbers of full-time faculty	– moderate growth

rate of younger faculty hirings	– rapid decline
numbers of older faculty	– rapid growth
constant dollar average faculty salary	– slow decline
constant dollar total full-time faculty salary expense	– slow growth
non salary accounts	– slow erosion

These trends cause unhappiness to a number of actors in the university system. Governments worry about costs. Faculty worry about academic stagnation as well as declining real personal incomes. University administrators worry about making ends meet and coping with irreconcilable internal pressures. Everyone worries about a now restricted capacity to innovate.

Because funding and salary policies and hiring practices have in the past been core determinates of the future shape of the university system it is in terms of changes in these policies and practices that solutions to current and expected problems are sought.

This paper will discuss reasons for past and future behaviour of staffing and funding aspects of the university system and will analyze the effect of a number of proposed solutions to perceived problems. A useful discussion should convey an explicit recognition of underlying assumptions, it should define crisply the boundaries of the system under study, and it should be precise. Consequently a computer model has been chosen as the exploratory medium. While the human mind, unaided, is well able to observe forces and relationships in the university system and to comprehend key structural aspects of this complex system it is limited in the number of factors it is able to consider simultaneously and is even more limited in its ability to trace their dynamic interaction over time. A computer based simulation model can help compensate for these limitations. It is a valuable tool for exploring complex system behavior, both past and future. The present model adds to the human strengths of observation and comprehension of complex structures, the capacity to consider large numbers of factor relationships interacting over time.

As a theory, a computer model forces a precise specification of underlying assumptions and provides a precise specification of their implications.

The complete text of the computer model used is available as an appendix to this paper, and is accompanied by a detailed discussion of the logic employed. While the model remains a theory about reality, it is an explicit theory and it encourages scrutiny and discussion.

Summary Description of the Model

Many social systems are self equilibrating in the sense that there exists some sort of equilibrium state of affairs, moving or static, which they seek to approach over time if they are left free from external shocks. This is true of the Ontario university system as a whole and of three of its sub-systems whose goal equilibriums are: (1) the achievement of a faculty complement size consistent with available funds, (2) the achievement of faculty salary levels consistent with available funds, and (3) the stabilization of the faculty age mix within available funds.

The dynamics of the three inherently self stabilizing sub-systems may be most easily summarized through the relatively simple causal flow diagrams outlined below.

In the causal flow diagrams which are used it is important to note that an arrow indicates a causal relationship between two variables, ceteris paribus conditions always obtaining. If the sign of an arrow is positive, it indicates that a change in the variable from which it comes will cause a change in the same direction in the variable to which it leads relative to the second variable's prior value. If the sign of an arrow is negative the direction of change in the second variable will be in the opposite direction. If the number of negative signs against the arrows in the simple feedback loop is odd, as it is in Figure 1, that loop will be self-equilibrating because an exogenous change in any one variable will set off a chain of events in the feedback loop which will eventually result in pressure on that variable in an opposite direction.

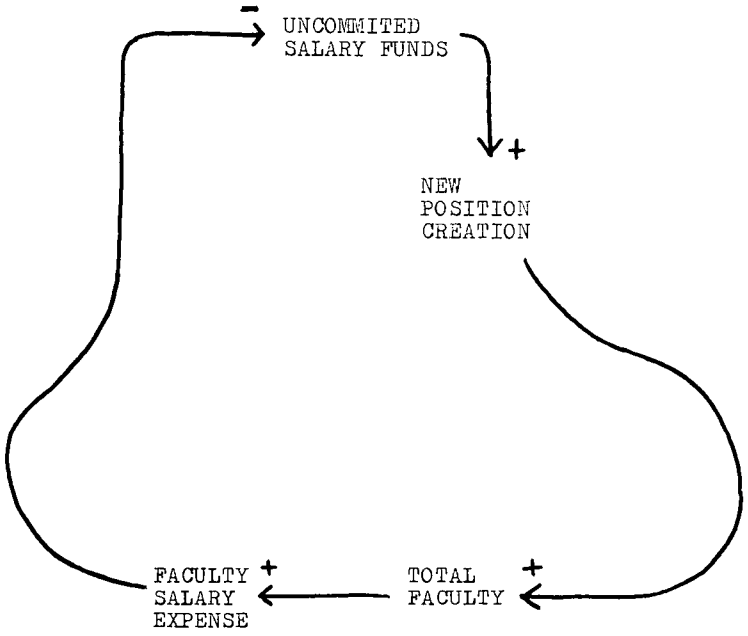

Figure 1

Faculty Complement Size and Available Funding

Figure 1 shows the relationships involved in the university system's faculty complement size and available funding sub-system. Any exogenous change in *Uncommitted Salary Funds*, resulting from, say, an increase in the salaries budget, will result in a change in the same direction in *New Position Creation.* In other words an increase will cause an increase and a decrease will cause a decrease. The resulting change in *New Position Creation* will cause a change in the same direction in the number of *Total Faculty*, and this will cause a change in the same direction in *Faculty Salary Expense.* Now the amount of *Uncommitted Salary Funds* available after these interactions will be reduced by an increase in *Salary Expense* and increased by a decrease. This is indicated by the negative sign of the arrow connecting

these two variables. Consequently there is a sequence of events which causes an increase in *Uncommitted Salary Funds* to result later in a decrease in them. Such a system is, then, seen to be self-equilibrating.

It is not intended to bore the reader with a complicated description of simple events, but to provide a methodology for understanding them. A series of such simple causal relationships is aggregated together to provide a representation of the entire model, and a methodology is then necessary to understand it because it is more complex. Further, the aggregated representation of the entire model is the framework for the full computer-based representation of the system.

Figure 2 displays the relationships involved between the university system's *Faculty Salary Levels* and its *Uncommitted Salary Funds.* An exogenous increase in *Uncommitted Salary Funds* causes and permits *Annual Faculty Salary Increases* which result in a higher *Average Faculty Salary* with the eventual result of a reduction in *Uncommitted Salary Funds.* A decrease in *Uncommitted Salary Funds* would similarly be dampened through these causalities over time.

Figure 3 displays a long run self-equilibrating sub-system which is currently a matter of considerable concern within the university system, namely stabilization of faculty age mix within available funding. Here an exogenous increase in *Uncommitted Salary Funds* results in an increase in *New Position Creation.* Most new positions are filled by younger faculty so the per cent *Junior Faculty* within the system increases. These faculty, with the passage of the years age, and the per cent *Older Faculty* then increases. As faculty age they are paid more and so the *Average Faculty Salary* increases, increasing the *Faculty Salary Expense* and reducing the availability of *Uncommitted Salary Funds.* The effect is a long term one covering many years.

Younger faculty hired during the sixties will age during the period they are on staff and this aging may continue until the turn of the century at which point they will retire. The magnitude of new position creation in Ontario during the sixties makes this feedback loop an important one despite the fact that its effects will only gradually be felt within the system.

A further factor stabilizing the faculty age mix may be described. Faculty age mix within the total complement is at equilibrium when the number of senior faculty at each relevant age is equal and the number of junior faculty is sufficient to maintain this equality given the numbers of junior faculty who are retained within the university system to become senior faculty. A relatively constant retention rate will tend to damp any skewing in the faculty age mix over time. As a skewed age mix retires it is replaced by junior faculty hired at a correspondingly skewed rate. Then, if for example the junior faculty retention rate is 70 per cent, only 70 per cent of that skewedness will immediately repenetrate the older faculty age group. The other 30 per cent will be "recycled" through replacement of junior faculty leavings by new junior staff. The damping of age skewing by this mechanism will be slow however as the cycling of junior faculty leavings takes five years and the cycling of a skewed senior faculty age mix takes about thirty years on the assumption of a junior faculty leaving decision after five years, entrance into the senior faculty group at age 35 and retirement at age 65. Each cycle removes only a portion of the skewing. Nevertheless the damping is sustained and the system's approach to an equilibrium age mix is a powerful reality.

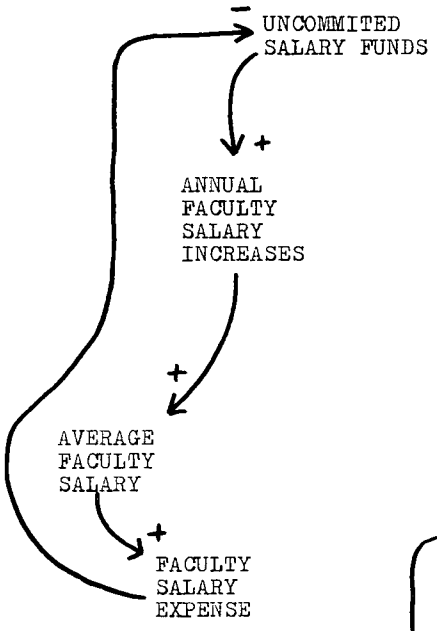

Figure 2

Faculty Salary Levels and Available Funding

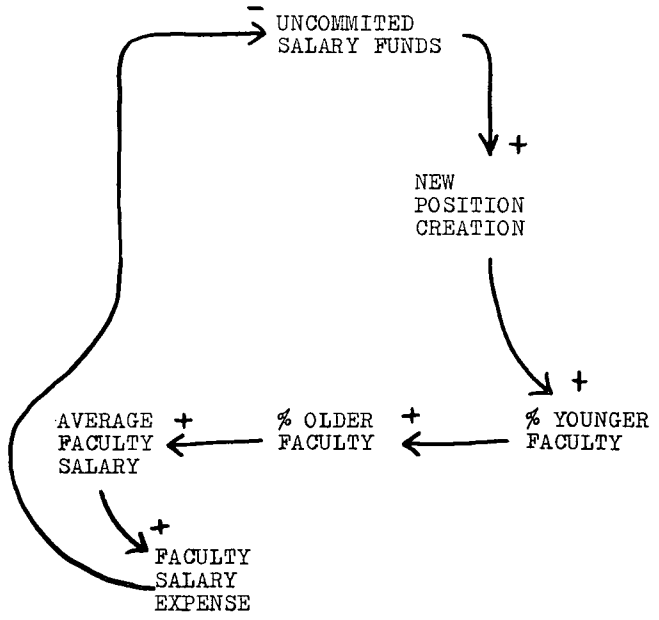

Figure 3

Faculty Age Mix and Available Funding

Because this paper treats the Provincial university system at a very high level of aggregation over a long period of time and is dealing directly with only funding, faculty staffing and faculty salary matters the model used adopts the system's operating funding level as its sole exogenous input. Factors such as student demand, social desire for educational activity, provincial ability to afford university expansion, creation of new universities, and the host of other factors external to this paper's explicit concerns are reflected in and subsumed by the operating funding level. It is composed of Provincial operating grants and students' fees. Figure 4 illustrates the major direct impacts of *Funding Level* in the university system.

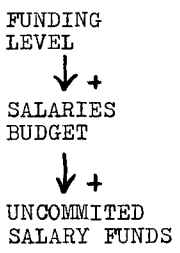

Figure 4

Direct Impact of Funding Level

The most interesting aspect of social systems' behaviour is often not the equilibrium state itself, which seldom exists in its pure form, but the effects on system behaviour of disequilibrating external forces and the ways in which the system and its sub-systems attempt to re-establish equilibrium during and after such shocks. The Ontario university system has received disequilibrating shocks from one major source in the past twenty years. This is the drive for rapid expansion which manifested itself in large increases in the funding of the system and was facilitated by the system's willingness to accept such increases for expansionary purposes.

Faced with increases in its *Funding Level* the university system responds by increasing its *Salary Budget,* among other things. When fractional increases in *Funding Level* are moderate then fractional increases in *Salary Budget* will be directly related to them. In other words all of the operating funding given to the system each year is spent and the system desires stability in the proportion of the funding level assigned to the *Salary Budget.* It cannot always maintain such stability. In times of rapid growth scarce faculty are difficult to obtain and are competed for by increases in non-faculty salary expenses which are more than proportionate to increases in the funding level. Such expenses provide better laboratories, libraries, technical and secretarial staff and the like. As a result fractional increases in *Salary Budget* are a declining rather than a direct function of fractional increases in *Funding Level* when the latter are high. Any increases in the *Salary Budget* result in immediate increases in the *Uncommitted Salary Funds.* It is through this route that the massive funding level increases of the sixties disturbed the self-equilibrating sub-systems described earlier and wrenched their goal equilibrium states.

In addition to external forces of disequilibrium the university system contains an important destabilizing feedback loop within itself.

Figure 5 displays the effect of new position creation. An increase in *Uncommitted Salary Funds* will cause an increase in *New Position Creation* resulting in an increase in the per cent *Younger Faculty* on staff. Most new positions are filled by younger faculty. Since younger faculty are paid less than older faculty a higher per cent *Younger Faculty* causes a decline in *Average Faculty Salary.* This causes a reduction in *Faculty Salary Expense* which increases the *Uncommitted Salary Funds.* Thus expansion begets itself. *Ceteris paribus* conditions obtain of course in this discussion. Obviously the reduction in salary expense effected by lowering average salaries by hiring younger faculty will be swamped by the in-

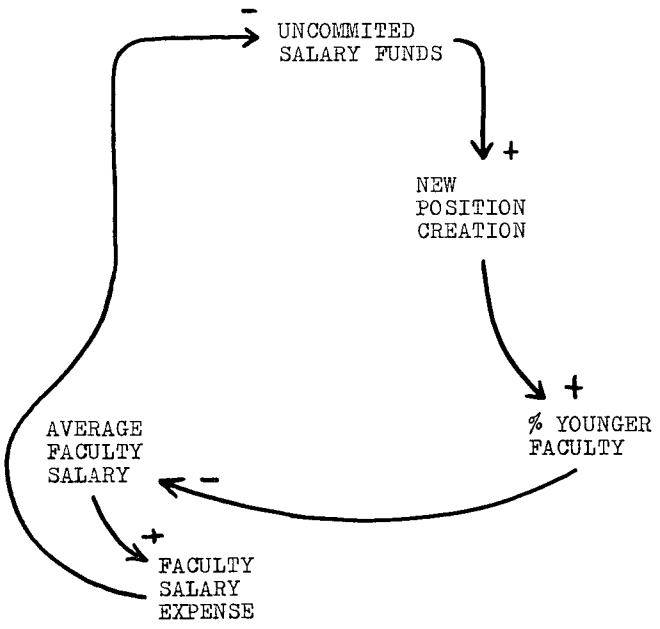

Figure 5

Destabilizing Effect of New Position Creation

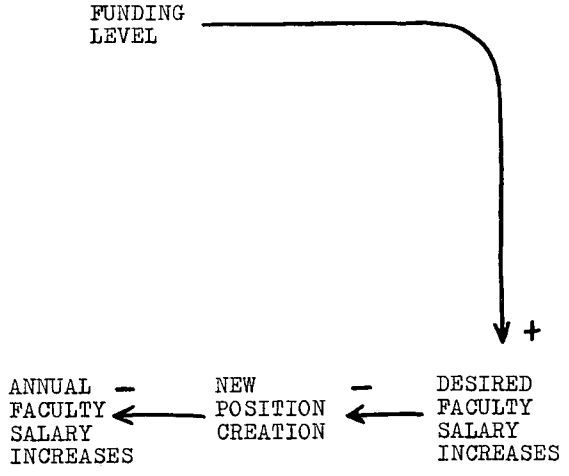

Figure 6

Faculty Salary Policy (Excluding Age-Related Salary Increases)

crease in salary expense resulting from increase in faculty numbers. It may also be disguised by across-the-board salary increases. Nevertheless the effect described has been present in the Ontario university system and it is precisely because it has been swamped and disguised that it has not been recognized. Now that the younger faculty previously hired have become older and a contrary effect is taking place it has become evident enough.

There is another aspect of salary policy apart from the age-related nature of faculty salary levels. This is the across-the-board increases that take place with the passage of time. These two aspects are treated quite separately in the model. The relationships governing the latter are relatively simple.

Given ample *Funding Level* increases, as obtained until the early 1970's, the university system tends to desire across-the-board faculty salary increases of 3.5 per cent a year in constant dollars. It awarded its faculty such increases until the early 1970's. Given *Funding Level* increases below 3.5 per cent the system will desire to pass on equivalent across-the-board faculty salary increases. The greater the *Desired Faculty Salary Increases* the less

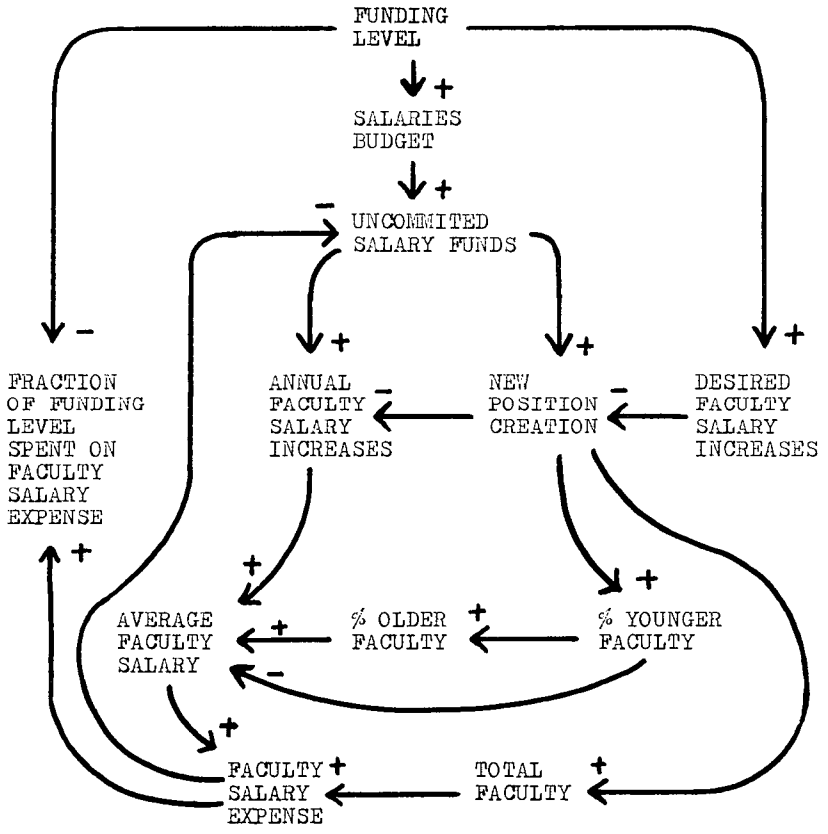

Figure 7

Simplified Causal Flow Diagram of the Model

the *New Position Creation* that can be afforded. This is simply because the greater the *New Position Creation* the less the actual *Annual Faculty Salary Increases* will be. These relationships are outlined in Figure 6.

All of the causalities discussed above may be aggregated together and presented in one simplified causal flow diagram of the model, Figure 7.

The variable *Fraction of Funding Level Spent on Faculty Salary Expense* is a useful indicator of events. It is self-explanatory and is calculated straightforwardly from the two variables on which it depends.

The reader is asked to satisfy himself that the causalities portrayed are reasonably clear. The quantification involved is not included in this diagram nor are the delays which obtain between changes in variables and the effects which these changes produce in other variables. A number of the causalities are governed by lagged functions. The reader is referred to the

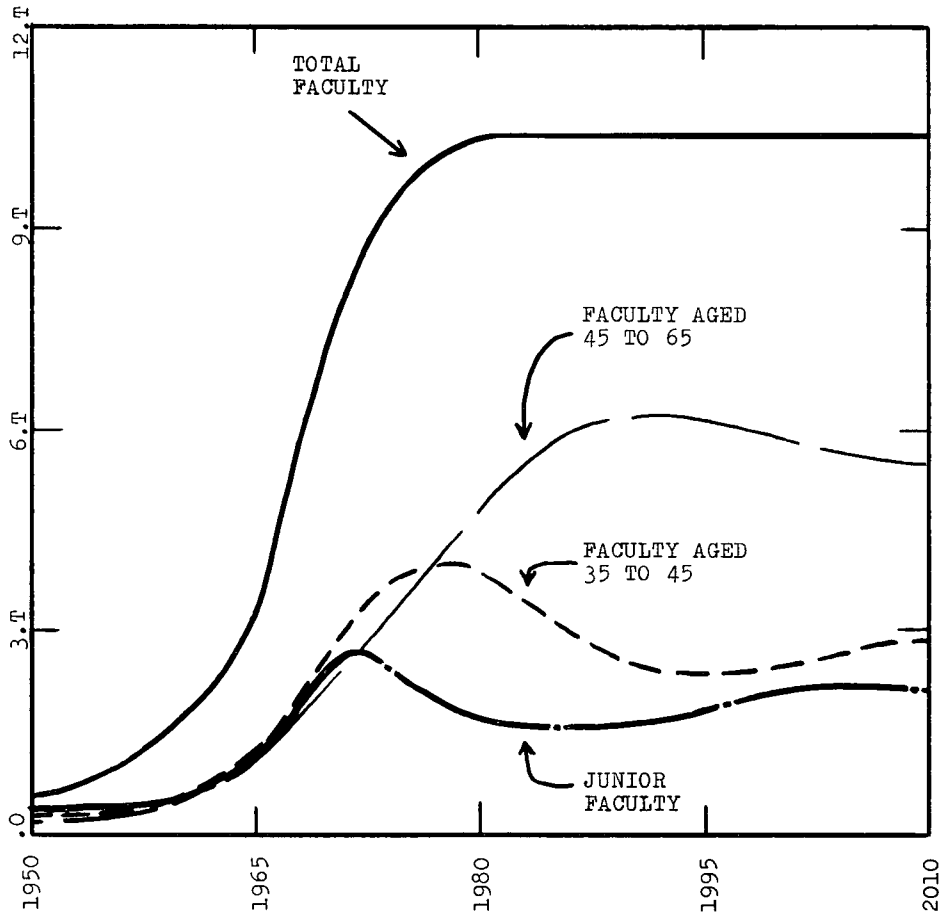

Figure 8

Standard Run of the Model – Highlight of Changing Faculty Age Distributions, 1950 to 2010

appendix for a discussion of the specification of these matters as used in the full computer model.

Figure 7 permits an understanding of how the action in any goal-seeking sub-systems alters the goal equilibrium of other sub-systems. For example, we established previously that if the "faculty salary levels and available funding" sub-system (Figure 2) is not in equilibrium it will seek it. In so doing one of the variables which it will attempt to move towards an equilibrium value in terms of that sub-system's total equilibrium is *Faculty Salary Expense.* But *Faculty Salary Expense* is also a component part of other equilibrium seeking sub-systems and their approach to their own equilibrium will be altered by the goal seeking behaviour of the "faculty salary levels and available funding" sub-system. Simply put, an endogenous change in one sub-system will exogenously affect other sub-systems. The mutual dependencies of the sub-systems are many and their effect on overall system behaviour defies analytical solution. They are too complex for the human mind to work out unaided. The computer model used, however, has the capacity to take these diverse causalities into account, and this is one of the primary reasons why it is used.

The bulk of the remainder of this paper will be concerned with the interaction of funding, staffing and salary policies. It is appropriate to say a word now about expected fluctuations in the full time faculty age mix as these are largely fixed by history. Figure 8 highlights changes in the age mix which have occurred to the present time and displays the future fluctuations described by the computer model. Operation of the full model produced the pattern of events contained in Figure 8. If we accept the model's result that total faculty will stabilize by 1980, the age components displayed in Figure 8 fall out quite simply from the aging of faculty now on staff, a small amount of new position creation to 1980, and cessation of new position creation after that time. It will be noted that the faculty (full-time professoriat) have been divided up into three age groups for analytical purposes. It is assumed that junior faculty are hired at age 30 and that 70 per cent are retained within the professoriat at age 35. The remainder leave the university system. Given a stable total faculty complement an equilibrium age mix is analytically determinable.* If a 70 per cent junior faculty retention rate is assumed the equilibrium age mix solves to 54 per cent aged 45 to 65, 27 per cent aged 35 to 45, and 19 per cent junior faculty.

The tendency of the age mix sub-system to seek equilibrium given a stable faculty complement is evident in the dampening of the oscillations after 1980 in Figure 8. The age composition of the faculty complement over time is displayed dramatically in percentage terms in Figure 9. It is clear that the age composition of the faculty in the 1960's was a

*An equilibrium faculty age mix is an age mix which, given retirements and junior faculty leavings and replacements, will remain unchanged over time if there are no net changes in the size of the total faculty complement. The equilibrium age mix may be found by solving the following equations.

$$TF = F4565 + F3545 + JF$$
$$F3545 = F4565/2$$
$$JF = F4565/(4*JFRR)$$

TF - total faculty (a given)
F4565 - faculty aged 45 to 65
F3545 - faculty aged 35 to 45
JF - junior faculty
JFRR - junior faculty retention rate (a given)

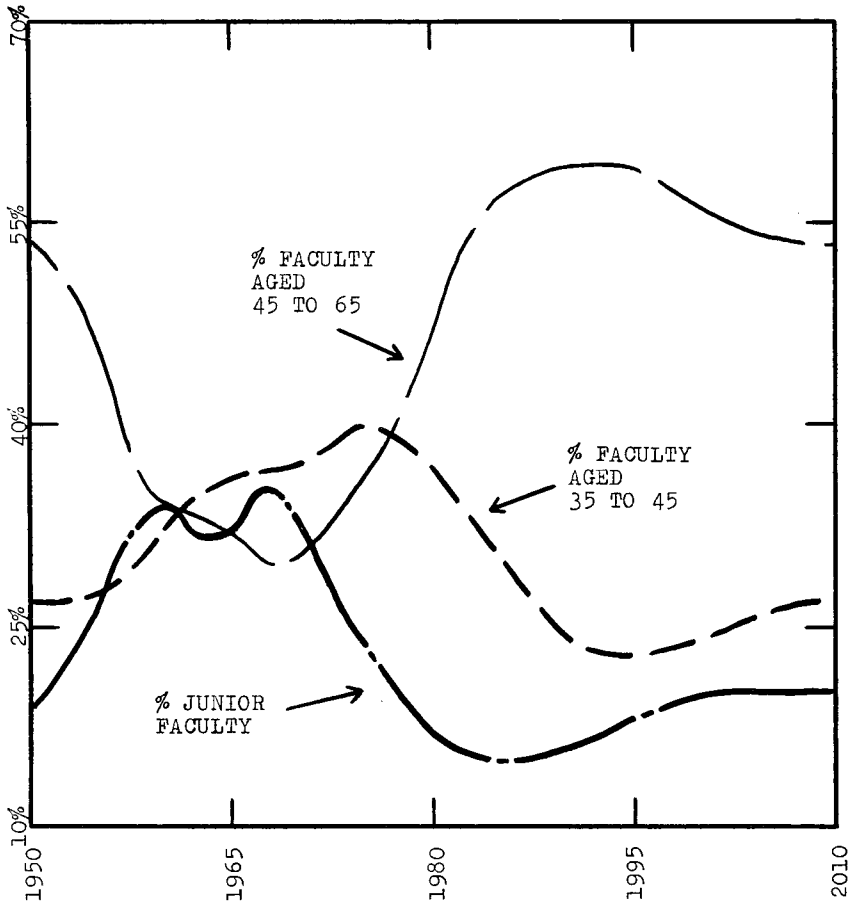

Figure 9

Percentage Distribution of Faculty by Age Group, Analysis of the Model's Standard Run

temporary abberation (based on expansion) and is not representative of a world to which the university system can hope to return. It is also clear that the average age of the faculty complement will increase until about 1990.

In most of the full computer model runs which follow, this pattern of faculty aging will be replicated. The reason is that it is determined in largest part by hiring decisions which have already been made, that is, by the ages of the faculty presently on staff. There are few policy options, as a result, which can alter this aspect of the future.

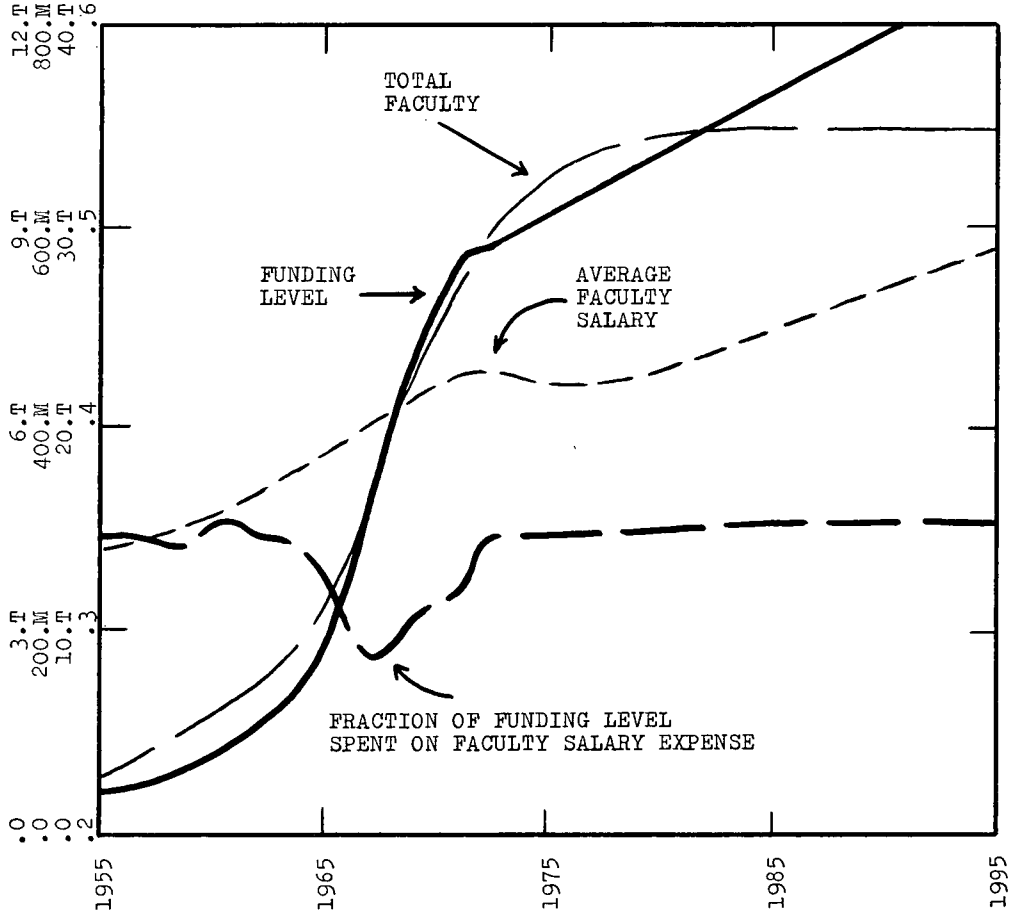

Figure 10

Standard Run of the Model

Analysis of System Behaviour

Standard Run of the Model (Figure 10)†

Figure 10 displays the model's standard run.The university system's funding level is the sole exogenous input. It is historically based to 1974 and thereafter is fixed by assumption to increase steadily at a rate of $M12.3 a year. (All money amounts are expressed in 1975

†The horizontal scale is time in years. Vertical quantity scales are indicated at the left side of the graphs. Reading from left to right, the vertical scales apply to *total faculty, funding level, average faculty salary,* and to *fraction of funding level spent on faculty salary expense.* For the numerical values, T indicates thousands and M indicates millions. Note that while the previous two graphs covered a time span from 1950 to 2010, the graphs which follow concentrate on the 40 year period from 1955 to 1995.

constant dollars.) The remainder of the model's behaviour is determined by the internal system policies and relationships discussed above.

The general pattern of system behaviour to 1975 is that which we know: rapid growth in funding level and total faculty, followed by diminished growth in funding level and gradual stabilization of total faculty.

The funding level begins to grow in the 1950's, slowly at first then more rapidly until 1971. Funding level increases are adequate to satisfy the system's desire for salary increases and still leave large sums remaining for new position creation. Over half of the new positions are filled by junior faculty and the size of this group rises (as was seen in Figure 8). The other new positions are filled by faculty aged 35 to 45 and 45 to 65 and their numbers increase also, though in relative terms at a lesser rate than the junior faculty. In addition normal aging takes place. Growth in the total faculty group is large. At the same time the average faculty salary has increased, from $13,689 in 1955 to $22,548, in 1971, an average increase of about 3 per cent a year. This increase has been moderated by the increased proportion of junior and less expensive faculty resulting from growth in the fifties and sixties. Without this moderating effect the average faculty salary in 1971 would have been 8 or 9 per cent higher.

During the period from 1962 to 1967 annual funding level increases were especially large. The university system was then unable to expand quickly enough to permit its faculty salary expense to rise in full proportion to the funding level increases. Consequently the index "fraction of funding level spent on faculty salary expense" dropped.

After 1971 the constant dollar funding level increases stopped momentarily and then continue but at a reduced rate. These increases are a reflection of the resources which society is willing and able to expend on university activities. In the model we do not deal with the factors which underlie these causalities, for example the economy, student enrolment, political processes. The increases after 1974, $M12.3 p.a., are set in the model as an assumption of the author and represent a simple extrapolation of funding level increases in the immediately prior years: alternative assumptions could be introduced, of course. The university system responds by beginning to stop creating new positions, with the effect of gradually stabilizing total faculty size. The pattern of slowed growth in numbers here is a result of the system's long run preference for reasonable salary increases rather than growth if forced to choose between the two, and its short run inability to halt immediately a rapid growth mode generated by years of not having to choose between the two. In the short run faculty salaries suffer and decline from a high average salary of $22,854 in 1971 to a low of $22,111 in 1978 (constant 1975 dollars). After 1978 growth in numbers will be sufficiently contained that salary increases can begin to approach increases in the funding level.

The index "fraction of funding level spent on faculty salary expense" is rising slowly from 1967 to 1970 as the system adjusts to a slightly diminished growth rate. The sharp funding level squeeze of the early seventies caused it to snap upwards until salary expenses could be reduced by temporary reductions in constant dollar compensation levels.

Under near stable total faculty conditions we may note the fluctuations in the age mix which occur. These were discussed previously. A word is in order here about the degree to which age skewing has and may continue to affect salary costs. Our conclusion is that it has had some importance but will be a lesser problem in the future. The following table

Table 1

Effects of Faculty Age Skewing on Average Salaries and Change in Salaries Expense

Year	Average Faculty Salary ($ 1975)	Average Faculty Salary if Equilibrium Age Mix Had Obtained ($ 1975)	Average Fractional Annual Increase in Faculty Salaries Expense Due to Age Skewing
1960	15600	16677	
			(.0005)
1965	18481	19800	
			(.0030)
1970	21711	23603	
			.0082
1975	21928	22881	
			.0068
1980	22667	22864	
			.0042
1985	24635	24344	
			.0010
1990	26694	26250	
			(.0011)
1995	28603	28283	

displays the relevant data drawn from the computer model. We note that age skewing will increase salaries expense 7 per cent between 1975 to 1990.

The resiliency of the university system, its capacity for self-equilibration, and the absence of observable catastrophies in the future is striking. This is a very different future than the one predicted by simple extrapolation of trends observed in the recent past. That future would be one of slow growth in funding level, continued expansion of the total faculty complement, erosion of other accounts to pay the salaries bill, declining real faculty income, costly aging of faculty, bleak employment prospects for would-be professors. Clearly, when the internal dynamics of the university system are taken into account the dangers of disaggregated trend extrapolation become apparent. The university system as we have modeled it is not terribly large and complex, but it is a little too large and complex for random enquiry.

A number of alternatives to present funding and staffing policies have been proposed by some. During the following computer runs we shall take several alternative actions and assess their results on behaviour. We shall assume that no significant policy revisions have been introduced to date and shall direct our attention to the period after 1975. The policy tests to be undertaken are:

(i) freeze funding level after mid-1975
(ii) double funding level increases to $M24.6 p.a. after mid-1975
(iii) reduce funding level $M12.3 p.a. after mid-1975
(iv) discontinue annual salary increases after mid-1975
(v) target annual salary increases of 3.5 per cent p.a. after mid-1975
(vi) freeze total faculty complement after mid-1975
(vii) replace only 50 per cent of faculty leavings and retirements and target 3.5 per cent p.a. salary increases after mid-1975.

Effect of Freezing Funding Level after Mid-1975 (Figure 11)

We wish to test the effect on system behaviour of alternate assumptions regarding the future funding level. In Figure 11 we freeze the funding level after mid-1975. Growth in total faculty remains about the same as in the standard run. Total faculty numbers are, in fact, very slightly larger due to the initial element of indecision and uncertainty which the freeze introduces to the system. The major effect is that salaries do not begin to rise again after 1978 as they did in the standard run, and the tail end of the growth mode is paid for by depressed salaries and a moderate increase in the fraction of funding level spent on total faculty salary expense.

We also conducted a computer run which doubled the standard run's assumed funding level increases after mid-1975 (not illustrated). Little effect on growth or the fraction of funding level spent on faculty salary expense resulted, but faculty salaries rose considerably.

We conclude that within the range of funding level increases between nothing and $M24.6 p.a. the dynamics of system behaviour render growth in total faculty numbers relatively insensitive to the funding level. Faculty salary increases, on the other hand, are seen to be quite sensitive to funding level increases within this range. The reason is, simply put, that

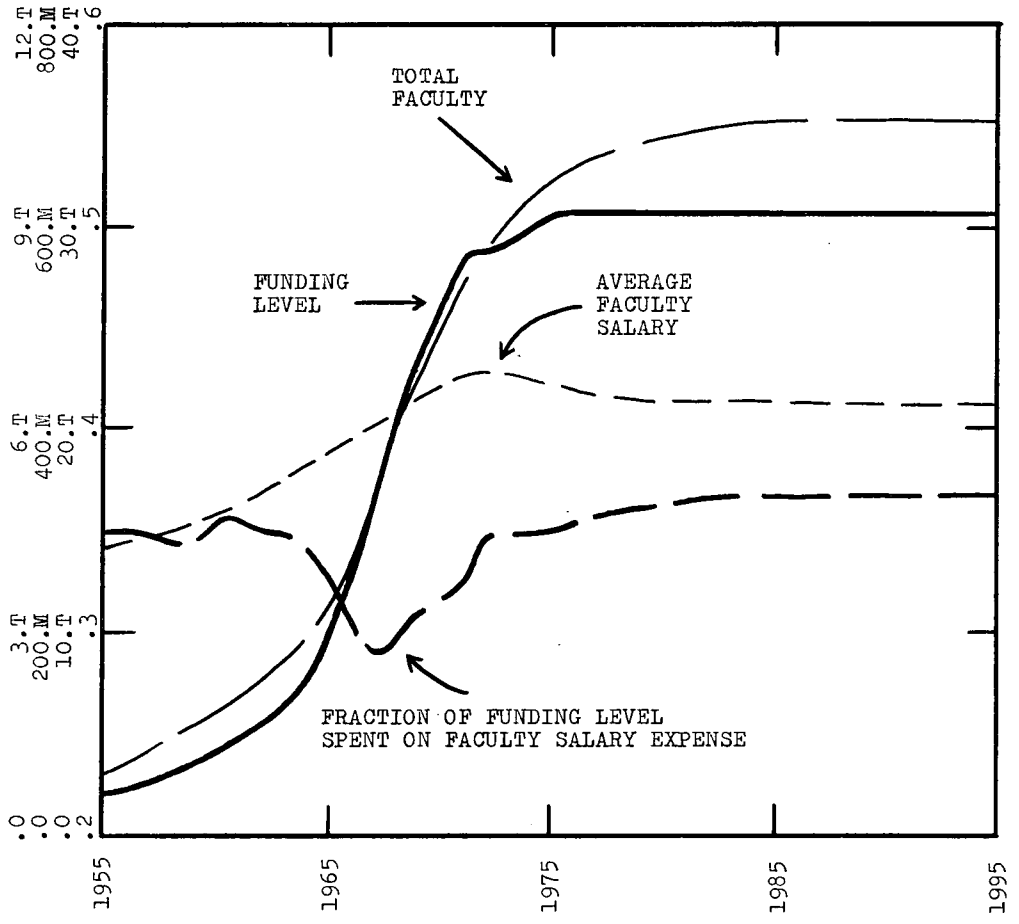

Figure 11

Effect of Freezing Funding Level After Mid-1975

the system would prefer reasonable salary increases to continued expansion and that within the range of funding level increases tested it cannot afford both. This fact combines with the system's inability to stop residual expansion during the seventies and produces the observed results.

We also conducted a computer run in which the funding level after mid-1975 was reduced by the same amount that it was increased in the standard run, $M12.3 p.a., (also not illustrated) and found that such a large reduction in funding level could not be accommodated without forced reductions in the total faculty complement.

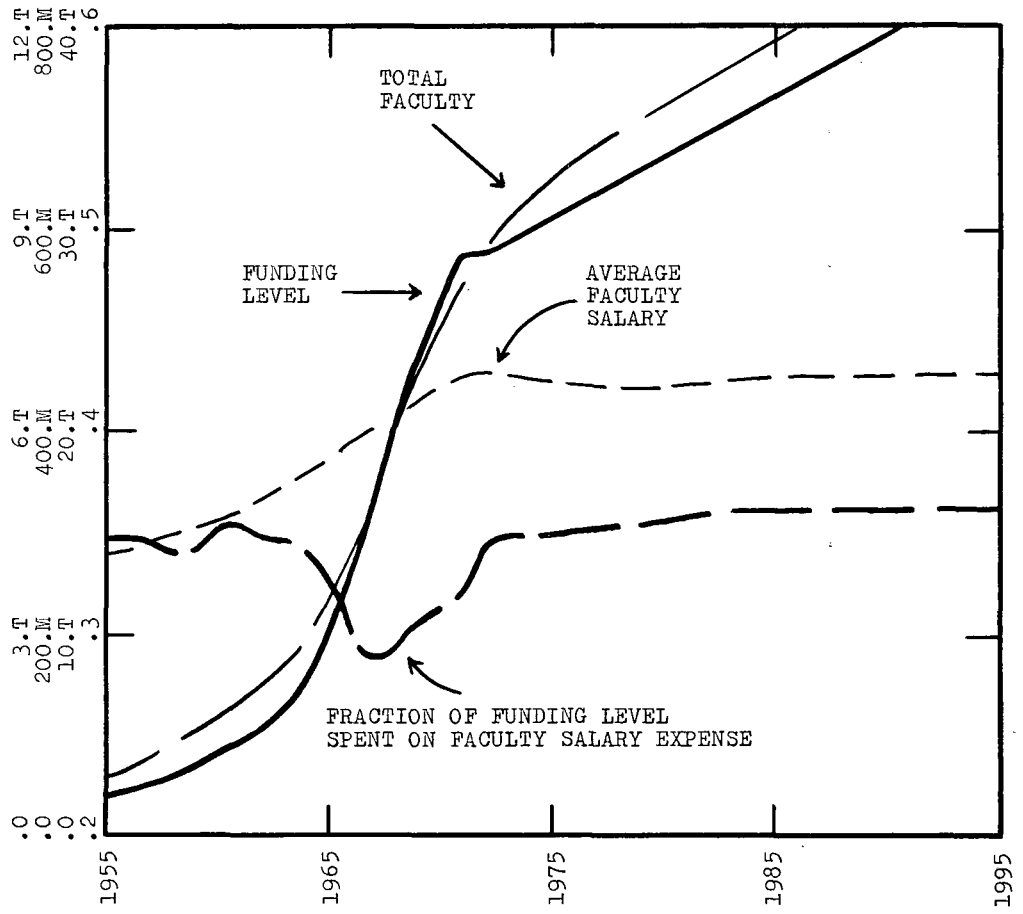

Figure 12

Effect of Discontinuing Annual Faculty Salary Increases After Mid-1975

Effect of Discontinuing Annual Salary Increases after Mid-1975 (Figure 12)

For the next computer runs we return to our assumption of a funding level which rises $M12.3 p.a. after 1975. We now wish to test the effect of a policy to discontinue annual faculty salary increases after mid-1975. As may be seen in Figure 12 the savings made are diverted into continuing expansion of the total faculty complement. Resultant changes in the age mix will delay return to an equilibrium composition as a consequence. The result of an exogenous discontinuance of annual faculty salary increases has been, in effect, to remove the major factor within the system which competes with expansion of complement for limited increases in resources. The effect of this policy can be seen to be highly desta-

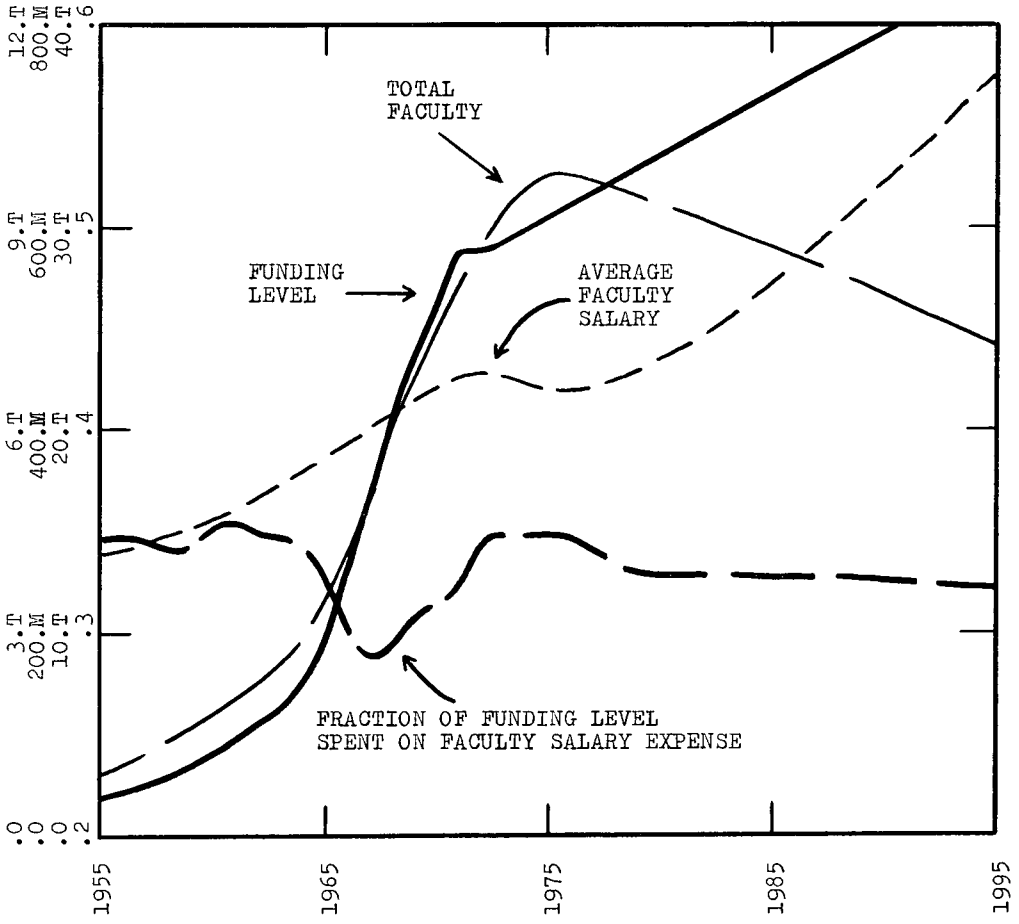

Figure 13

Effect of Replacing Only 50% of Faculty Leavings and Retirements and Targeting a 3.5% p.a. Faculty Salary Increase After Mid-1975

bilizing. If stabilization is desired in both salaries and complement size adjustment of the funding level would be the more effective policy implement.

Effect of a Target Annual Salary Increase of 3.5 per cent p.a. after Mid-1975. (not illustrated)

A policy to set an arbitrary target salary increase rate of 3.5 per cent after mid-1975, on that other hand, does result in a slightly earlier containment of the growth in total faculty numbers through diversion of funds away from expansion, but the salary increases which

result can only be accomplished through raising the fraction of funding level spent on faculty salary expense to an unacceptable level.

Effect of Freezing Total Faculty Complement after Mid-1975 (not illustrated)

A decision to freeze the total faculty complement after mid-1975 produces results of little interest as the total complement is well on its way to stability by that point in any case. The reduction of complement size effected by 1990 is about 5 per cent and the funds thus freed may be used for other purposes.

Effect of Replacing Only 50 per cent of Faculty Leavings and Retirements and Targeting 3.5 per cent p.a. Faculty Salary Increases After Mid-1975 (Figure 13)

In prior policy tests a constraint has existed that reductions in the total faculty complement not take place. We now introduce a policy to reduce the complement to its 1970 level by 1995 through attrition and to divert the monies thus saved to faculty salary increases and to other purposes. The computer run indicates that such a policy would be able to produce its intended effects, but also would result in a faculty complement very heavily dominated by older professors and drawing very few younger persons. In 1985, for example, junior faculty would comprise only 7.6 per cent of the total, as compared with 15 per cent in the model's Standard Run. As a standard for comparison junior faculty comprised 33 per cent of the total in 1970.

Conclusion

This paper has presented a view of the history of funding, faculty staffing and faculty salaries in the Ontario university system; a discussion of the internal dynamics of the system which determine its behaviour; an outline of the future system behaviour generated by these dynamics; and a testing of the efficacy of various policy modifications to alter that behaviour.

A snapshot picture of the results of the computer runs at 1990 is presented in Table 2.

Model tests indicate that faculty salary levels are quite sensitive to changes in the funding level within a moderate range of such changes, but that faculty complement size is not. Faculty salary increases are seen as competitors with complement expansion for funding level increases in so far as interventions which halt the former will fuel the latter. Interventions to halt growth in complement size are seen as of questionable value as the complement size is well on its way to stability through existing pressures. Enforced reductions in complement size through attrition can be effected, but only at the cost of further biasing an already skewed faculty age mix.

In evaluating the funding and staffing policy alternatives dealt with in this paper we see that certain trade-offs may be made. Hopefully use of the model will have served to clarify some of these and the relative magnitudes involved so as to shed a little more light on the future implications of action being contemplated now.

Nevertheless, our major conclusion is that the Ontario university system is strongly self-

Table 2

State Variables in 1990

	Funding Level ($M 1975)	Fraction of F. L. Spent on Faculty Salary Exp.	Total Faculty	% Junior Faculty	% Faculty Aged 35-45	% Faculty Aged 45-65	Average Faculty Salary ($ 1975)
Standard Run – Increase Funding Level $M 12.3 p.a. after mid–1975	792	.35	10457	16	25	59	26694
Freeze Funding Level after mid-1975	615	.37	10614	16	25	59	21259
Increase Funding Level $M 24.6 p.a. after mid-1975	969	.34	10451	16	25	59	32015
Reduce Funding Level $M 12.3 p.a. after mid-1975	438	.40	10065	16	24	60	17214
Discontinue Annual Salary Increases after mid-1975	792	.36	12735	19	28	54	22483
Target Annual Salary Increase at 3.5% p.a. after mid-1975	792	.39	10084	16	24	60	30638
Freeze Faculty Complement Size after mid-1975	792	.33	9813	16	24	60	26774
Target 3.5% p.a. Salary Increases and Replace only 50% of Faculty Leavings after mid-1975	792	.32	8007	09	20	72	31991
1975 All Runs	608	.35	9683	24	40	36	21928

equilibrating along the dimensions of it which we have examined, and that reasonableness in the funding level provided to it is the major prerequisite for a return to an equilibrium state of affairs. Given the system's own tendency towards equilibrium, direct interventions in its internal policies may be of limited usefullness and risk being disruptive. Further, we conclude that the faculty salary practices, the youthfulness of the professoriat, and the generous funding of non-faculty salary expenses which occurred during the 1960's were an inevitably transitory phenomenon, made possible only by an unsustainable growth rate, and are not representative of a world to which the university system can hope to return.

Three appendices ("Description of Model Equations," "Specifications for Computer Model Runs," and "Sample Computer-plot Output – Standard Run of the Model") have been prepared by the author. Copies of these appendices are available from the Editors.