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The Operating Growth Budget at Yale University is a model used to indicate what would happen to the university's various endowment funds over a substantial period of time, under verying conditions of both university policy and the business cycle. The role of the return from endowment in the operating budget can thus be calculated for yearly planning purposes. The model is discussed in terms of (1) its context in the other budgets at Yale, (2) the rationale leading to its development, (3) its mechanism, and (4) the uses to which it has been put. The model is built around 12 simultaneous differential equations. The inputs include (1) initial values of state variables such as market values of the various fund classes, book values, and realized gains, (2) flow variables such as gifts to endowment and the yearly operating budget, and (3) system parameters such as rate of return, yield rate, and trade rate. The outputs include market and book values of funds, realized and unrealized gains, and capital gains appropriations. (HW)

A BUDGET MODEL OF A UNIVERSITY

By Edward H. Bowman

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This paper deals with a rather specific problem and specific model. It is concerned essentially with endowment funds and the role that the return from endowment can and should take in the budget of Yale University over a period of time. The paper is organized in four parts:

1) Context of this model, the Operating Growth Budget, in the other budgets at Yale.
2) Rationale leading to the development of this analysis.
3) Mechanism of the model itself.
4) Uses to which the model has been put to this point in time.

We are presently using half a dozen budgets at Yale for planning and control purposes. The Operating Growth Budget, which is one of these, will be described in some detail later. The Yearly Operating Budget lays out for one year in extensive detail the projected income and the allowable expenses. It poses two problems, which are rather simply stated. Is the money being spent in the right way and are we spending the right total amount of money? For the first question an economist can state a simple rationale--that the incremental dollar spent for each activity is bringing back a return equal to the return from all such activities. Though difficult to measure, this is essentially what the University Budget Committee, composed of the Provost, the Treasurer, and the Comptroller, are trying to do. A simple guide to the second question is that expenses must match income, at least in the long run. Because of the great upward pressure on expenses experienced in a University, we have adopted the tactic that expenses must match income in the short run (one year). One can make the case, of course, that a five year period or a ten year period could be chosen in order to match expenses to income, and

within which certain trade offs and smoothing effects could be allowed to take place. The risk in such an approach, given the political realities of the University would, however, seem quite large.

A long range plan, which has been developed by the Development Office, can be considered as a 10 year budget for some purposes. Each department chairman had been asked to project his department's use of resources, including those which would become available due to retirements, at several prescribed rates of increase. Using modifications of these projections, and adding new programs, the President and Provost of the University constructed a long range plan. This detailed plan of education and physical projections, including financial inputs from the Comptroller's Office, then permitted the University Development Office to get some measure of the additional capital resources for endowment and buildings which would be required during the next ten years. The development program of 388 million dollars over the next ten years has been the result of this long range plan.

The Capital Budget of the University is still another budget which the Comptroller's Office has been working on. This budget lays out in one place the building programs in process and in the explicit planning stages. It includes the funds estimated for each stage in the process, the amounts authorized by the Corporation for each stage, the source of the funds to pay for each stage, the amount expended to date for each stage, and the remainder cash flow expected by year. The various control mechanisms then help assure that the actual experience will be in line with the authorized plans. The real pressure on a capital budget once made does not seem to be the construction people but rather the faculty whose ideas change and expand during the time required for detailed design and initial construction stages.

Our work on a cash budget has been an interesting experience. When we first started, a daily cash sheet with the balance at each bank was all that existed. It seemed to us that what was needed was a projection, perhaps by

week for the next month, of cash inflows, cash outflows, and projected balances. We did some initial work with a PhD student in the Department of Administrative Sciences on a simulation model for these cash flows. However, as we came to understand the problems better, what seemed to be desirable were some structural changes which would permit very rapid response to short term feed back of information, which included daily telephone calls and wire transfer of funds. By changing the structure of the problem, and only looking ahead for several days, we have been able to pull several million dollars of cash out of the University operation, put it in short term financial paper and earn an added number of hundred thousand dollars per year in interest. While it would have been possible to construct a rather extensive Operations Research Model for the process which existed, I believe that this would have missed the main point of the structural change--perhaps not.

As are many people today, we are in the early stages of working on a program budget. This is a project which we are allowing to develop at a leisurely pace, and I suspect that a number of Universities will pass this mark before we get there.

The following points, perhaps, will supply the rationale which led to the Operating Growth Budget model. Remembering that our model focuses on endowment, what are the total sources of income for the University? They breakdown as follows:

Tuition and fees	23%
Gifts	9%
Government and other Sponsors	33%
Miscellaneous (including the Press and Athletics)	10%
Endowment	25%

At the present the total from these sources is about 90 million dollars.

Yale is one of the private Universities where the Endowment is large enough to provide a major source of income. These Endowment Funds, which are presently worth about 500 million dollars, and which help provide the real independence of the University's program, must be well managed. Several years ago the Yale Corporation, its governing body, decided that considering the needs of the future a sensible endowment management policy would involve the ownership of equity positions, the current yield from which would be relatively small. However, the return from these equities when yield plus capital gain are considered would be more attractive than high yield bonds. To permit this type of endowment management, the Corporation, therefore, decided that they would appropriate a prudent amount of realized capital gain each year as operating income. Parenthetically, the management of the endowment funds has been placed in the hands of a new company, Endowment Management and Research Corporation in Boston, which was formed by Yale, in which Yale has a substantial ownership position, and in which Yale is the primary, though not the only, client.

The question of what amount of capital gains appropriation as income is prudent led to a good deal of analysis including the Operating Growth Budget. The basic rationale of prudence is that the demand on endowment each year, yield plus gain, will be allowed to grow at a rate which can be sustained by all future administrations. Our annual operating budget includes a calculation of this sustainable growth rate of demand on endowment. Perhaps some numbers will make this clearer. Let the inputs to endowment each year using an exponentially weighted average and composed of yield plus gain plus gifts equal X% of market value of the endowment. The output from endowment is about 4.5% to be used as income for the year, and this then allows X-4.5% to be plowed back in the endowment base permitting larger future dollar returns. Now because the yield of the endowment (dividends, interest, net rentals, etc.) is about 3.5%, the appropriation from net realized gains is about 1.0% of the market value of the endowment.

While this rationale of growth and the allowable income for the operating budget can be provided from a fairly simple set of equations, it ignores some crucial factors in its aggregate approach. To wit, all endowment funds of the University can not be treated in the same manner. They differ in what can be considered income, and they differ in the purposes for which that income can be spent. Below is a chart which presents some of these differences:

Sources \ Purposes	Restricted	Augmented Restricted	Unrestricted
Yield Only			
Yield & Gain			
Expendable			

As can be seen, a three by three chart suggests that there are nine different categories of funds, only some from which capital gains can be appropriated. The Operating Growth Budget was constructed to show what would happen over a substantial period of time to these various funds, and under varying conditions of both University policy and business cycle input.

Before describing the mechanism of the simulation model, perhaps it would be useful to say something about its size. The model is built around twelve simultaneous differential equations. It is programmed in FORTRAN with about 100 lines of input, 120 lines of computation, and 90 lines of output. The program size is about 5000 words, and a 20 year simulation takes 17 seconds of execution time on an IBM 7094/7040 coupled system.

The inputs include a) initial values of state variables, such as market values of the various fund classes, book values and realized gains, b) flow variables, such as gifts to endowment and the yearly operating budget, and c) system parameters, such as rate of return, yield rate and trade rate. Many computations are made for each period, and although we only make a print out once each year, the period for simulation purposes is on the order of a week. These computations are made for each fund class and include new market values and book values and the effect of capital gains appropriations after gain, gift and yield inputs. The outputs printed include market and book values of funds, realized and unrealized gains, and capital gains appropriations.

What kinds of uses did we make of this simulation model? These could probably be summarized into three classes: a) aggregation affects, b) variance affects, and c) structural affects. In terms of planning the operating budget for the following year and its use of endowment funds and capital gains appropriation, simple, perhaps overly simple, calculations are made which aggregate all funds as though they were homogeneous. The simulation permitted us to disaggregate these funds to measure what the affects of this assumption were. The results were that it appears that we can use the fairly simple calculations for yearly planning purposes.

Our initial simulations used average growth rates for yield and gain in the market place. It is obvious that this is not the manner in which the financial markets will behave. In order to get some idea as to the affects of market variations on our system, we took the actual experience of the past ten years--the ups and downs--and cycled them through the simulation twice for the twenty year period. To add to our understanding we chose as the initial year (ie, next year), each of the ten years. In other words, we stepped into the cycle at ten different places. From these

simulations it was possible to construct some simple cumulative probability distributions which give at least some idea of the probabilities of certain things happening to the realized gains pools and the expendable funds. Here in a sense we have two criteria levels, and we were interested in both of them.

The structural changes that the simulations were then addressed to had to do with the possibility of splitting the one investment pool of securities. Because the various funds, or claimants to the investments, had different kinds of restrictions connected with them, and therefore suggested different investment goals, we tried to match separate subpools to these funds in order to see what the effects would be. It now appears that several separate investment pools matched to the needs of separate funds might be a good idea and such a change is under active consideration. In all we ran about 200 simulations for these three basic kinds of questions.

Let me summarize this paper as follows. We have been working on a critical problem that the managers of the University, including the Corporation, were concerned about. Perhaps a good place to start operations analysis for education is on those problems that most concern the institutions' managers, and about which they can take some action.

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