Cognitive Biases in Capital Budgeting

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Introduction

The importance of capital budgeting and investment in economic development and public financial management has been well documented. The decisions in this area affect a myriad of other areas. Put simply, an effectively developed and executed capital budget can help a jurisdiction greatly in reaching their long-term economic and financial goals, and a poorly developed or executed one can cause problems for the jurisdiction for several years. Recent cases of bad capital decisions and resulting bankruptcies in Jefferson County, Alabama and Harrisburg, Pennsylvania (the latter we will discuss further) demonstrate the importance of these decisions strikingly.

However, despite the importance of this area, little detailed academic work has been done to understand the decisions made around capital budgeting. Most of the literature in this area that looks at capital budget decisions is normative and prescriptive, invoking rational decision making principles to explain how decisions should be made. The bulk of the academic literature that deals with capital budgeting treats some aspect of it as an independent variable, relating it to some economic or financial outcome. The few pieces of research that seek to explain behavior in this area do so within the frameworks set out in the normative literature. Almost no research has been done into *how* capital budgeting decisions are made.

In this paper, our goal is to set forth a modeling framework for examining capital budgeting decisions. We introduce the concept of behavioral economics and finance as a way to motivate discussion of the decisions arrived at through the capital budget process. It is our hope that researchers will take this framework, expand it, and apply it to their area of knowledge and research. In the next section of the paper, we examine the existing literature on capital budgeting

as well as introducing the literature on behavioral economics and finance. In the final section of the paper we introduce the general framework for examining capital budgeting decisions.

Literature and Discussion

Capital Budgeting

There is very little research into the decisions that are made in capital budgeting processes. Most of the academic literature on capital budgeting has concentrated on the techniques used for analysis of capital projects or programs (on this point see Vogt (2004)). What little research that does exist usually takes the position that broad institutional forces and political factors are what influences budgetary processes in the capital realm. Forrester (1993) used a survey mailed to budget officials in large US cities (population in excess of 75,000) in order to assess whether cities use formal capital budget processes or more informal procedures such as those found in operational budgeting. He found support for the thesis that while "rational economic" processes were present in most cities capital budget processes, those processes were also infused with political and other considerations. Sekwat (1996) administered a survey to county government officials throughout the United States in order to try to detect patterns in the use of various techniques for project analysis. He found that most county governments preferred relatively simple techniques for the analysis of capital projects, and found some limited patterns in the use of techniques by degree of urbanization. Most recently, Srithongrung (2010) examined capital budgeting processes in Illinois. She assessed interview responses with state officials involved in the capital planning and budgeting process, and found that a variety of technical and non-technical approaches were used to develop the capital budgeting process.

Behavioral Economics & Finance

The "rational" model of decision making has traditionally been the lens through which public capital investment decisions have been viewed. In this model, rational actors evaluate all possible outcomes and make decisions based on the expected utility of the outcomes. Risk or uncertainty is assessed through using subjective weights representing the probability of events, producing risk-adjusted measures of potential outcomes.

However, Tversky and Kahneman (1974), Thaler (1991), and many others have identified another theoretical basis – behavioral economics and finance. Behavioral economics stresses that economic actors approach uncertain decisions through the use of heuristics because of the overwhelming complexity of evaluating the outcomes and probabilities of even relatively small problems. In essence, in the behavioral approach the weights used in the Bayesian updating process are not objectively determined but rather subjectively determined and are influenced by which heuristic is chosen. The use of these heuristics often create biases in the decision making process.

Prospect Theory.

Prospect theory was the general term developed by Tversky and Kahneman (1974) to describe the process that individuals use to solve complex problems, especially those involving risk. They model the decision making process not as one continuous step where all options and potential outcomes are evaluated but rather as a two-step process. The first step that individuals follow is editing, where complex decisions are simplified through one of several processes. These processes are:

- Coding: This is when individuals assess outcomes not as their absolute value but as values relative to some reference point. This reference point can be affected by problem framing;

- Combination: When decision makers combine probabilities for outcomes they view as identical (or similar);

- Segregation: Decision makers facing a decision with a high level of risk attempt to separate the riskless component from the risky component and then discard the riskless component;

- Cancellation: When components shared by risky prospects are discarded

- Simplification: This is when individuals estimated broadly the probability of some event occurring (a probability of 0.19 may be seen as a 1 in 4 chance), this also involves the discarding of extremely unlikely outcomes (viewing the probability as zero when it is in fact just very low; and

- Detection of dominance: If two options facing a decision maker are similar in terms of their probabilities and outcomes, individuals may search for one aspect on which to discard one option altogether.

Then after the decision is simplified the evaluation phase takes place. To Tversky and Kahneman, it is the first step that present problems for decisions in the form of biases that emerge from the simplification processes. In a later formulation, Kahneman (2011) clarifies that the biases emerge most often when automated thinking processes are engaged (as opposed to deliberative thinking processes where less simplification is used (and therefore fewer biases generated). Thaler and Sunstein describe a simple example of automated decision processes by

laying out a set of problems they give their students and ask to solve quickly. One such problem

is given below.

> PROBLEM: The size of an algae bloom in a pond was recently observed to be
>
> doubling every day. If the pond is fully covered in 42 days how long did it take to
>
> for the algae bloom to cover half the pond (Thaler and Sunstein, 2008, p. 21)?

Not surprisingly, when the students had to answer the problem quickly, most answer 21

days. The correct answer is 41 days, which they readily see if they have a couple of minutes. The

students are responding to obvious clues in the answer (half and 42) and without time to

deliberate they often arrive at the easy and incorrect answer. Kahneman (2011) puts forth the

conditions when automated thinking processes are more likely to dominate the decision making

of individuals. Not surprisingly, these processes are dominant when time is short to make a

decision. However, they also can be engaged when there is an emotional element to a decision.

Finally, when a significant amount of uncertainty surrounds the values or probabilities of

outcomes, automated processes become much stronger in individuals.

Anchoring Bias.

The first cognitive bias that we think has importance for analyzing capital investment

behavior is anchoring bias, sometimes referred to as anchoring and adjustment bias. This bias

emerges from the simplification process, when decision makers may focus on a single piece of

information on which to form estimates of unknown or uncertain values. In the classic example

of this, students were asked questions where anchors to the answers were likely to be common,

such as the year when George Washington was elected President of the United States (Epley and

Gilovich, 2001). The subjects were then interviewed about the way they answered the question.

It became evident that the subjects formed "anchors" for their responses based on the known

signing of the Declaration of Independence (1776) and then adjusted their estimate based on that

year. In solving the problem this way, subjects grossly underestimated the answer (the mean

estimate was 1779, the actual year was 1788).

In the capital budgeting arena, there are many possible anchors for decision making. One

obvious set are the decisions taken by other jurisdictions, especially ones where there is some

familiarity or competition. Often there are "trends" in capital project choice such as the

construction of sports arenas and related infrastructure that can be thought of as arising out of a

need to be a "major league city". What is happening is essentially the choice of an anchor (if the

arena is good for city A then it can work here!). Another trend can be seen in the adoption or

lengthening of light-rail systems, sometimes in cities with little chance of sustaining

transportation investment (e.g., Detroit).

Another vivid anchor which may be present with regard to capital investment decisions is

the sheer size of the dollar values referenced by capital decisions. In the classical economic

literature on decision making, individuals should view dollar values of costs neutrally in a

comparison with benefits received. However, as the previous example of determining the date of

the Constitution signing, individuals tend to overestimate values when given a large anchor. At a

recent talk on this subject, we let the audience participate in an example of this. We gave them

the entire value of the U.S. federal deficit ($17.7 trillion as of September 22, 2014). We then

asked them to estimate the amount that every citizen would have to pay extra in taxes every

month to pay off that amount within 30 years. Most of the answers from the audience were in the

thousands range ($2,000, $1,000, etc.). The actual answer ($265 per month at 4% interest) is

much lower than this. In the terminology of Epley and Gilovich (2001), individuals try to adjust

from the anchor but they tend to do so incompletely. In the context of capital budgeting, this may present a problem as citizens (even those who know finances) may not properly assess costs when faced with large anchors in the form of the "ticket price" of the investment.

Loss Aversion and Status Quo Bias

Loss aversion and status quo bias are other biases that arise from the editing process of decision making. These biases arise from the coding process. In loss aversion, instead of coding gains and losses in terms of their absolute effect on utility, as predicted by classical investment theory, individuals tend to react to gains and losses relative to a particular reference point. This effect is most easily explained by examining a common bias noticed among investors. Many of them, even when they are relatively risk averse, tend to become more aggressive with their investments in response to losses. In gambling terms they tend to "double down" on their bets, taking risks they otherwise would not have otherwise taken in order to try to recoup losses. Kahneman and Tversky (1984) document the example of loss aversion referring to a problem of approval of a public health problem. In one set of choices among two programs, outcomes were stated in terms of how many people would be saved. In the second set of choices, outcomes were stated in terms of how many people would die. The outcomes were designed so that if one chose the more certain program in the first case, they should also choose the more certain program in the second. However, what Kahneman and Tversky documented was a striking preference reversal. When the program outcomes were stated as lives saved, respondents preferred the more certain program, but when outcomes were stated as lives lost, they preferred the more risky outcome. Kriz (2004) has used loss aversion examples when discussing the market behavior of municipal bond investors.

In the area of capital budgeting, a perfect example of such behavior is offered by the

Harrisburg, Pennsylvania bankruptcy case. In this case, the city of Harrisburg built a large solid

waste incinerator designed to bring money (and jobs) into the community through the processing

of waste for the entire region. When it became apparent that the incinerator was not making

money and was failing to draw business from surrounding communities, instead of cutting their

losses, the city decision makers made the decision to increase the size of the incinerator, adding

even more capacity (and debt to finance that capacity). The results were predictably bad. Viewed

through the lens of conventional decision making, there is no way to explain the decisions made

by the city. However, when viewed through behavioral economic theory, one can see that the city

was merely exercising the same loss aversion that makes individuals buy more of a stock that has

gone down.

Other common reference points against which to measure changes in utility are our

current position and the last decision taken. Kriz (2004) pointed out that incremental budgeting

for operational purposes can be seen as a form of status quo bias. In status quo bias, the last

decision taken or last observation made is given an irrationally high weight in deciding the next

action. So in a budgetary context, the last agreed upon budget level (with a small increment) is

taken as the most rational value for the future budget amount because of the computational

complexity (and time effort) needed to address wide changes in the budget amount. It is simply

less computationally costly to those trying to assess a complex or risky decision to code the

decision in terms of a change from some reference point and then assess whether the benefits

received are greater to the change in cost. In the capital budgeting context, the relative

uniqueness of projects and lack of prior reference points for many of the larger projects provides

a challenge for decision makers. Therefore a more deliberate process is necessary for deciding on

large capital projects.[1]

Availability Bias.

One of the cognitive biases identified by Tversky and Kahneman (1974) and others is the

availability bias – the use of an easily recognizable or vivid example to estimate the probabilities

or outcomes of a more difficult problem. So for example, if one is asked to estimate the

probability of a tornado after a tornado (or even a particularly violent thunderstorm) has

happened, people's estimates of the probability will be higher than it would be otherwise. This

can create biased behavior on the part of people such as building storm shelters in areas which

have only a small probability of ever encountering a tornado.

In an interesting example of this from the pension economics literature, workers in

branch libraries in a city with a centralized hiring process had remarkably more similar

contribution rates into their defined contribution pension plans than their investing profiles (age,

time to retirement, stated risk preferences, actual market conditions and historical returns) would

indicate. So in different branches the contribution rates of workers were more like their

coworkers in their branch than they were with more similarly situated workers in other branches.

The fact that the city hiring system was centralized made it unlikely that the branch libraries

would be far different in terms of who they hired. What appeared to be happening is that the

workers were communicating about the investment options and the opinions of coworkers were

weighted more heavily than objective evidence provided (historical returns and the advice of

investment professionals – Duflo and Saez, 2002).

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[1] This may also explain a need to "routinize" the capital planning process through the use of leasing plans and routine replacement schedules.

In the capital budgeting venue, availability bias can create both opportunities and challenges for capital project approval. Consider the Minneapolis bridge failure. In the wake of the highly publicized collapse of the Interstate 35W bridge and resulting deaths and inconvenience. One could reasonably predict that people might overestimate the number of bridges in poor condition as a result of their updating their posterior Bayesian probabilities by too large of an amount. On the other hand, consider the case of the "Big Dig" in Boston. With massive cost overruns and delays in opening, it might be reasonable to update prior probabilities to reflect the likelihood of cost overruns and delays on a project. Therefore, support for large projects (especially tunnels, the theory would suggest) might fall by more than a "rational actor" model would predict. Also, the information given to decision makers as they face their investment decisions can exert an influence on the likelihood that projects will be approved.

Conclusion: A Model Framework for Evaluating Public Capital Budgeting Decisions

As we said earlier, a model for evaluating public capital decisions has not been explicated. However, we can apply the model framework recently developed by Mullainathan, Schwarzstein, and Congdon (2012). In their model, they point out that the generic model for a government engaging in an activity that produces benefits at a level *b* and has a price of *p(t)* (the t indicating a tax if positive and subsidy if negative) is to take the action wherever the benefits exceed the costs or:

$$b > p(t)$$

when agents act as strictly rational individuals. However, when behavioral biases are present, agents in reality take actions if

$$b + \varepsilon(b, t) > p(t)$$

where ε is an "error" caused by the behavioral bias and is a function of b and t. If the ε term is positive it means that the bias is distorting the perceived benefits of the activity higher. If it is negative it means that the bias is reducing the perceived benefits of the activity. The authors give many examples of how it might be applied to analyze various decisions by economic agents. Within the context of public capital budgeting, we can use experiments to see what types of information seem to bias perceptions of benefits and costs.

Whatever model is chosen, the basic points of our paper are first, that some model of decision making within this venue is needed and second, that model should take into account the problem of behavioral biases that has been noted by numerous authors. Previous research in this area has largely been quiet with respect to the perceptions of benefits and costs that citizens, representatives, and agency personnel use to evaluate public capital investments. It is incumbent on academics to develop models that predict behaviors in this area.

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