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How Far Ahead Do People Plan?

by

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Abstract

We report on a simple experiment which enables us to infer how far people plan ahead when taking decisions in a dynamic risky context. Usually economic theory assumes that people plan right to the end of the planning horizon. We find that this is true for a little over half of the subjects in the experiment, while a little under one half seem not to plan ahead at all.

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How Far Ahead Do People Plan?

Introduction

Economic theory assumes that people, when taking dynamic decisions, plan right to the planning horizon. Evidence that this might not be so comes from previous experimental investigations (for example, Bone *at al* (2003), Carbone and Hey (2001) and Hey (2002)), but the inferences from these have been clouded by doubts concerning the preference functions of the subjects in the experiments. We present here the results from a simple experiment which requires only the assumption that preferences satisfy monotonicity and therefore do not violate dominance. This requires a particular design, which we discuss in the next section. We then report on the results from the experiment which suggests that only slightly more than half of the subjects actually do plan to the planning horizon. On the contrary, a little less than a half do not. We speculate on the implications in the concluding section.

The Experimental Design

We represent dynamic decision problems in the form of a tree. We use in this experiment what we call *3+3 trees*. These have three *decision nodes* interleaved with three *chance nodes*. The tree starts with a decision node, and subsequently decision nodes are followed by chance nodes and *vice versa*. After the third chance nodes, there are payoff nodes. In the payoff nodes there are amounts of money which the subject is paid if he or she reaches that node. An example is shown in Figure 1, in which the subject starts at the bottom and works up through the tree to one of the payoff nodes at the top. At each decision node, there are just two possible decisions – Left or Right. At each chance node, there are just two possible moves – by 'Nature' – Left or Right. Subjects are told that Nature moves Left and Right with equal probability and that all moves are independent of each other and of the moves by the subject. Even in this simple 3+3 tree branches and payoff nodes proliferate – so that there are 64 of the latter. Each of these contains a payoff denominated in money.

The structure of the payoffs in these nodes is central to the design of the experiment. We built the 3+3 trees used in the experiment from 2+2 trees with what we call the *dominance property*. A 2+2 tree is simply a tree with two decision nodes interleaved with two chance nodes; it has 16 payoff nodes. A 3+3 tree is obtained by combining four 2+2 trees. The dominance property is as follows, where we denote the payoffs in a 2+2 tree by x_i $i = 1,..,16$. The payoffs satisfy the following conditions, where by $(y_1, y_2,\ldots,y_n) > (z_1, z_2,\ldots,z_n)$ we mean that $y_i \geq z_i$ for $i = 1,\ldots,n$ and that there is at least one i for which $y_i > z_i$.

1. $(x_1,x_2) > (x_3,x_4)$
2. $(x_5,x_6) > (x_7,x_8)$
3. $(x_9,x_{10}) > (x_{11},x_{12})$
4. $(x_{13},x_{14}) > (x_{15},x_{16})$
5. $(x_1,x_2,x_5,x_6) > (x_9,x_{10},x_{11},x_{12})$
6. $(x_9,x_{10},x_{11},x_{12},x_{13},x_{14},x_{15},x_{16}) > (x_1,x_2,x_3,x_4,x_5,x_6,x_7,x_8)$

In a 2+2 tree there is one decision node at the first decision level and four at the second. Conditions 1 through 4 imply that Left is the best decision (for a subject whose preferences satisfy dominance) at each of the four second-level decision nodes. Condition 5 implies that Left therefore is the best decision at the first decision node for a subject whose preferences satisfy dominance *and who plans ahead* – thereby eliminating from the tree those payoff nodes that he or she knows will not be reached because of the decisions that will be made at the second level. Condition 6 implies that, for a subject who does not eliminate these payoff nodes, and thus thinks myopically about the implications of the decision at the first level, will choose Right at the first decision node. So one route through the tree (always play Left) **is** best for a subject who plans ahead while another (Right at the first level and Left at any of the second) **appears** best for a subject who does not plan ahead. We construct our 3+3 trees from four different 2+2 trees with this dominance property. Moreover, we do it in such a way that (1) one route through the tree – LLL – **is** best for subjects who think two moves ahead (right to the end of the tree), (2) another route through the tree – RLL – **appears** best for those subjects who plan just one move ahead; and (3) a third route through the tree – RRL – **appears** best for those subjects who do not think ahead at all. Such a 3+3 tree has once again what we call the dominance property[2]. We then randomise so that the respective routes through the tree are not the same for all subjects[3]. Because of this randomisation, we use from now on the notation +++ to indicate the route chosen by the fully-planning-ahead person, −++ the route chosen by a subject planning one move ahead and by −−+ the route chosen by a person not planning ahead. 92 subjects took part in the experiment in two separate treatments – Treatment 1 in which the dominance at the first level was strong and Treatment 2 where the dominance was weak, in that either decision at the first decision level was optimal for the person fully planning ahead[4]. Usual experimental protocols were observed and the subjects paid accordingly[5]. Subjects were allowed four different attempts at the same decision tree.

Results

We fit the following model[6] to the data. We assume that a proportion p_1 of the subjects do not plan ahead at all, a proportion p_2 plan ahead just one period, and a proportion p_3 plan ahead two periods. In order to account for other responses, and to allow for the usual phenomenon that subjects make mistakes when performing the experiment, we allow for *trembles* at each decision level. Specifically we assume tremble probabilities of t_i at decision level $i =1,2,3$. So at decision level i the subject implements the intended decision with probability $(1-t_i)$ and implements the unintended decision with probability t_i. Thus we get Table 1 for treatment 1, and Table 2 for treatment 2. Let us denote by F_{ij} the frequency of outcome labelled ij in Tables 1 and 2. We estimate p_1, p_2, p_3, t_1, t_2 and t_3 to minimise the sum of squared differences between the observed

[2] We can provide more formal statements of this property on request.
[3] Obviously the property is retained that one route through the tree is best for those who plan two moves ahead, a second appears best for those who plan just one move ahead and a third appears best for those who do not plan ahead at all.
[4] Note, of course, that they had to do the planning ahead to realise this.
[5] The written Instructions are attached as an Appendix. Full details of the experimental implementation are available on request.
[6] We should note that we have fitted a variety of other models to the data (specifically (1) with a constant tremble probability and (2) with a tremble probability that varies across types of subject rather than across the decision levels) but this formulation fits the data significantly better than the other formulations.

frequencies and those implied by Tables 1 and 2 – that is $\sum_{j=1}^{8}(F_{1j} - np_{1j})^2 + \sum_{j=1}^{4}(F_{2j} - np_{2j})^2$. We use GAUSS to calculate the estimated parameters.

The estimated probabilities are $p_1 = 0.41710$, $p_2 = 0.00046$ and $p_3 = 0.58244$. The estimated trembles are $t_1 = 0.09919$, $t_2 = 0.28995$ and $t_3 = 0.10866$. The actual and fitted frequencies of the various outcomes are reported in Tables 3 and 4. The model seems to fit the data rather well.

The results suggest that some 41.7% of the subjects do not plan ahead at all, some 58.2% plan ahead to the planning horizon (as they should according to economic theory), while almost no-one plans ahead just one period. The conclusion is that the subjects neatly bifurcate into two groups – the planners and the non-planners. The tremble probabilities are interesting – with very small trembles at the first and third decision levels and a rather large tremble at the second decision level. It would seem that the planners almost completely implement their plan while the non-planners have considerable difficulty in implementing any kind of decision rule.

Conclusion

The conclusion is straightforward, though we had hoped for greater richness in the data. There are two types of people out there: those who plan completely ahead and implement their plans almost perfectly, and those who do not plan and indeed have difficulty in implementing any kind of rule. If the same bifurcation is the case generally, then we get the kind of story that is often told in the economics literature – two kinds of agent: naïve and sophisticated. The implications of this have already been explored. This paper gives some evidence that it is a realistic story.

References

Bone J D, Hey J D and Suckling J R (2003), "Do People Plan Ahead?", *Applied Economics Letters*, 10, 277-280.

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Table 1: the probabilities of the various paths through the tree (treatment 1)

Prob.	Outcome	Implied by the model
p_{11}	+++	$p_1 t_1 t_2 (1-t_3) + p_2 t_1 (1-t_2) (1-t_3) + p_3(1-t_1) (1-t_2) (1-t_3)$
p_{12}	−++	$p_1 (1-t_1) t_2 (1-t_3) + p_2(1-t_1) (1-t_2) (1-t_3) + p_3 t_1 (1-t_2) (1-t_3)$
p_{13}	+−+	$p_1 t_1 (1-t_2) (1-t_3) + p_2 t_1 t_2 (1-t_3) + p_3(1-t_1) t_2 (1-t_3)$
p_{14}	++−	$p_1 t_1 t_2 t_3 + p_2 t_1 (1-t_2) t_3 + p_3(1-t_1) (1-t_2) t_3$
p_{15}	−−+	$p_1(1-t_1) (1-t_2) (1-t_3) + p_2(1-t_1) t_2 (1-t_3) + p_3 t_1 t_2 (1-t_3)$
p_{16}	−+−	$p_1(1-t_1) t_2 t_3 + p_2(1-t_1) (1-t_2) t_3 + p_3 t_1 (1-t_2) t_3$
p_{17}	+−−	$p_1 t_1 (1-t_2) t_3 + p_2 t_1 t_2 t_3 + p_3(1-t_1) t_2 t_3$
p_{18}	−−−	$p_1(1-t_1) (1-t_2) t_3 + p_2(1-t_1) t_2 t_3 + p_3 t_1 t_2 t_3$

Table 2: the probabilities of the various paths through the tree (treatment 2)

Prob.	Outcome	Implied by the model
p_{21}	*++	$p_1 t_2 (1-t_3) + (p_2+ p_3)(1-t_2) (1-t_3)$
p_{22}	*−+	$p_1(1-t_2) (1-t_3) + (p_2+ p_3)t_2 (1-t_3)$
p_{23}	*+−	$p_1 t_2 t_3 + (p_2+ p_3)(1-t_2) t_3$
p_{24}	*−−	$p_1(1-t_2) t_3 + (p_2+ p_3)t_2 t_3$

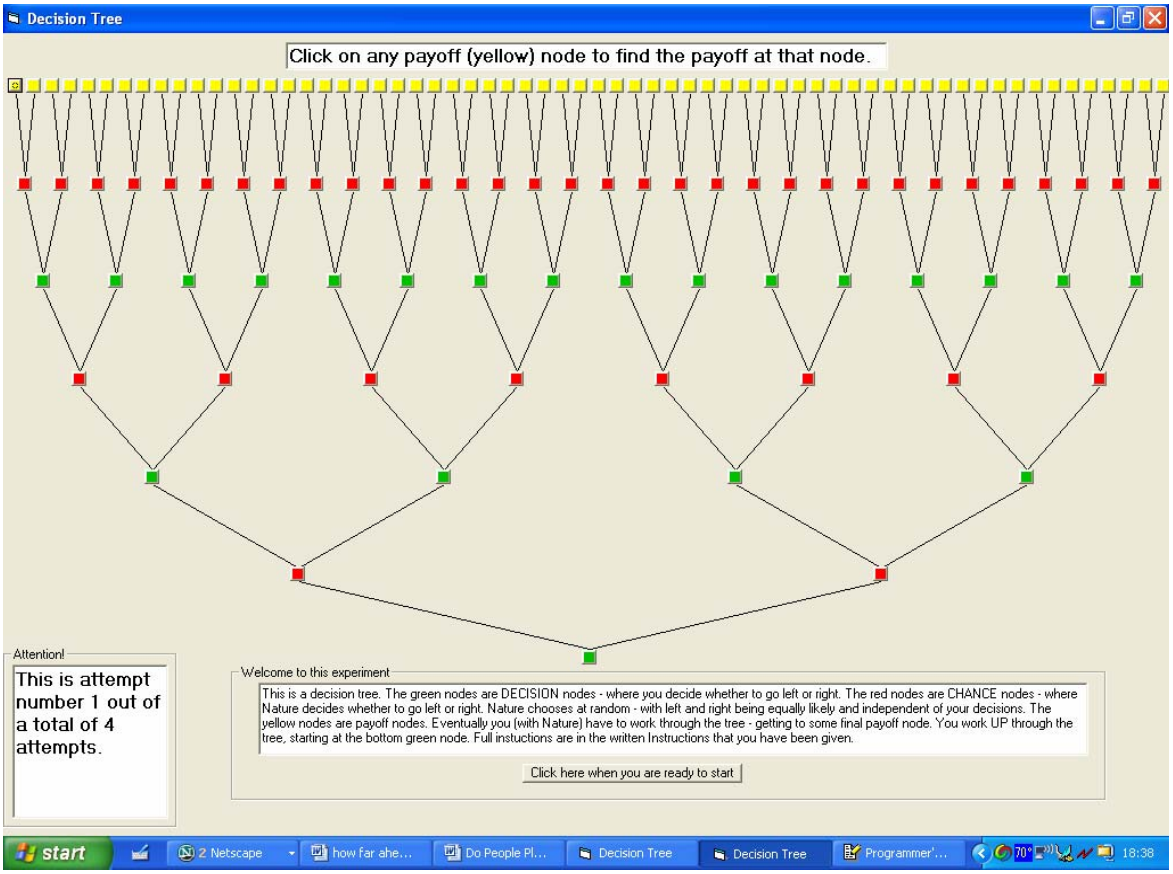
Table 3: the observed and predicted frequencies (treatment 1)

Outcome	Observed frequency	Predicted frequency
+++	65	63
−++	26	25
+−+	27	30
++−	3	8
−−+	44	47
−+−	3	3
+−−	8	4
−−−	8	6

Table 4: the observed and predicted frequencies (treatment 2)

Outcome	Observed frequency	Predicted frequency
*++	86	88
*−+	78	76
*+−	10	11
*−−	10	9

Figure 1: A 3+3 decision tree



Appendix: The experimental instructions NOT FOR PUBLICATION

INSTRUCTIONS

Welcome to this experiment. It is an experiment on the economics of dynamic decision making under risk. The Economic and Social Research Council of the UK (ESRC) has provided the funds to finance this research. The instructions are straightforward, and if you follow them carefully you may earn a considerable amount of money which will be paid to you in cash immediately after the end of the experiment. Please read the instructions carefully and take as much time as you need. There are no right or wrong ways to complete the experiment, but what you do will have implications for what you are paid at the end of the experiment. There is no participation fee for this experiment – what you are paid at the end depends partly on the decisions that you take during the experiment and partly on chance.

Your Various Attempts at the Experiment

You will be allowed a number of attempts at the experiment. The actual number will be told to you when you start the experiment. On each attempt at the experiment, there will be a payoff. Your payment for the experiment will be a randomly chosen one of these payoffs. We give more detail below. Each attempt will involve working your way through a decision tree – which we describe below.

The Decision Tree

The experiment concerns a *Decision Tree* which is composed of a sequence of *choice* and *chance nodes*. At each node there are two subsequent paths to follow: Left and Right. At each *choice node* **you** will have to take a *decision* - in each case whether to go Left or Right. At each *chance node* a chance device - which we call **Nature** - will determine whether Left or Right is chosen. Nature operates in a totally random way – so that Left and Right are equally likely and independent of any past moves by either you or Nature. In total there are *three* choice nodes and *three* chance nodes, starting with a *choice* node and then alternating the two types until the final *chance* node. So the entire sequence is: choice, chance, choice, chance, choice, chance. After the third and final chance node is played out you will arrive at an *end* **node**. Each *end node* has associated with it a *payoff* - a certain amount of money which is your payoff for that attempt if you arrive at that end node. To discover the payoff associated with any particular *end node* you should *click* on that node - using your mouse. The payoff associated with that node will be written in the box at the top of the screen.

Nature

'Nature' is our way of describing a totally random device. It is important that you understand what this means. At any chance node, when Nature moves, it moves in such a way that Left or Right are equally likely and independent of any moves made by you or by Nature at any time. This means that it is impossible to predict what Nature is going to do and the only information on which you can work is simply that Left and Right are equally likely. It may be useful to you to note that the way that Nature is implemented on the computer is through using the random number generating software of the computer. Even with this knowledge you are unable to predict any move of Nature.

Notepads

All nodes, except the final payoff nodes, have associated *Notepads* which can be opened by clicking on that node with your mouse. Once open, you can leave notes in the Notepad for future reference. These Notepads may prove useful to you as places to keep notes to help you in deciding what to do as you move through the tree. Indeed, since we will not allow you to use paper and pencil nor to take any other notes during the experiment, the use of these Notepads is the *only* way you can take and keep notes to help you in your decision making. You can use these Notepads as much or as little as you wish. The information that you put in the Notepads will remain there (unless you edit it or delete it) throughout all attempts at the experiment.

More Details

You should read these instructions carefully, and then turn to the computer. You will first be shown a PowerPoint presentation of these Instructions. Then the main program for the experiment will be run. You will first be told how many attempts at the experiment you will be allowed. The program will then proceed to the main screen. This contains the decision tree: starting at the bottom with a single highlighted (white) choice node, and then proceeding upwards through a level containing 2 chance nodes (red squares); then to a level containing 4 choice nodes (green squares); then to a level containing 8 chance nodes (red squares); then to a level containing 16 choice nodes (green squares); then to a level containing 32 chance nodes (red squares); and finally to the top level containing 64 end nodes (yellow squares). See the figure attached to these instructions for a preview. On each attempt at the tree, you will ultimately move up through the tree until you reach one of the end nodes; which end node you end up at will determine your payoff for that attempt. At each choice node you come to, you will eventually have to decide whether to go Left or Right; at each chance node you come to, Nature will choose whether you go Left or Right. As we have already remarked, Nature choose at random so that Left and Right are equally likely and independent of any past moves. So the final end node you end up at depends partly on your choices and partly on chance.

Looking at Specific Nodes

On any attempt, and at any stage in the whole process, either before taking any choices or playing out any chance nodes, or after taking one or more choices or after playing out one or more chance nodes, you can explore the tree and leave notes in the Notepads associated with any node. This is simply done by clicking on that node with your mouse. You will notice that when you click on any node, it turns white. Moreover, if it is a payoff node, the payoff associated with that node is shown in the box at the top of the screen; whereas if it is a choice or a chance node, the Notepad associated with that node opens.

Examining the Notepads

Once you click on a choice or chance node, the node turns white, and the associated Notepad opens and you can read its contents. You can then add to or amend the contents of the Notepad simply by typing in the usual fashion. To then close the Notepad you click on the key "If you want to close and save the Notepad click here". As we have already remarked, the information that you put in the Notepads will remain there (unless you edit it or delete it) throughout all attempts at the experiment.

Making Moves

To make a move at the *current* node, click on that node and, in addition to the Notepad, a box will open telling you what to do. If the current node is a *choice* node, then there will be a box with "Are you ready to decide?" at the top. If you are ready, then click on "Move Left" or "Move Right" as you wish, and then click on "Click here to confirm your decision". If the current node is a *chance* node, then there will be a box with "It is Nature's move" at the top. If you are ready for Nature to move, then click in the button "Click here when you are ready for Nature to move". As we have already remarked, Nature chooses at random so that Left and Right are equally likely and independent of any past moves. *Please note that you or Nature can make moves only at the* ***current*** *node: you if the current node is a choice node and Nature if the current node is a chance node.* You should also note that when you or Nature makes a move, then the half of the remaining tree that is excluded by your or Nature's move turns grey – indicating that that half is no longer available.

Payoffs

The payoff for the tree is the payoff in the final end node. This will be shown at the top of the screen when you reach that final end node on any one attempt. When you have completed all allowable attempts there will be a message at the top of the screen telling you the payoff on each of the attempts that you have completed. At this stage you should call one of the experimenters. He or she will ask you to complete a brief questionnaire and will pay you the final payment. How this is determined is explained below. You will be asked to sign a receipt for the payment.

Your Payment for Participating in the Experiment

As we have already remarked, you will be allowed several attempts at the tree. The precise number of attempts will be told to you when you start the experiment, and you will be reminded throughout of how many attempts you have done and how many remain to be done. On each attempt there will be a *payoff*, denominated in money. Your payment for the experiment will be a randomly chosen one of these payoffs. For example, suppose you are allowed 4 attempts at the tree. There will be 4 payoffs – one for each attempt. At the end of the experiment, you will be invited to call over one of the experimenters. He or she will have 4 cards, numbered from 1 to 4. These cards will be shuffled and you will be invited to pick one of the cards (obviously without seeing the number written on it). The number on the card that you pick will be noted and you will be paid the payoff on that numbered attempt.

Other

If there is any aspect of these instructions about which you are not clear, please ask the Experimenter. It is clearly in your interests to understand these instructions as fully as possible. Please also feel free to call the Experimenter at any time.

THANK YOU FOR YOUR PARTICIPATION