The Effect of Feedback Control and Feedforward Control on Organizational Performance: A Simulation Analysis Using NK Model

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Abstract

This study examines the effect of feedback control and feedforward control on organizational performance by using computer simulations. Feedback control and feedforward control in management accounting have been studied since the late 1960s; however, findings on the effects of these controls have been inconsistent in existing research. The limitations of observing feedforward control without feedback control can be one reason for these inconsistencies. This study uses computer simulation and the NK model to analyze the effects of controls without limitations of observation. I add three factors—memory, environmental change, and control structures to the basic NK model—to analyze the effects of control. The simulation results indicate that effective control differs, according to the variability of the environment and the degree of interdependency among organizational decision factors. Additionally, simulation results show that the simultaneous use of feedback control and feedforward control is effective at high environmental variability and high interdependence among decision factors.

Keywords

Feedback control, Feedforward control, Management control, Simulation, NK model

(1) Introduction

This study uses computer simulations to analyze how feedback control, feedforward control, and the joint use of these controls influence organizational performance under different conditions.

Demski (1969) introduced the concepts of feedback control and feedforward control in the discipline of management accounting. Since then, many researchers have used these concepts to understand management accounting. Using feedback control enables the discovery of problems that occur and advances the exploitation of existing capabilities to solve problems (Ferreira and Otley, 2009; Grafton et al., 2010). It also enables discovering new potential opportunities and advancing the exploration of new capabilities (Grafton et al., 2010).

Although feedback and feedforward controls have been shown to have these advantages, the influence of these controls on organizational performance is inconsistent, as reported in existing studies (Grafton et al., 2010; Ismail, 2013; Lerch and Harter, 2001). These inconsistencies can emerge from differences in environments faced by organizations, such as variability and complexity (Fowler, 1999; Lerch and Harter, 2001).

Measuring the state of these environments requires detailed investigation and considerable costs. Additionally, organizations using effective feedforward control will simultaneously use effective feedback control, as feedforward control requires information obtained using feedback control (Demski, 1969). Acquiring empirical data on organizations that use feedforward control without feedback control has been difficult.

Thus, this study uses computer simulations to analyze how feedback control and feedforward control influence organizational performance. Computer simulation allows for the acquisition of virtual data on the environments faced by organizations and the influence of only feedforward control on organizational performance.

The remainder of this study is organized as follows. In the next section, I discuss the concepts of feedback control and feedforward control. Section 3 introduces the NK model as the base model. In Section 4, the NK model is developed to express feedback control and feedforward control. In Section 5, I present the results of the simulation analysis, while Section 6 concludes this study.

(2) Feedback control and feedforward control

1. Definition

Demski (1969) introduced the concept of feedforward control in management accounting research by presenting a "decision-performance control" framework. This framework contains not only feedback control, which uses feedback information such as past results to control the implemented decision, but also feedforward control, which uses feedforward information such as environmental information to develop the best strategy. In the decision-performance control framework, feedback control is defined as the control that uses information that results from the physical process, as well as further environmental information to control decision making; feedforward control, however, is defined as the control that uses forecast information based on internal and environmental information.

Maruta (2005) compared the computation structure of feedback control with that of feedforward control and demonstrated the difference between these controls from two perspectives: a time structure and a relationship between standards and objects. Feedback control is the process through which a controller makes actual outputs closer to standards of control, while feedforward control is the process through which a controller makes the forecast outputs closer to standards of control. For example, traditional budgetary control is a feedback control that uses the difference between the actual profit and forecasted profit to manage an organization. Thus, this control uses actual profit as the object of control and forecasted profit as the control standard. Budgeting is a feedforward control that uses differences between forecasted profit and target profit to manage an organization. Budgeting therefore uses forecasted profit as the object of control and target profit as control standards. The difference between traditional budgetary control and budgeting is whether the objects of control are actual values or forecasted values.

Both Demski (1969) and Maruta (2005) emphasize that feedback control uses results or output information after implementation, while feedforward control uses future forecast information before implementation. Additionally, Maruta (2005) shows that research in various disciplines states that the major difference between the concepts of feedback and feedforward is the perspective of after implementation or before implementation. This study focuses on this basic difference in modeling and analyzing feedback control and feedforward control[1].

Demski's (1969) framework considers feedback control and feedforward control as a series of processes. An organization's manager or decision maker usually requires past information acquired by feedback control to perform feedforward control. However, analyzing the influence of only feedforward control on organizational performance requires separating these controls; thus, I conceptually separate these controls in the analysis model .

2. Relationships among feedback control, feedforward control, and decision-making environments.

This subsection discusses the relationship between feedback control, feedforward control, the variability of decision-making environments, and the interdependency among decision variables.

Using feedback control enables organizations to discover problems and solve them, modify action, advance organizational learning, and exploit existing capabilities to solve problems (Ferreira and Otley, 2009; Grafton et al., 2010). These functions can only improve actions after strategies decided in the past are implemented. Feedback control is useless for organizations to take advantage of new potential opportunity (Nørreklit, 2000). Additionally, this control has shortcomings, in that recognizing occurring problems takes time (Maruta, 2005).

Using feedforward control enables organizations to discover new potential opportunities, advance the exploration of new capabilities, and to act before problems occur (Grafton et al., 2010). This indicates that feedforward control enables organizations to explore a new decision

[1] I discuss whether controlling lagging indicators by using a leading indicator is feedback control or feedforward control; this study treats such a control as feedforward control. Control requires clear objects of control (Maruta, 2005). If lagging indicators become objects, a leading indicator enables forecasting of the future states of objects (Demski, 1969).

option, based on the extant decision, at the complex interdependency among decision variables. However, the use of forecast information requires a precise forecast model and the observing information about the change in the input variable for the forecast model (Fowler, 1999). Thus, the use of feedforward control can be inefficient when the environment significantly changes. Additionally, using only feedforward control limits organizations' ability to modify the extant action when the forecast is wrong.

Lerch and Harter (2001) investigated the effects of feedback and feedforward control. Their findings indicate that using only feedforward control has negative effects on performance, while using only feedback control or even no control can gradually improve performance. Their study also shows that using either both controls or no controls affects performance more than using only feedback or feedforward control. Lerch and Harter (2001) explain the reason for their result from the perspective of interdependency among decision variables. For the small number of interdependencies among decision variables, using only feedforward control results in relatively low performance. A few interdependencies enable the efficient exploration of alternatives without feedforward control. Thus, feedforward control leads to unnecessary cost increases and negative effects on performance at a few interdependencies.

Maruta (2005) considered the process of budget updating as a feedforward control. Budget updating is the process of renewing forecasted values before recognizing the actual value output, when recognizing environmental change. This process requires recognizing environmental changes before performing feedforward control. Recognizing environmental change requires feedback control that becomes clear due to the difference between past and current information. These requirements show that feedback control is more important than feedforward control in managing environmental change, and that feedforward control provides an additional effect.

The findings on the relationship between feedback control, feedforward control, and organizational performance is inconsistent in existing studies. One reason for this inconsistency is that the effectiveness of both feedback control and feedforward control vary, depending on the decision-making environment. Existing research indicates the variability of decision-making environments (Fowler, 1999; Maruta, 2005) and that the interdependency among decision variables (Lech and Harter, 2001) influence the effectiveness of feedback control and feedforward control; however, research examining this relationship is limited.

From the next section, I examine how the variability of decision-making environments and the interdependency among decision variables influence the effectiveness of feedback control and feedforward control by using computer simulation.

(3) NK model

This section explains the NK model, the base model used in this study.

The NK model was introduced by Kauffman and Levin (1987) as a model in the evolutionary biology field. This model allowed biologists to analyze the evolutionary process in cases for which characteristics or genes are interdependent on each other (Kauffman, 1995; Kauffman and Levin, 1987). The model has been used in management discipline since Levinthal (1997) used it to analyze the cause of diversity in organizational forms. Researchers have also studied issues relating to "exploration and exploitation" (March, 1991) or "differentiation and integration" (Lawrence and Lorsch, 1967) by using the NK model.

The NK model aims to express situations in which managers try to improve decisions gradually, to thereby improve organizational or departmental performance. The decision in the NK model has N decision variables that have only two states. For example, whether the firm buys equipment A or B, or whether the firm makes a component itself or buys it. These variables do not directly affect performance. The performance of a variable depends on the states of the other variables. A variable's performance can depend not only on one other variable but also on multiple other variables; thus, the number of dependences per variable is expressed as parameter K. Changing K enables us to express the complexity of decision making.

Combinations of decision variable states increase exponentially as N increases; however, managers have insufficient capacity to consider all variables simultaneously.

This insufficient capacity limits the number of decisions that the manager can consider simultaneously; it also limits the number of variables that the manager can use to forecast performance change that can change at once. These limitations enable the model to express real managerial situations wherein decisions are made adaptively.

I formulate these situations as follows: The simplest model has a single agent that can make a decision. This single agent is generally interpreted as an executive manager who makes decisions at every time-step.

First, I define decision making. N decision variables are binary decisions, that is, $d_i \in \{0,1\}$, $(i = 1, \ldots, N)$. Feasible decision is defined as N-dimensional binary vectors $\boldsymbol{d} = (d_1, d_2, \ldots, d_N)$. Therefore, the number of decision patterns is 2^N. Existing studies mainly set N from 6 to 10 (e.g., Siggelkow and Levinthal, 2003; Siggelkow and Rivkin, 2006; Wall, 2016). Such a small N still allows us to express sufficiently complex situations.

Second, I define the performance obtained through the decision. Each of the decision variables makes a certain contribution c_i, $(i=1, \ldots, N)$. The value of the contribution function c_i depends not only on decision variable d_i but also on other K decision variables. Thus, the contribution function has K + 1 variables; that is, $c_i\left(d_i \mid d_{i(1)}, d_{i(2)}, \ldots, d_{i(K)}\right)$, where i (k) is the function that returns the number of the k-th decision variable that influences the contribution of d_i. At the beginning of the simulation, a random value from a uniform distribution is allotted to each of input vector $\left(d_i, d_{i(1)}, d_{i(2)}, \ldots, d_{i(K)}\right)$ as the return value of contribution function. The performance of decision $\boldsymbol{d}$ is defined as the average of the values returned by the N contribution function:

$$V(\boldsymbol{d}) = \frac{1}{N}\sum_{i=1}^{N} c_i(d_i \,/\, d_{i(1)}, d_{i(2)}, \ldots, d_{i(K)}). \quad (1)$$

When K is larger, the influence of changing a decision variable spreads to other decision variables more, and decision-making is more complex. The smallest value of K (K = 0) achieves the highest performance by changing the decision variable one by one, because all decision variables are independent of each other and the graph of $V(\mathrm{d})$—that is, the fitness landscape—has a single peak. In contrast, the largest value K (K = N − 1) limits the improvement of the decision. In this situation, changing certain decision variables to increase contributions can lower global performance, as all decision variables are interdependent and the fitness landscape has many local peaks. Thus, improving global performance requires simultaneous consideration of multiple decision variables at the same time.

In these environments, a single agent, an executive manager, make decisions repeatedly, following "hill-climbing method" algorithm. The manager has insufficient cognitive capacity to survey all alternatives at once; therefore, the manager searches for a fixed number of alternatives that is sufficiently close to the decision implemented in the previous time-step at one time-step. The number of alternatives and the distance form decisions implemented in the previous time-step are the parameters under this manager capacity assumption.

Distance was calculated using the concept of the "Hamming distance." This concept defines distance as the number of different components between two vectors. For example, the distance between vector (0, 1, 1, 0) and vector (0, 0, 1, 1) is two, because these vectors have two different components: the second and fourth components. Thus, selecting a decision sufficiently close to the decision implemented in the previous time-step means that the manager can only change a limited number of decision variables at once.

Subsequently, I explain the concrete algorithm of hill-climbing:

1. The decision implemented at time-step 0 is decided at random.
2. Let recent time-step be t. The manager searches decisions at random from alternatives that are sufficiently close to decisions implemented at time-step $t-1$.
3. The manager adopts the decision that produces the highest V(d) from alternatives searched at step 2 and the decision is implemented at time-step $t-1$.
4. Step 2 and step 3 is repeated until termination conditions are fulfilled.

In the simplest NK model, a single agent reaches a local peak that is nearest to the initial decision. This agent stays at this local peak because of its capacity limit, although the other decision, which is producing higher performance, exists far from the current decision (Kauffman, 1995). This indicates a limitation of gradual improvement in organizations that face complex environments and the dependency of the current state of organizations on the initial state of the organizations.

(4) Expansion of NK model

Analyzing the relationships among feedback control, feedforward control, and organizational performance using the NK model requires the introduction of the structure of feedback control and feedforward control into the NK model. Introducing the memory structure of an agent (Wall, 2016) and environmental change (Levinthal, 1997) allows the NK model to express both feedback control and feedforward control.

In my model, an agent is interpreted as an organization or a manager who represents an organization. Thus, agent memory indicates organizational memory and the searching process indicates the organizational search of decisions.

1. Memory structure

In the basic NK model, an agent chooses a current decision by comparing the performance obtained through decision implemented in the previous time-step and the forecasted performances which could obtained by implementing feasible decisions. This setting is limited, in that it is difficult to manage past information and future information. In my model, an agent stores information in memory. Feedback control allows an agent to memorize the combinations of decisions implemented in several previous time-steps, and their performance; feedforward control allows an agent to memorize the combinations of decisions that are feasible in several future time-steps and the forecasts of their performance. An agent can use memorized information as an alternative way of making a decision at each time-step. However, when environmental changes occur, memorized information can lose its relevance to the current environment. The capacity of memory has no upper limit, and thus, memorized information remains until the feedback or feedforward control process reveals that the information is incorrect.

2. Environmental changes

Examining the influence of feedback and feedforward control on organizational performance requires us to consider environmental changes. My model uses a structure in which the contribution functions change on a regular basis. This structure is also used in Levinthal's (1997) model, but unlike their model, the degree of environmental change varies in my model, depending on the variability, ranging from 0 to 1.

When environmental change occurs, each return value of the contribution function changes to a random value from a uniform distribution that has an upper limit and a lower limit, as expressed in the equation below.

$$\textit{upper limit} = \textit{value before change} + (1 - \textit{value before change}) \times \textit{variability}.$$

$$\textit{lower limit} = \textit{value before change} - \textit{value before change} \times \textit{variability}.$$

No environmental change occurred when the variability was zero. The contribution function values reset independently of their values before environmental change when the variability is one.

3. Feedback and feedforward structures of the relationships between decisions and performance

This study mainly uses the concept proposed by Demski (1969) to address feedback control and feedforward control. In my model, feedback control is treated as the process in which a manager uses past performance information to control current decision making, while feedforward control is treated as the process in which the manager forecasts the relationships between feasible decisions and performance, and uses the forecast information to make the best decisions possible. Feedback control enables managers to obtain information on the results of past decisions, whereas feedforward control enables forecast information to be obtained before implementing a decision.

In my model, the variable T indicates the time distance between the current time-step, information obtained at that time-step, and the interval of information acquisition [2]. First, I define the no-control situation as $T = 0$. A no-control situation allows an agent to search only decisions feasible in the next time-step but not to memorize those decisions. This represents a situation in which an agent lets its actions take its own course.

A T-value smaller than zero indicates existing feedback control. For example, at $T = -5$, an agent acquires and memorizes information about decisions implemented during the past five time-steps and the performance related to these decisions.

At this stage, past information about decisions and performance is inserted into the agent's memory. Extracting past performance information from memory enables the selection of decisions that produce higher performance. Demski (1969) treats the concept of feedback control as a control, with a comparison between current states and standards or assumptions. This model expresses only a comparison between the current states and assumptions. For example, if memory states that implementing decision (0, 0, 0, 0) produces a performance of 0.6, but implementing decision (0, 0, 0, 0) produces only 0.4 in actuality, an agent modifies that statement in the memory to a new one. If memory has no information about implementing decisions (0, 0, 0, 0), the statement that implementing decision (0, 0, 0, 0) produces 0.4 is inserted into memory.

If T is larger than zero, it indicates existing feedforward control. For example, at $T = 3$, the agent acquires and memorizes the forecast information about several decisions that are feasible during the next three time-steps and the performance

[2] I define the interval of information acquisition as the other variable. For example, the model can contain rolling forecast structures that the information of several future time-steps is obtained at every time-step. This study excludes this structure from the analysis to simplify the model; this point will be examined in future research.

obtained from these decisions per three time-steps. In the NK model, the relationships between decisions and performance are decided randomly at the beginning of the simulation. The memory in which information about such a relationship is stored is the decision model, which is referred to by Demski (1969). In my model, the feedforward process searches for new relationships between decisions and performance. This expresses the advantages of feedforward control: paying attention to new potential opportunities and advancing the exploration of new capabilities. An agent has limited capability to make optimal decisions, and thus, they can only forecast decisions that are feasible in the near future; thus, feedforward in my model is conceptualized differently from that in Demski (1969) who treats it as an optimization.

When using feedforward control, the forecast processes are as follows: First, an agent searches for a decision that is feasible at the current time-step and acquires information about the relationship between the decision and performance produced by implementing it. Second, the agent searches for a decision that is feasible at the next time-step and the information, on the assumption that the agent implements the decision searched by the agent in the previous step. If T is larger than three, the second step is repeated recursively. The decisions searched after the second step are distant from the decision implemented at the last time-step; therefore, implementing those decisions requires several time-steps.

The forecast uses contribution function values before environmental change, although the forecast period contains the time-step at which change will occur. The observer (researcher) knows this time-step, because the change interval is fixed; however, an agent in the computer model does not know this. This condition setting reflects the shortcoming of using only feedforward control has a limited ability to cope with environmental change. In reality, managers can acquire several actual performance indicators without feedback control and evaluate the validity of information from the feedforward process. However, limiting the acquisition of actual performance information without feedback control enables the clarification of the characteristics of feedforward control. Thus, in my model, only feedback control verifies the information acquired by the feedforward process after implementation.

4. Flowchart of analysis model

This subsection presents a flowchart of analysis model (Figure 1). Initially, the decision implemented at time-step 0 is decided by randomly allotting each decision variable to zero or one. Simultaneously, the return values of the contribution function are set at random values from a uniform distribution $U(0, 1)$ for any decision vectors. These values change every 50 time-steps, depending on the variability.

Based on the absolute value of T time-steps, information acquisition by feedback and feedforward process occurs.

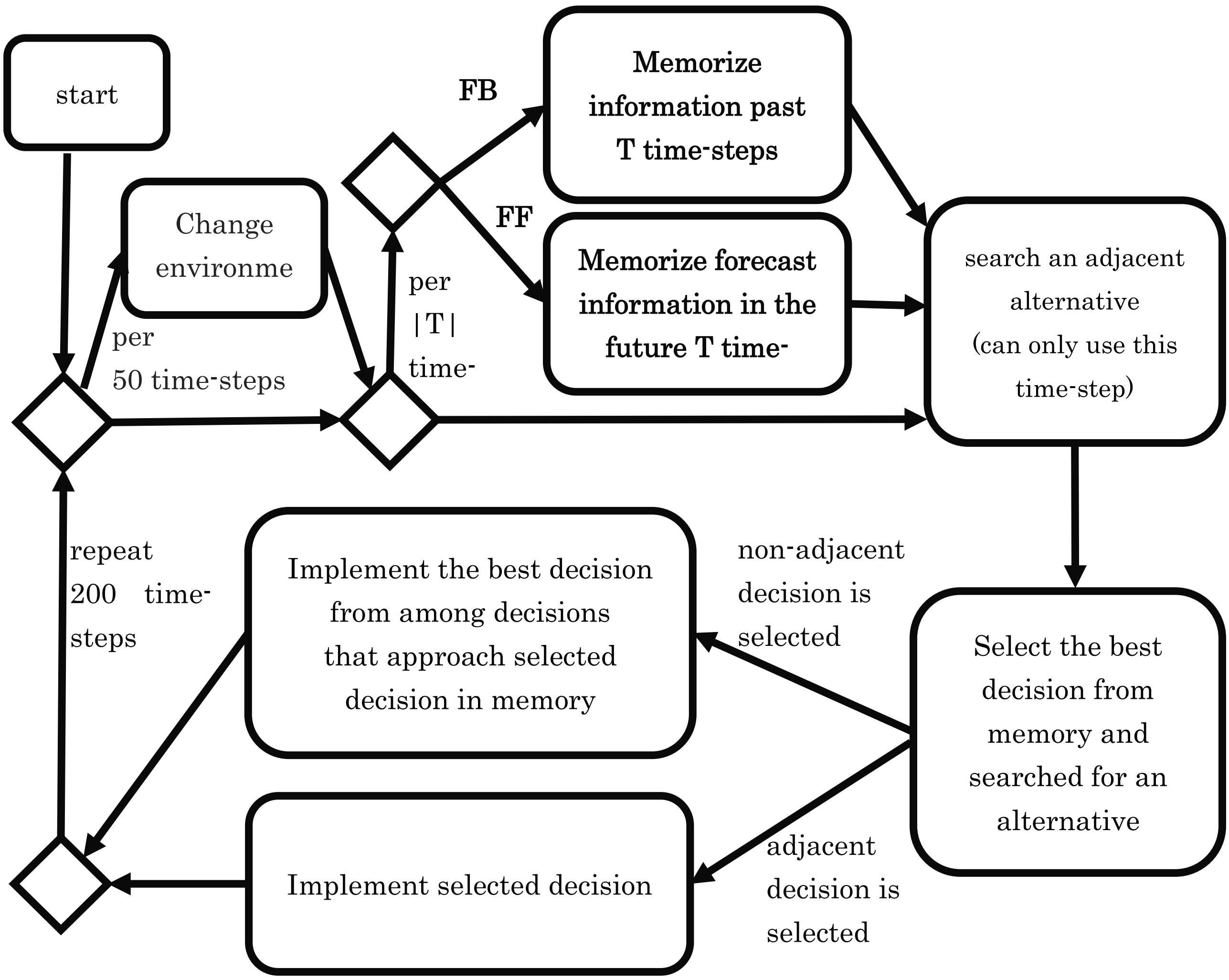

Figure 1: Flow Chart of Simulation Model

Using feedback control allows an agent to memorize the relationships between decisions and performance that actually occurred in the past T time-steps. Using feedforward control allows an agent to search and memorize forecasted relationships between decisions and performance that will occur in future T time-steps.

Next, regardless of the feedback or feedforward process, an agent searches for an alternative. This alternative is made by replacing one randomly-chosen decision variable in the decision implemented in the last time-step. The agent uses this alternative only in this time-step. After this search process, the agent selects the best decision from among the decisions in the memory and searches for an alternative. If the selected decision is accessible at the current time-step, the agent implements this decision. If the selected decision is not accessible at the current time-step, the agent implements the best decision from among decisions that approach the selected decision in memory.

The agent repeats this process 200 time-steps. I treated these 200 repetitions as one trial and analyzed them using this model.

(5) Simulation results and discussion

1. Method and variable settings

This section presents and discusses the results of the simulation.

The control structures were the main parameters in this analysis. The control structures had four patterns. “NO” is in the state of $T = 0$, meaning that no control exists. “FB” is the state of $T = -3$, meaning that feedback control only exists. “FF” is the state of $T = 3$, or feedforward control only exists. “FB&FF” is the state in which both feedback control ($T = -3$) and feedforward control ($T = 3$) are used simultaneously[3].

The other important parameters were N that is the number of decision variables, K that is the number of dependencies per decision variable, and variability. In this analysis, N is fixed at 10, while K varies between 0, 5, and 9. Variability varies from 0 (no change) to 0.2, 0.5, and 1.0. Therefore, the combinations of the parameters become 48 patterns. this research conducted 1,000 trials per combination of parameters, changing random number seeds, and used average values to analyze the simulation results.

In the basic NK model, performance $V(\mathrm{d})$ is the average value of the contribution that can take any value from 0 to 1 at random. Therefore, the maximum value of $V(\mathrm{d})$ differed among the different trials. This makes comparison among trials difficult, and therefore, I use relative performance—the value dividing $V(\mathrm{d})$ by the maximum of $V(\mathrm{d})$—in each trial.

I used Repast Simphony 2.6 software, a tool for agent-based modeling, to conduct the simulation.

2. Independent influence of feedback control and feedforward control on performance

This subsection discusses the influence of the use of only feedback or only feedforward control on organizational performance. To accomplish this, I used the average of the relative performances from 1 to 200 time-steps (Table 1).

Figure 2 shows the difference between the relative performances of FB and NO (FB in Figure 2) and the difference between that of FF and that of NO (FF in Figure 2). The relative performances were clearly different for low variabilities (0 or 0.2) and for high variabilities (0.5 or 1.0).

For low variabilities, the performance of FB showed few differences from that of a case at K = 0. As K increased, FF had a greater advantage than FB. Additionally, at K = 9, the difference was greater than at K = 5. This indicated that a larger K value caused a greater advantage of FF at low variabilities.

The reasons for these results are clear. Using feedforward control allows an agent to search for decisions that are unreachable directly but that could lead to high performance in the future. This prevents the

[3] I use three as the absolute value of T because other values (1–5) do not change the relationship that this study aims to analyze; thus, I adopt a median value between 1 and 5.

agent from adopting a decision that is easily available but can only reach low peaks; therefore, the agent can adopt a decision that enables performance to reach a high peak. This tendency is more obvious at a higher K value, because the fitness landscape has more low peaks at higher K. This is consistent with the function of feedforward control referred to by Grafton et al. (2010), which advances the exploration of new actions.

Variability	K	FB	FF	FB&FF	NO
0	0	0.985	0.987	0.991	0.750
0	5	0.881	0.919	0.922	0.643
0	9	0.835	0.895	0.900	0.639
0.2	0	0.978	0.976	0.977	0.798
0.2	5	0.900	0.910	0.927	0.701
0.2	9	0.865	0.891	0.901	0.696
0.5	0	0.950	0.923	0.939	0.810
0.5	5	0.884	0.838	0.896	0.713
0.5	9	0.858	0.826	0.878	0.708
1.0	0	0.893	0.822	0.861	0.751
1.0	5	0.829	0.730	0.842	0.643
1.0	9	0.811	0.729	0.835	0.638
Average		0.889	0.871	0.906	0.707

Table 1: Average performance 1 – 200 time-steps (confidential intervals are from ±0.001 to ±0.010)

For high variabilities, the relative performance of FB was higher than that of FF, contrary to low variabilities. When not using feedback control, recognizing the change in performance caused by environmental changes is difficult. Using feedback control enables the recognition of such changes by acquiring information about actual performance after environmental changes. In other words, using feedback control enables quick learning from mistakes and therefore quick recoveries after environmental changes.

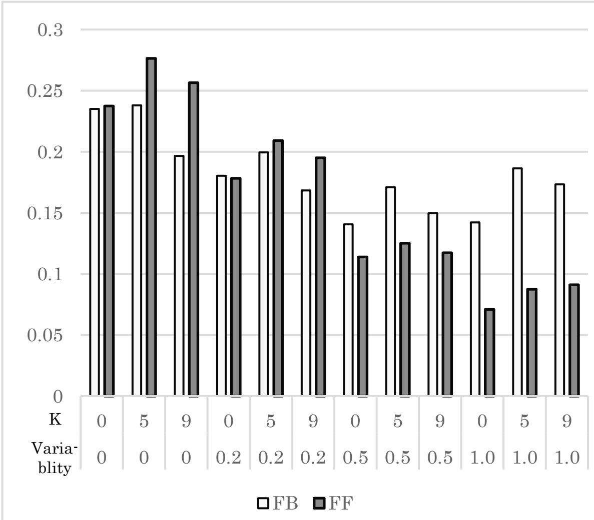

Figure 2: Relative performance of FB and FF

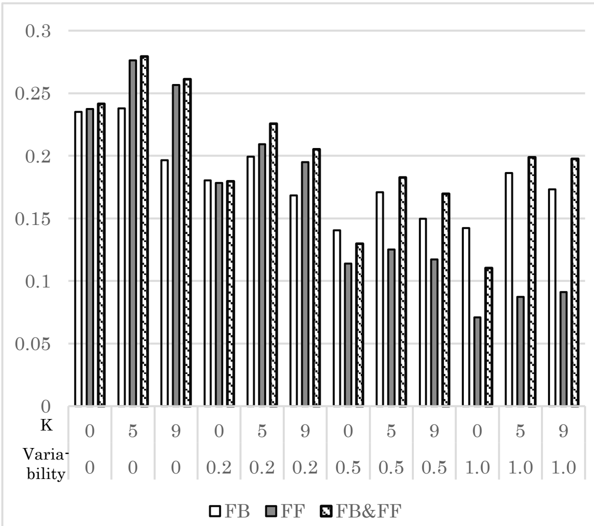

Figure 3: Relative performance of FB&FF

3. The influence of simultaneous use of feedback and feedforward control on performance

This subsection discusses the influence of the simultaneous use of feedback and feedforward control on organizational performance. Existing studies show that such simultaneous use is more effective than other patterns. This study obtains different results in some variable patterns.

I add the difference between the relative performances of FB&FF and that of NO to Figure 2 (shown in Figure 3).

For low variabilities, the relative performances of FB&FF were on the same level as the relative performances of FF.

For high variabilities and K = 0, the relative performance of FB&FF was lower than that of FB. Forecast information by feedforward control becomes incorrect information after changing the environment; therefore, feedforward control prevents an agent from making sound decisions at high variabilities and low interdependence among decision variables.

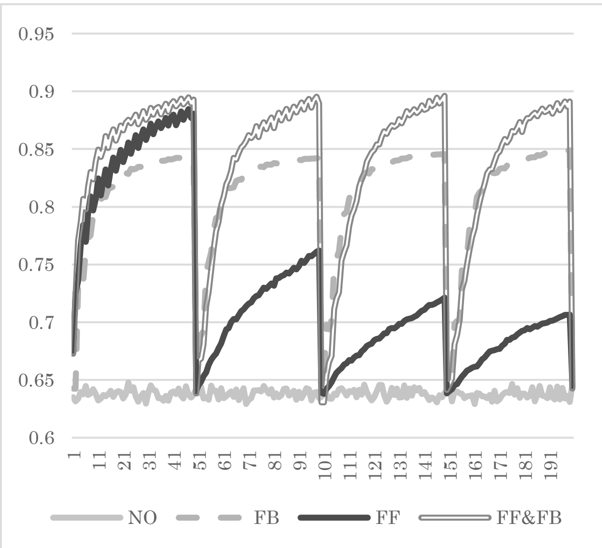

Figure 4: Transition of performances for K = 9 and variability is 1.0

For high variabilities and high K, however, the relative performance of FB&FF was higher than that of FB. To analyze these results, I show the transition of relative performance from 1 to 200 time-steps (Figure 4). Although Using only feedback control enabled quick improvement of decisions, once the local peak was reached, improvement was paused until the next environmental change. Thus, in the case of FB, the relative performance was not very high. Feedforward control compensates for this shortcoming of feedback control. Feedforward control enables the agent to leave the local peak that was reached at once and search for distant but better decisions; therefore, the simultaneous use of feedback control and feedforward control enables the continuous improvement of decisions.

(6) Conclusions

This study examines the effects of feedback control, feedforward control, and the simultaneous use of these controls on organizational performance using a computer simulation.

This study makes two contributions to the literature. First, I have shown that the influence of feedback and feedforward control on performance varies according to the degree of interdependence among decision factors or the variability of the environment. Second, this study demonstrates that the simultaneous use of feedback control and feedforward control is effective at high environmental variability and high interdependence among decision factors, and suggests the reason for these results.

In this study, I was unable to address the accuracy of feedback and feedforward control to model. Although this factor influences organizational performance, it was not used in this study to keep the complexity of the model as low as possible and to simplify the analysis (Labro, 2015).

Our future work will address the accuracy of the control and examine the influence of accuracy.

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