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Evaluating the Performance of an Ambidextrous Bank Using an Agent-based Modelling Approach: A Case Study of Sepah Bank

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ABSTRACT

Banks are the financial institutions that collect assets from various sources and allocate them to the sectors that require liquidity. Therefore, banks are an inherent element in the system of every country. As private banks enter financial markets, the demand for diverse banking services increases dramatically. Banks seek to use various techniques to improve their performance in attracting customers to increase their market share and profitability. In this regard, assessing the performance of banks is of utmost importance and has become a major activity of bank managers. With the constant changes in the modern world and incessant attempts of competitors to increase their market share by gaining competitive advantage, special attention should be paid to ambidexterity as a key strategy to increase competitive advantage and achieve high performance in dynamic business environments. The present study aimed to identify the ambidextrous factors affecting the performance of banks and present a model to assess the performance of an ambidextrous bank using an agent-based modelling approach. The main objective of the research is to achieve an applied model for managing the performance of the banking industry. The simulation model is processed using the agent-based modelling approach in any Logic software environment.

1 Introduction

A persistent concern in the literature of strategic management and organizational theory is the decision-making of firms regarding investment in various activities in order to survive in the competitive atmosphere of the modern era, while moving toward future prosperity in an ever-changing environment [1, 2]. As a solution, previous studies have suggested that due to conflicting administrative routines and managerial behaviours, as well as limited organizational resources, firms must trade off and explicitly or implicitly decide between exploitation for survival and exploration for prosperity [2, 4]. However, recent studies have proposed that organizational ambidexterity is a more viable option for firms, which is roughly defined as the simultaneous pursuit of exploitation and exploration activities by organizations in their product and service offerings. This viewpoint has become well established in the field of management and organizational studies [1, 5, 7].

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The current literature regarding organizational ambidexterity mainly relies on thoughtful, experience-based conceptualizing, which is mostly achieved through case studies with convenience sampling or survey-based empirical studies. These studies are typically focused on the effects of organizational ambidexterity on organizational performance [1, 3, 5, 8, 10] or the organizational features that facilitate ambidexterity [5, 9, 11, 12]. Furthermore, the literature in this regard elaborates on the impact of leadership on the execution of organizational ambidexterity [3,7]. Although previous studies have provided a sound basis for the recognition of organizational ambidexterity, there are still significant gaps in the body of knowledge in this respect. Some of the mains issues to be addressed are determining the most effective strategies to accomplish organizational ambidexterity and techniques to attempt to achieve this quality. There has been significant progress in the current literature on organizational ambidexterity. The present study aimed to identify the influential factors in ambidexterity and investigate the correlations between the dimensions of organizational ambidexterity and performance using an agent-based modeling approach for the banking industry.

2 Literature Review

2.1 Ambidexterity

Duncan et al. [13] introduced the concept of organizational ambidexterity, asserting that a dual organizational structure is required to initiate and implement innovation. Furthermore, an influential report by March [2] proposed exploitation and exploration as two different learning activities, which should be pursued in a balanced manner, while simultaneously competing for organizationally scarce resources. Correspondingly, many scholars incorporated the exploitation and exploration concepts into their research in various contexts, such as organizational learning, technological innovation, organizational adaptation, strategic management, and organizational design [1, 6, 8, 10, 14, 17]. On the same note, Venkatraman et al [18] stated that the ‘time’ factor has been overlooked in the literature, suggesting the twin concepts of 'simultaneous ambidexterity' and 'sequential ambidexterity'. Ambidexterity is defined as the combination or simultaneous pursuit of exploitation and exploration in an organization [1, 3, 7]. Firms simultaneously pursuing both activities are likely to become internally inconsistent, which in turn leads to their inferior performance [4]. However, an organization that exclusively engages in exploitation is typically affected by obsolescence. In other words, the exclusive pursuit of exploration may lead to an unending search, efforts or research and development expenditure without an appropriate return [6]. Basically, the consequence of ambidexterity is that exploration and exploitation are not in direct competition for resources as they act at different times. Therefore, companies are able to apply periods of exploitation between periods of exploration and vice versa. It is often suggested that companies reorganize the structure, culture, processes, and informal state of the organization to reflect the changed environmental conditions or strategies [19, 20].

2.2 Ambidexterity and Financial Performance

The importance of the banking sector in that the economy is indisputable as banks are not only the cornerstone of modern economics, while they play a pivotal role in the stimulation of more social sectors and mechanisms. In addition to its value and size, the banking sector largely differs from other industries due to the nature of its product (i.e., financial services) and its evolution, the rate of which is

significantly higher compared to other manufacturing services as it is expected of financial markets [21]. Bank management is a complex process, which involves interactions between countless factors, among which risk-taking and profitability are considered to be the foremost performance indicators of banks. Innovation is the most important influential factor in risk and profitability as innovative banking activities improve the efficiency of the monitoring and screening of facility recipients, thereby reducing risk and increasing profitability [22]. Financial innovation refers to the activities that diminish the internal costs and risks in banks, while addressing the needs of the clients more efficiently in terms of the external requirements [23]. The focus of organizational strategies should be the selection of their locus of investment in various activities, as well as the methods they aim to apply to this end [24]. Organizations are faced with numerous competitive demands, some of which are contradictory. Considering the higher complexity of global environments in the modern ear, organizations and organizational managers are pressured to handle several strategic competitive demands [25], and organizations must be able to manage such contradictions most efficiently [12]. With respect to ambidexterity, organizations must outline long-term sustainability to meet various demands simultaneously and permanently [26]. Exploration and exploitation are two types of learning/innovation activities that senior executives focus on, invest in, and allocate their resources to [2]. In this regard, March proposed a theory based on the findings of Schumpeter and Holland [2]. In his famous work of exploration and exploitation, March distinguished between two organizational behaviours; exploration refers to the behaviour of the firm that deals with searching, experimentation, variability, acting, discovery, invention, creating knowledge beyond business routines, risk-taking, and innovation, while exploitation requires the organizational behaviours that are distinguished by implementation, productivity, production, selection, repetition, adaptability, efficient use of the existing knowledge, and reduction of variance [2]. Exploration is against the exploitation of various states, including organic structures against mechanical structures, loosely connected systems against tightly connected systems, independence and chaos against control and bureaucracy, emerging markets and technologies against sustainable markets and technologies, and development of a larger functional variance as opposed to a more stable performance [27]. While March considers both activities with contradictory nature to be essential to organizational progress, the combination of these activities remains a major organizational challenge [2]. In fact, the simultaneous use of two contrary activities plays a pivotal role in the long-term performance of an organization [28].

Radical and incremental innovation is one of the main themes in the literature of technological innovation. Continuous innovations are synonymous to exploitative innovations, which are designed to address the needs of the existing clients [29]. These innovations enhance the available knowledge and skills, improve designs, and increase the efficiency of the existing distribution channels [30]. Therefore, continuous innovations reinforce the existing skills, structures, and processes based on the existing knowledge [29]. Radical innovations are the explorative innovations that are designed to address the needs of emerging clients or markets [9]. These innovations offer new designs, create new markets, and develop new distribution channels [30]. It is also notable that explorative innovations require new knowledge [29].

3 Research Methodology

In the scientific literature, agent-based modeling is characterized as bottom-up approach for understanding systems and their behavior and is thus a powerful tool for analyzing complex, non-linear markets. Agent-based modeling is opposed to traditional modelling which is usually based on a top-down

approach. While in traditional modelling certain key-aggregated variables are observed in the real world and then reconstructed in a model where the correlation between aggregated variables is the focus of interest, in the agent-based approach the properties of individual agents and the processes upon which the system's behaviour is built, i.e. how the behaviour of individuals gives rise to the aggregated result, are in the centre of attention.

ABM is an essentially decentralised, individual-centric (as opposed to system level) approach. Generally speaking, when designing an agent-based model, the modeller follows a structured methodology composed of the following steps:

1. Construction of a population of artificial agents(agents' identification, specification of the inner structure of agents and of their decision rules, i.e. definition of their attributes)
2. Parameterisation of agents' attributes and behaviours (e.g., using survey data and field research or making an initial best guess and later calibrating these values by comparing the output of the model with the real world system).
3. Construction of a relational parts system (agents' placement in a certain environment, establishment of connections, if needed)
4. Execution of the simulation

Based on the above explanations the modelling process is described below:

When clients enter the bank, they generate income for the bank either by depositing and providing the fee to the bank in return for the services. Evidently, the net profit of the bank is the differences in the total income from the tax expense after deduction. In order to attract clients and meet their demands (physical facilities, personnel behaviours, technology, finance, and new services), banks must attain ambidextrous costs that affect the performance of the bank, which are referred to as profit and revenue. The client chooses either us or other banks based on the degree of desirability that we or other banks create regarding the specified factors for the clients. In fact, exploration operation (new product offering) and exploitation operation (quality improvement) will result in changes in the entry of clients into the bank, which in turn changes the profitability and revenue of the bank.

Table 1: Categorization of Customer Preferences and Ambidexterity Variables

		Ambidexterity variables	Clients Utilities[34]	Indicators
Ambidexterity	exploitation	Structuring[31,32]	Physical features	Investing on Setting Up a New Branch
		Procedural[21,31]	behaviour of Employee Technology	Investing on Training Investing on E-banking Development
		Controlling[31,33]	Financial	Investing on Increasing Profit Rate
	exploration	Cultural[21,31]	New services	Investing on New Products
		Connecting[31,32]	New services	Investing on New Products
		R&D Expenses[5,21]	New services	Investing on New Products
		Top Management Principles[21,31]	New services	Investing on New Products

According to the literature, banks must create a balance between exploration and exploitation in order to be ambidextrous considering the temporal dimension based on structural/simultaneous ambidexterity or sequential ambidexterity. Previous findings have denoted that banks require seven features to be ambidextrous, which are divided into two categories of exploration and exploitation based on the literature review. The categories of client preferences, ambidextrous variables are presented in Table1.

Customer Agent:

- In the mode of receiving service, clients choose a bank with the maximum value of utility (utility five: new services), while in the mode of deposit, clients choose a bank with the maximum value of the final score (utilities 1-4: physical features, behaviors of employees, technology, and finance). The final score is calculated by total deviation from the mean of the utilities 1-4.
- In the mode of irrational decision-making (logical decision-making probability=0), the client chooses a bank only randomly.
- With the entry of the client into each of the mentioned modes, the revenue of the bank, number of the services/deposits, value of the services/deposits, profit, and exploration and exploitation budget are updated. At this stage, the following variables should be defined:

- entry rate of the customers
- Logical decision-making probability (probability of choosing a bank with maximum utility of 0-1);
- Possibility to receive a service/deposit (If the client serves, only utility five is involved [new services], which has been shown as utility5 in the software environment, and if the client deposits, there will be four other alternatives [physical features, behaviors of employees, technology, and finance], which have been displayed as utility1, utility2, utility3, and utility4 in the software environment, respectively.);
- Service variable (minimum and maximum value of a service provided to the bank by the clients);
- Minimum and maximum value of a service provided to the bank by customer.
- Deposit variable (minimum and maximum value of a deposit provided to the bank by the clients)

Central bank Agent:

- maxexploit variable: Maximum limit of exploitations by banks
- maxexplore variable: Maximum limit of explorations by banks

Banks Agent: (otherbank1 to otherbank5)

Each bank decides to improve the least utility based on budget limitation, as well as the limitations of the maxexploit and maxexplore; therefore, the variables should be defined as follows:

- Income variable, which is added by the client entering only the amount of service v and deposit v.
- Profit variable, which is added by client entry and determined by the profit percentage parameter (showing the percentage of the income considered as profit in each bank).
- Budget for explore-exploit variable, which is characterized by the budget percentage parameter (showing the percentage of the profit considered as exploration and exploitation budget in each bank).
- Policy variable, which is defined as four modes:

- Justexplore (only exploration)
- Justexploit (only exploitation)
- With probability (structural ambidexterity)
- Exploit probability and exploit probability variables, which indicate the probability of exploration and exploitation as characterized below:
- Cost and impact variables, which indicate the required costs to improve each utility and effects of the improvement on the utilities.
- Duration variable, which indicates the required time to improve the utilities.
- Exploreno and exploitno variables, which indicate the frequency of exploration and exploitation.
- Explore success probability and exploit success probability variables, which indicate the probability of the success of the exploration and exploitation projects.
- The amount of utilities

AnyLogic software is able to monitor the profit and behavior of the agents. Before the implementation of the program, the user should specify a series of initial settings, including the entry rate of clients, probability of receiving a service/deposit, probability of logical decision-making, initial values of service v and deposit v, profit percentage, budget percentage, values of utility, and frequency of explorations and exploitations, which is limited by the central bank. After coding and initial settings, the software is executed by selecting the Run option. Some scholars have acknowledged that there are two validation steps for the simulation of agent-based modeling, including internal validation and external validation. The internal validation process also involves two processes, which are known as conceptual validation and explanation. The validity of the model determines whether it is appropriate for its purpose. The entire validation process seeks to eliminate the problems of the model [35].
During the external validation process, the accuracy of the model is also assessed, which determines to what extent the model could reflect the reality that the accuracy value could be measured from zero to 100% [35]. In the proposed model, conceptual validation has been used to examine its conceptual validity, and the opinions of five experts in the banking sector were provided via in-person interviews and approved after necessary revisions. In accordance with the views of the two experts regarding the simulation, the process of model explanation was confirmed.

4 Results and Discussion

The current research aimed to review the literature regarding the concepts related to ambidexterity and its association with the identification of the functions, dimensions, and implications of these concepts. The ambidexterity variables were determined and confirmed via interviews. Following that, the desired factors were defined, and the behaviour of the agents and their correlation with the function were defined as well.
In addition, appropriate algorithms and mathematical functions were selected for modelling. To analyse the proposed model, several scenarios could be examined, which have been discussed in the following sections. To analysing this model, several scenarios can be tested, which are listed below.

First scenario: Sepah bank (case study) only exploits and other banks only explore: In this case, various situations may arise. This mode is checked: the client both serves and deposits with the possibility of irrational decision-making (0.5). Accordingly, 50% of clients decide logically, while 50% decide illogically. As it is shown the income of all the banks increases. But based on the defined scenario, the revenue of Sepah Bank and Bank 1 will further increase (Figure 1).

Fig. 1: First scenario: Sepah Bank only exploits and other banks only explore

The second scenario: Sepah Bank only explores and other banks only exploit. Similar to the first scenario, this scenario also involves various situations. However, we have only reviewed one situation in the second scenario. The client refers to serve and deposit with the possibility of unreasonable decision-making (0.5). In this case, the income of all the banks will increase, while based on the defined scenario, the income of Bank 4 will further increase (Figure 2).

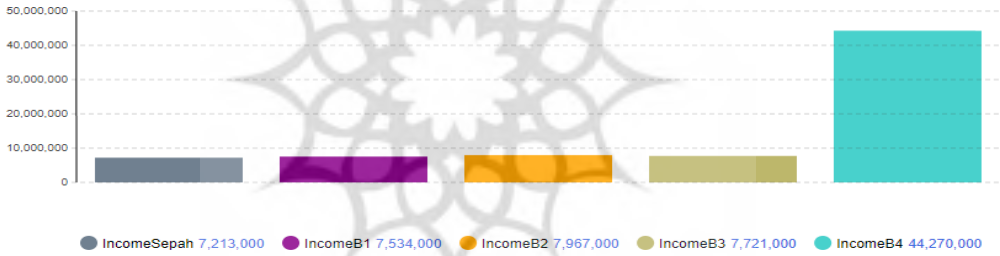

Fig. 2: second scenario: Sepah Bank only explores and other banks only exploit

Third Scenario: At the same time exploration and exploitation (structural ambidexterity) by Sepah Bank and other banks. Similar to the first and second scenarios, various situations may arise in the third scenario, while we have only reviewed one: The client refers to serve and deposit with the possibility of unreasonable decision-making (0.5). As can be seen, the revenue of Bank 4 is higher compared to the other banks due to its favorable conditions in terms of client preferences (Figure 3).

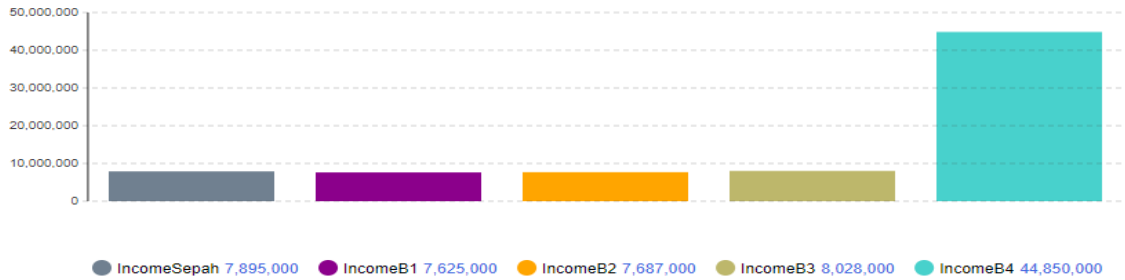

Fig. 3: third scenario: Simultaneous exploration and exploitation by banks

5 Conclusion and Suggestions

The findings of the current research could be summarized, as follows:

- When banks are the only financial institutions in the industry, their income will increase more significantly in the ambidextrous mode compared to only exploration or exploitation [21, 36].
- If the first scenario dominates the industry (Sepah Bank only exploits, and other banks only explore), Sepah Bank will perform more efficiently [9, 37, 38].
- If the second scenario dominates the industry (Bank Sepah only explores, and other banks only exploit), Bank 4 could perform more efficiently.
- If the third scenario dominates the industry (structural ambidexterity), Bank 4 will receive the highest revenue.
- When there are various banks in the industry, it is not necessary for all banks to function ambidextrously in order to achieve better performance [39]. Evidently, although the income of Sepah Bank in the first scenario, income of Bank 1 in the first scenario, and income of Bank 2 in the second scenario are higher compared to the other scenarios, comparison of their income with the income of Bank 4 in the mode of the ambidextrous scenario indicates a significant difference between the revenues of these banks.
- Since the maximum number in the figures (44850000) belong to Bank 4 , it could be concluded that in order to attract more clients, banks need to substantially invest in ambidexterity, so that they could become similar to Bank 4 as a leading financial institution.

If Sepah bank wants to take advantages of ambidexterity and attract more clients, it should:

- According to the obtained results, the performance of Sepah Bank was below average in the first utility (physical facilities). In order to improve its performance, the bank must reduce the costs of setting up its branches (i.e., operating costs) The inefficiencies associated with the establishment of the branches include political reasons rather than economic reasons (no studies of the economic justification for the establishment of the branches), improper location of the branches, and establishment of branches with purposes other than profitability (e.g., increasing employment and services, expanding the network).
- The results of the study indicated that Sepah Bank is below-average in second-order performance, indicating that the bank employees receive shorter durations of training. Therefore, this bank must lower their training costs and increase the training hours. For instance, instead of implementing training hours that imposes heavy costs on the bank, monthly meetings could be held at the bank branches and headquarters, allowing colleagues to exchange opinions and information through the Bank Portal and encourage teamwork.
- The third-order performance of Sepah Bank (technology) is below average, indicating that the number of the POS devices (sales terminals) is low. Which in turn decreases the current costs associated with POS set-up. So it can have PSP companies independently and avoid the high costs associated with renting POS devices.
- With the exception of Bank 4, the performance of all the banks was below the average in terms of the fourth utility. In other words, the costs of raising the interest rates are high in these banks.

Therefore, these banks must attempt to attract cheaper deposits or increase income through investment in various sectors of the economy so as to reduce the costs of deposit payment.

- According to the obtained results, the performance of Sepah Bank was below the average in terms of the fifth utility (new services). To improve its performance, these banks must enhance their R&D budget, so that they could market more new products, thereby generating higher revenue with more client entering.

In this research, the characteristics of ambidextrous banks was described, and an agent based model was introduced as well. The model presented in this research is generic and extensible and can be test various assumptions. Since the proposed model is computational, the assumed values of the parameters could change easily. It is also hoped that the proposed simulation method could be applied to discover proper policies for the accurate and timely selection of ambidexterity in the organization.

- The money taken by the banks from the central bank or at the central bank can be considered as the relationship between the central bank and other banks and vice versa.
- The price of currency, gold and inflation is constant, which is recommended to consider in future research.

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