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Economic Valuation of Environmental Resources in Hamoon International Wetland, Using the Choice Experiment Method

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Abstract For implementing the conservation project of the wetlands in Iran, Hamoon wetland and its satellite wetlands were selected as one of the sample sites in partnership with UNDP. It aimed to reduce the major threats facing this wetland using a comprehensive management plan. This study examines and explores the citizens' preferences and willingness to pay in Sistan plain to improve the environmental characteristics of Hamoon wetland using the choice experiment method. Required data and information were achieved from the citizens of Sistan in 2013 and the mixed logit model was used for analyzing them. The results showed that the maximum willingness to pay belongs to improvement of water level of the current crisis to the desired level (26,000 Rials per year for each family). Achieving optimum water quality (straw rate), the number of ducks and Amur fish in the wetland (23,000, 14,670, and 11,300 Rials / year per family, respectively) are placed in the next rows of people's willingness to pay.

Keywords Choice experiment, Willingness to pay, Hamoon wetland, Mixed logit model

1. Introduction

From the perspective of economists and ecologists, valuation of natural resources and environmental systems follows some goals such as knowledge and understanding of ecological and environmental benefits by human, presentation of the environmental issues of the country to decision-makers and planners, link between economic policies, and natural income. It also seeks for modification of national measures such as GDP and avoidance of damage and uncontrolled exploitation of these resources [16]. Attempts done to estimate the monetary value of environmental resources such as wetlands and lakes has a double role in caused by a mutual management of human and natural systems. at the micro level, valuation studies provides an access to information related to the structure and function of ecosystems and their diverse and complex role in supporting human well-being. In the macro level, valuation of ecosystem can create and modify the parameters that contribute to human welfare and sustainable development [20]. The choice experiment has mostly developed in economics and marketing to determine consumer preferences for products with multiple features [24]. Recently, the application of this method has expanded more than other fields such as environmental management and now it has become a common tool for environmental valuation [6, 17].

In some studies, due to lack of data and real markets for public goods, it is difficult to quantify in monetary units, so the risk of ignoring them increases in decision-making process. In most cases, the contingent valuation method [6] is used to estimate consumer willingness to pay for nonmarket goods. In this situation, valuation of each feature in multi-attitude goods is almost impossible [5]. For example, CV damage incurred by the use of Hamoon wetland has some impacts on wetland water levels as well as wildlife. Here, contingent is able to evaluate and estimate the overall value of wetland conservation, but it cannot avoid their effects on its own. Therefore, the choice experiment as an alternative approach for the stated preference approach can identify the value of any individual characteristics [5].

In environmental economic studies, choice experiment has had several applications in the field of forests, wetlands, energy, water resources, seas, and air quality in recent years some of which are mentioned in wetlands. In order to reflect the preferences of people on the ways used for developing a wetland in southern Sweden, Carlsson et al. [12] used the choice experiment. The results obtained from estimating the Conditional logit model [1] and the random parameter logit [2] show that biodiversity and convenient walking facilities have the greatest positive impact on the utility and people's

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willingness to pay, whereas construction of sea walls and presence of king prawns in a wetland leads to reduction of welfare among people. Othman et al. [30] determined willingness to pay among Malaysian households to set optimal management strategies for Matang- mangrove wetlands in Perak state, Malaysia as Euro 2.7- 3. Birol et al [8] used the choice experiment to estimate the value of economic, social, and ecological functions in Cheimaditida wetlands in Greece. The results show that from the Greeks point of view, biodiversity and retraining people had the most and the least importance, respectively. Smyth et al. [34] also used the choice experiment to assess individuals' preferences regarding management scenarios for Champlain Lake, the U.S., and Canada. The findings show that healthy fish consumption encompasses the bulk of the respondents' utility. In another study, Eggert and Olsson [13] attempted to estimate the economic benefits obtained from improved water quality in west coast of Sweden. They found out that environmental concerns are highly significant for the responders and have the highest value to avoid the loss of biodiversity and fish stocks. Westerberg et al. [38] used the choice experiment to facilitate decision- making process for policy makers in the managing Marais Des Baux wetland in southern France. The results of estimating the logit model for random parameters and calculating the willingness to pay show that one-third restoration of the wetland, biological control of insects, dense vegetation, recreational facilities, and high levels of biodiversity are among the most important factors. In their research, Liu and Wirtz [23] considered the management practices of the oil spill in the North Sea of Germany. They also observed that environmental attributes including quality of the beaches (Euro 0.7/ km), sea birds (Euro 0.0069/ bird), and the ratio of oil collected from the sea (Euro 1.23/ ton) had a greater impact on household utility than the seawater quality (Euro 0.32/ km^2). Wallmo and Liu [37] analyzed the optimization value of endangered and threatened marine species in terms of American households in a national level. The results show different preferences of people for recovery of fish species and seals. It was recognized that differences in WTP depend on the species and its recovery level. Firouz Zare and Gorbani [3] used the time data collected through field survey in Mashhad and employed the choice experiment approach and overlapping logit model to examine welfare effects of policy changes on air pollution. The results referred to high importance of health effects and air pollution from the perspective of the citizens.

Hamoon wetland is one of the most important international wetlands and the largest freshwater lake throughout the Iranian plateau. Its area is about 5,700 square kilometers and its depth ranges from 1 to 5 m in desert and arid areas of the East of the country, Sistan, within E6039 to E 633535 and N3115 to N3132. It has significant economic, cultural and aesthetic, recreational, scientific, and protective and ecological values. Its rich biodiversity is one of its most evident values. In fact, it is the hometown of a freshwater fish species (Amur) and the habitat of thousands of seasonal migratory birds [1]. The recent drought periods have dropped the wetland's water level dramatically and a vast area of the land is subject to wind erosion, which has brought a sharp decline in fish population and consequently, has reduced acceptance of the migratory birds. These factors have lowered the quality of ecosystems and have threatened its capacity and ability to provide ecological, economic, and social functions. Regarding the importance and the specific and critical ecological conditions of the wetland, Hamoon Comprehensive Management Plan was codified to create a unified frame for planning and implementing of the national and provincial institutions within the catchment area. It also considered the principles of ecosystem management. This program consists of three managerial objectives: (1) Increasing awareness of the wetland values and enhancing community participation in its management (2) establishing sustainable management of water resources and agricultural land (3) Biodiversity conservation and sustainable use of the wetland resources. For each of these objectives, the main priorities and related measures are defined [1]. Regarding the point that resources available for the management of Hamoon wetland are limited just the same as any other similar ecosystem and since designing such a wide program of management requires a demand for intense competition in various fields, analysis of social tendency about managerial decision between multiple scenarios seems quite necessary. International experience shows that sustainability of natural resources such as wetlands and lakes primarily depends on the level of community participation in their management. Therefore, local communities should be involved in Hamoon wetland conservation and management [1]. In this research, the preferences and citizens' willingness to pay are evaluated, using the choice experiment, to improve the environmental characteristics of Hamoon wetland in Sistan. Undoubtedly, reflecting the obtained information and results will contribute to the formation of efficient and sustainable management policies accepted and supported by the public.

2. Materials and Methods

The choice experiment, a subset of the stated preference methods, is a multi-attitude selection and selection modeling. In a multi-attitude approach, it is believed that in order to understand a person's willingness to perform transactions and balances, it is possible to use environmental attitudes and features characteristics of products. CE can be considered as a multi- option version of the conditional valuation in which goods and services are described by the attitudes of these attributes and levels. In this method, there are several selection series. Each of them has two or more options. These choices are presented to the respondents and they are asked to select their preferred option. A number of attributes or characteristics of goods describe each choice and these attributes can have different levels by themselves. One of these attributes in most cases is price in which a basis that is consistent with the status quo can be observed [33]. Like contingent valuation, the choice experiment is able to

estimate the total economic value of environmental goods and services. CE has greater flexibility in estimating the value of environmental services than CV and in comparison with CV, it provides more information with a much smaller sample size. Moreover, some common CV biases such as Strategic bias, Positive response bias, and Effects of surrounding are removed [9]. The choice experiment is founded based on Lancaster value features' theory [22] and Random utility theory (RUT) [26, 29]. Lancaster believes that desirability of a product can be analyzed into desirability resulted from the features of the product. Random utility models are Econometric models of discrete choice in which it is assumed where all respondents have accurate and thorough understanding whereas the analyzer does not have enough information and inevitably, he will face the problem of uncertainty [28]. According to Random utility theory, the resulted desirability is composed of a selection, a particular component, and a disturbing component. So an indirect utility function *M* can be divided into two parts: (1) a certain element (agent) which is selected as a linear function from the attributes (X_i) of J^{th} choice in the selection series, and (2) a random element (e)which shows imperceptible impacts on individual choices [15, 27, 29].

$$Uij=V(Xij)+eij \quad (1)$$

In the probability function that covers the selected options, it is assumed that consumer aims to maximize utility. In order to obtain an explicit expression for the above-mentioned probability, it is necessary to specify the distribution type of disrupting components e_{ij}. A common assumption is disturbing elements are directly and equally distributed and matched with a first type littoral distribution; the probability of choosing the item j can be shown as logistic distribution. The current model is known as Conditional logit model (CLM) [27, 15, 29].

$$\boldsymbol{p_{ij}} = \frac{\boldsymbol{exp\{h_{ij}\}}}{\boldsymbol{exp\{h_{ik}\}}} \quad (2)$$

$$h_{ij} = ASC+ \beta\ 1X1+ \beta\ 2X2+\cdots+ \beta\ nXn \quad (3)$$

In this equation X_i(i=1,2, ..., n),the attitudes and ASC (alternative specified attribute), the effect of unobserved variables on the choice shows that if we choose managerial choices, it becomes 1 and if we select the status quo, it becomes 0. An important rule in application of this model is the assumption of independence of irrelevant alternatives (IIA) [3]. Based on this rule, the relative probability of the two options to each other does not depend on other Alternatives and it does not change by their removing or adding. This assumption was measured with Haussmann's stipulates test. Haussmann and McFadden (1984) believe that if a subset of the selection set is unrelated, its removal from the model will not change the estimated parameters. If we do not consider these selections, the results will be inefficient but consistent. In cases where the assumption is not accepted, the results will be biased and it is necessary to use models that are more complex. Mixed logit model1 is a general model which includes the standard conditional logit. Moreover, it allows the parameter estimates be various for different people. There is also no obligation to comply the assumption IIA [15]. The Mixed logit model allows us to model people's taste changes, but it is required to consider the probability distribution for the number of coefficients. Given that each person, i, has his own parameter vector which is different from the population mean: $\boldsymbol{\beta_I = \beta+\eta I}$ the desirability of each option will be: [18 and 35]

$$UIJ=V(XJ(\beta+\eta I))+ej \quad (4)$$

Where vector coefficients B_i with a certain density $f(B)$ of population is different and independent of the density, e. If Bi is observed, the probability of the selection will be simply a standard logit. Since B_i is unclear, the integral of standard logit probability is obtained for all probable values Bi, so the logit probability of the random parameters is (18 and 35):

$$P_{ni} = \int \left(\frac{e^{\beta' x_{ni}}}{\sum_j e^{\beta' x_{nj}}} \right) f(\beta)\, d\beta \quad (5)$$

Introducing the parameters as random variables in this method requires simulated maximum likelihood estimation method [36]. The coefficients obtained for the attitudes are used to estimate the respondents' parity and exchange between attitudes. In interaction with other attitudes, price evaluates respondents' willingness to pay in accordance with the following equation and copes with various levels of gain or loss. This is also called implicit price [19]:

$$WTP = \alpha + \beta X + \nu \quad (6)$$

where i WTP is the willingness to pay of individual i, α is some constant, Xi is a vector of demographic variables, and i ν is a normally distributed random term with a mean of zero and a variance = σ2 (i.e. i ν ~ N(0, σ2)).

The first step in designing the choice experiment is to set the attributes and their associated levels for the desired item. In this study, the evaluated item is the management scenarios of Hamoon wetland. In this regard, the required attitudes were chosen by studying the available literature, making interviews with target groups, and taking consultations from the environmental experts of Sistan and Baluchistan province. These attributes are also consistent with the second and third aims of Hamoon wetland comprehensive management plan. So, the environmental attitudes of water level (water quantity), the amount of straw available in the water, the number of ducks and Amur fish in the wetland. For each attitude, three levels are allocated in which the first level shows current conditions and the other two levels represent the future potential terms in case of implementation of managerial plans. Experts have classified the height of water level of the wetland into three levels of long-term balance (1276 m), ecological balance (12741) and minimum level (1271 m).

The level of long-term balance shows an optimum quantity of water. In the ecological balance, minimum water

requirement of the wetland for stable performance is provided and in the minimum level, the amount of water in the wetland is insufficient and critical. Ideally, the amount of straw in the water in desired, average and critical states (Table 1)show that the most appropriate level for the survival of animal species, especially Amur, is amounts more that 300 g/L and in straw volume with less than 220 g/L, survival for these living organisms is difficult. Classification of available ducks and Amur fish in the wetland was performed based on a 25-year (long- term), 5- year (short- term) aims at a comprehensive management plan of Hamoon Wetland [1]. In spite of its environmental features, a price provides the possibility of WTP estimation, which is present in the selection series. In order to determine the levels of price, a previous study was used which was performed on Hamoon wetland using Contingent Valuation Method [4]. Table 1 shows the attitudes, levels, and related interpretations. Although there are five 3-level attitudes and the Full factorial, design is used (L AC), all possible states are used for improvement alternatives of 55149 combinations [25]. It is quite clear that doing such a test among all these combinations for the respondents is difficult, Partial factorial design with SAS 9.2 [21] was used for finding 36 alternatives and finally, 18 selection series were chosen. Allocating attitudes between the alternatives is like general models and their levels were determined using the coding system of standard deviation comparison2. Then, the created selection series in this research were inserted in six trio blocks. Each selection series includes two improvement scenarios of the environmental condition and a status quo option.

The gathered data were codified with the method of coding the effects. The advantage of this method is that it shows the uncorrelated estimates of intercept component in the model [25]. In codifying the effects, at least one surface of each attribute is not defined as a variable. Since the removed level is often a surface that has the most negative effect on the environment, this critical state of the attitudes is considered as the removed surface. Figure 1 shows a sample of the selection series.

The statistical population in this study consists of local families of Sistan (13,761 families) who were sampled randomly. Using Cochran formula, 170 sample families were chosen. Tools for data collection and designing the questionnaires were interviews with these families and the results were evaluated with Regression models using STATA software 11.

3. Results and Discussion

According to the available statistics (Table 2), the average years of residence of the respondents in Sistan was 18.25 years of which %76 had visited Hamoon wetland more than 3 times. The average household size was 4.9 people, average monthly household income was 5,655,000 Rials, and the number of years of education was 13 years. Assessment of environmental trends used a series of statements such as interest rate of reading environmental publications, watching videos and programs related to the environment, wishing to visit the natural aqua scenery, and choosing eco-friendly products while purchasing. The respondents were asked to express their interest rate for the above- mentioned topics in Likert's five scopes. During data extraction, five codes were used, 0 as the least and 4 as the most favorite. The population's environmental trends were determined by using the mean and standard deviation showing that % 16, %46, %20.8, %16.8 of people had strongly negative, negative, positive and strongly positive tendencies.

Table 1. Evaluated Attitudes and Levels in Hamoon Wetland

Attitude	Height of water balance level	Amount of straw available in water	Duck	Amur fish	Price
Levels	Critical (1271m)	Critical (straw less than 220 g/L)	Critical (less than 1000 pairs)	Critical (less than 11 fish/ L)	75000 Rials
	Average (1274.1 m)	Average (220-30 g/L)	Average (1000 pairs)	Average (11 fish/ L)	150000 Rials
	Optimum (more than 1276m)	Optimum (more than 300 g/L)	Optimum (4000 pairs)	Optimum (40 fish/ L)	300000 Rials

Source: Hamoon Comprehensive Management Plan and opinions of Environmental Protection Administration experts in Sistan and Baluchistan

Sample question	Item 1	Item 2	Item 3
Water level of the lake	optimum	average	I disagree with any change in Hamoon current situation and I am not willing to pay any money.
Amount of straw in water	average	critical	
Duck	optimum	average	
Amur fish	average	optimum	
Willing to pat (Tomans)	15000	7500	
Which item do you prefer?			

Figure 1. A Sample of Selection Series

The results, obtained from the opinions of 150 people were evaluated with the conditional logit model, are shown in the first column of Table 3.

Mark coefficients represent the impacts of these attitudes and features on the ideal selection probability of selecting the desired characteristics. Here, all attitude coefficients (except desirability level of Amur fish) have some expected marks. The environmental marks have a positive mark, so that improvement in the environmental quality shows that they can increase desirability by themselves. Based on the theory of economics, price has a negative mark. All characters are the determinants of compliance and the overall consistency of the model is measured by McFadden p2 (0.35) that copes with common standards [19 and 25]. In order to determine the validity of IIA hypothesis, Haussmann- McFadden test (1984) was used.

Table 2. Results of Descriptive Statistics of Respondents

Variable	Mean	Deviation	Max.	Min.	Description
Age	34.5	10.13	56	19	Respondent's age (year)
Education	13.2	2.23	20	9	Years of education
Stay	18.45	12.3	54	0.6	Years of living in sistan and Baluchistan
Family size	4.9	1.76	11	2	No. of family members
Environmental tendency	10.9	2.65	16	4	Using 4 attitudes and Lickert scope were scored as 0-4
Income	5557000	446700	400000	200000	Monthly income (Rials)
No. of visits	0.75	0.42	1	0	More than 3 visits= 1, otherwise, 0

Table 3. Results of Mixed and Conditional Logit Models

Variable	Conditional logit	Mixed logit	Mixed logit or mutual impacts		
	Coefficient rate	Coefficient rate	Standard deviation	Coefficient rate	Standard deviation
ASC	-0.32 (o.35)				
Balance level altitude (optimum)	0.36***(0.12)	0.76***(0.23)	0.69**(0.28)	0.78***(0.23)	0.78***(0.26)
Balance level altitude (average)	0.94***(0.1)	0.71***(0.15)	0.57**(0.25)	0.65***(0.13)	0.38(0.29)
Water quality (optimum)	0.35***(0.12)	0.63***(0.21)	0.45**(0.22)	0.65***(0.20)	0.21*(0.35)
Water quality (average)	0.20**(0.1)	0.05(0.16)	-0.032(0.27)	0.05(0.15)	-0.034(0.25)
Duck(optimum)	0.05(0.10)	0.42**(0.19)	0.64***(0.23)	0.45**(0.18)	-0.6(0.23)
Duck (average)	0.23***(0.08)	0.051(0.13)	0.18(0.25)	0.022(0.12)	-0.1(0.3)
Amur fish(optimum)	-0.28**(0.12)	0.30*(0.20)	0.3*(0.25)	0.32**(0.20)	0.41*(0.24)
Amur fish(average)	0.52***(0.1)	0.24(0.13)	0.35**(0.17)	0.016(0.12)	0.30*(0.20)
Price	-0.0003***(0.00005)	-0.0003***(0.00001)			
Age* price				0.0000031***(0.0000012)	
Gender* price				0.0000092***(0.000023)	
Education * price				0.0000065*(0.0000035)	
Number of visits * price				0.000037**(0.000019)	
Likelihood logarithm	-513	-376		-365	
Likelihood ratio	167***	16.7**		13.05**	
P2	0.35				
Sample volume	490	490		490	

Figures inside the parentheses show standard errors. *, ** and *** respectively represent meaningfulness in levels of %1, %5, and %10.

Table 4. Results of Calculating Willingness for Final Payment (Unit: Rials)

Level features	Balance level altitude		Water quality		Duck		Amur fish	
	optimum	average	optimum	average	optimum	average	optimum	average
Willingness to pay	26000	22667	23000	2000	14667	767	11333	600

4. Results of Mixed Logit Model

In this model, all attitudes with a normal distribution, except price, were considered based on resources [32, 35]. The results are shown in the second column of Table 3. It shows that there is no conprehensive preference in average levels of attitudes such as water quality, ducks, and Amur fish. Signs of the coefficients supply theoretical expectations, and quite reasonably increase higher levels of attitudes and the possibility of selecting the managerial scenarios. The negative sign of price means that items with higher bids reduce people's utility and compared with other options, it has lower selection probability. Statistical significance of the calculated standard deviations for high levels of qualitative and quantitative features of water, number of ducks and both feature levels of Amur show their unequal preferences. They also focus on the possibility of reverse preferences for these attitudes, i.e., some respondents with lower levels of these attitudes have more utility, whereas they are not enough to overcome the views and preferences of majority of the samples; therefore, the estimated standard deviations are not so high to change the overall marks of the coefficients. Ultimately, it is worth to note that the samples preferred high levels of these environmental attitudes, whereas the mixed logit model considers the unobserved inconsistency of the preferences and it cannot recognize those who are not affected any political changes. In other words, this inconsistency is unclear [11]. In order to get a general view of the reasons and resources of these inconsistencies and determining social, economic, and population attitudes that may underlie these inconsistencies , the mixed logit model is evaluated considering these variables.

5. Results of Mixed Logit Model with Mutual Effects

To estimate the mixed logit model with mutual effects, numerous states of available multiplication relations among personality attitudes and specific attitudes of the alternatives were tested. Finally, those variables such as age, gender, education, and total number of visitors multiplied by price have significant impact. The results of this model are shown in column 3, Table 2. They show that females (like the previous studies [12 & 39]), people with higher education (like the previous studies [7, 13, 8, 10]) and older people (like the previous studies [31, 39]) and those who had visited the wetland more than 3 times (like the previous studies [8, 10]) selected the wetland managerial scenarios with higher prices.

6. Calculation of Tendency toward Final Payments

The rates of coefficients have a direct interpretation ability to determine meaningful levels. In order to make it more practical, the final price is calculated as an alternative for environmental attitudes and price fluctuation (Eq. 6). These ratios represent the tendency to final; payment for changes in the above- mentioned attitudes. Given the normal distribution of attitudes and stability of price variable, the tendency for final payment will possess normal distribution. Table 4 represents the resulted obtained from final payments for different levels of environmental attitudes in accordance with the mixed logit model and mutual effects. As it can be seen in the table, changing the current critical state of the wetland and its balance surface height to normal state requires the respondents to pay 26000 Rials/ family annually and be willing to pay 22670 Rials to reach to an average level. In addition, in order to elevate the water quality in spite of little straw into normal state (straw rate of more than 300mg/ L) and the average level, the estimated amount is 23000 and 2000 Rials per year. Tendency to pay among these citizens for improving the current state of ducks to optimum and average levels is 14670 and 770 Rials per year. To increase the reservoirs of Amur fish and move from the current state into the optimum and average levels, the respondents were willing to pay 11330 and 600 Rials per year. It can be inferred from Table 4 that the obtained results for tendency to pay is in accordance with the preference theory in which the attitudes which have improved more have higher tendency to pay.

7. Results and Recommendations

Hamoon wetland is selected as one of the sample sites for implementing protection plan for Iran wetlands with assistance of the development program of the UN (UNDP/ GEF). This plan attempts to reduce the major current threats of this protected wetland by using ecosystem management and implementing a comprehensive managerial program. This article estimates the financial benefits of Hamoon managerial scenarios and tries to enrich the available literature. As far as the choice experiment enforces people to make a balance among these attitudes, they have to choose the most important ecological attitudes. The results obtained from the mixed logit model with mutual impacts not only inform the related managers, but they also represent the public's support from the ecosystem management plan. These findings show several positive and significant benefits of Hamoon environmental attitudes. As mentioned earlier, attitudes such as water quality (balance level height), water quality (rate of straw available in water), number of ducks, and reservoirs of Amur fish have the most and the least rates of willingness for payment. Likewise, they show the highest importance and preference i the managerial management among people of Sistan. So that based on people's preferences, the quality of water is the most important and effective factor in people's utility, so it needs further attention i managerial policy- making processes.

The quality of water and the number of ducks in Hamoon are the subsequent effective factors and the last place is given to Amur fish. Moreover, the results show that there is an

imbalance state in preferences derived from variables such as gender, age, education, and frequency of visits. Based on the obtained results, it can be concluded that willing to pay for various attitudes of Hamoon wetland mostly depicts the public's tendency to support the wetland and save it from the current critical situation. It shows that one of the best approaches for improvement of the environmental condition of the wetland is the public participation of the citizens. On the other hand, codifying a uniform basin program for allocating percentages of water to this wetland and optimizing water consumption- especially in agriculture section as a major factor may control the falling trend of the water balance level. Undoubtedly, the present paper is a pilot study that aims to provide more precise information about expenses and benefits gained from the environmental improvement in Uremia Lake, and it requires a more comprehensive study for analyzing the expense benefits.

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