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Abstract: The aim of this paper is to introduce the Contingent valuation Method (CVM) as an efficient method allowing to modify the utility level, of an economic agent to following the consumption of environmental goods. In the absence of the market for natural assets, the CVM allows us to create a hypothetical market to evaluate the economic value of those assets by purchase and sale transactions. However, this valuation can be constrained with the quality problem of the physical nature of those environmental assets. The theoretical framework had shown that a change in the utility function and consumer surplus on the one hand, price and profit of the monopoly on the other hand, is be needed to keep the measures of economic efficiency and social equity.
Key words: CVM, Environmental assets, utility function, willingness to pay (WTP)

1. Introduction

In the absence of markets allowing to providing a real measure of the economic value of environmental assets, hypothetical or simulated markets are used. The contingent valuation method (CVM) uses this approach (creation of hypothetical markets) where users could simulate buying and selling products and services linked to environemental assets. This method is based on consumer surveys. The theoretical basis of the CVM is based on the theory of economic utility and the welfare theory. It is asked to individuals to directly reveal their preferences in terms of WTP subsequently to different scenarios presented to them. Indeed, given its importance, the contingent valuation approach has been widely used in several areas such as ecotourism; forest management, health infrastructure, the finance ... etc.

Various studies conducted in developing countries on the economic evaluation of environmental assets well have concluded to the effectiveness of the CVM (Whittington, Laura and Mu 1991; Whittington et al 1990). Also, several government and international agencies use the information provided by these studies to base their decisions (as US Environmental Protection Agency, World Bank). In general, in all cases where the preference revelation of households is necessary to improve the management of an environmental asset, the CVM is supposed to be the most appropriate technique (Georgiou et al (1997)).

However, like any method of observation, the CVM suffers from some limits well recognized by theorists. First, the reliability of the CVM depends on the design and management of the investigation, which mean the intervention of subjective considerations. Second, this method suffers mostly of bias problems, which are commonly found in statistical surveys, such as sampling error; misspecification of the WTP scenario and the lack of explanatory variables ... etc (Freeman 1979). Nevertheless, despite all problems mentioned above, this method still valid to value an environmental asset. The previous researches showed that the CVM could be applied to estimate the willingness to pay to receive better service or to allow price changes without affecting the well-being of users. This method offers intensive informations and allows consumers to assess their utility functions.

It should be noted that the economic problem related to the concept of the environment is the existence of external effects so common. Recall that the externality exists when the activity of an economic agent affects the usefulness of other agents, without existence of transactions or compensation on the market. Indeed, the respect and protection of environmental resources is achieved when the community records a surplus in its well-being (for example an improvement in the quality of the environment, or damage assessment related to environmental degradation allowing the adoption of new economic policies aiming to reproduce the environmental resources). However, the major problem facing the environmental goods is the absence of a real market through which passes the environmental assets transactions. But we should note that the absence of market and price system does not mean that environmental assets have not no value. So it is necessary to try to measure even approximately all profits generated by these environmental assets.

Thus, it seems necessary to address the value of environmental assets through various valuation methods. In this perspective the economic theory has developed a range of assessment methods in consumer preferences which are used in the case of absence of markets (for example, the CVM which is able to measure all the values of environmental goods).

Thus, in this context is elaborates our paper which aims the valuation of environmental goods using the CVM by some changes in the utility function of consumers. To well respond to our problematic we will divide the article in five sections. The second one will analyses how the economic value of an environmental asset is determined. The third section shows how the CVM determines the WTP. The fourth section will analyze the change in the value of individual utilities following a change in the quality of environmental assets. The fifth and last section concludes the paper.

2. The economic value of an environmental asset

The economic valuation of an environmental good is deducted by the revelation of consumer preferences which are expressed, by the WTP. It is noted that the total economic value of an environmental asset has not been always viewed in the same manner by economists. For example, according to Turner, Pearce and Bateman (1994) the total economic value of

environmental good is defined as the sum of the value of real use plus the existence value plus the option value. Munasinghe (1992) proposed a more detailed decomposition, since he considers that the total economic value equals to the use value plus non-use value (where the use value= the direct use value + indirect use value + option and the non-use value = legacy + the existence value).

We note that the direct use value is that resulting from the use of the environment for production or consumption purposes. Option value, measures the satisfaction drawn by individuals when they know they can use an environmental asset, when they want (while deciding not to do so). For example, individuals can to enjoy from some satisfaction when they know the existence of woods forests although it isn't necessary that they use them effectively. Option value can be obtained by investigation and can be positive, negative or indeterminate, if it was assessed in the uncertain. Non-use values are expected to correspond to a non utilitarist view to the environment. According to Lescuyer (2000), those values measure the benefits which individuals can have, subsequently, to the availability of environmental goods without they will be intended to be used. Bequest value is linked to the desire of agents to transmit the environmental heritage for future generations. Existence values are based on moral or religious considerations encouraging to retain and protect, partially or totally, the ecosystem (as the protection of certain remarkable species).

Thus for good estimation these values it is necessary to proceed by the method of contingent valuation. However the MCV may present difficulties in its implementation which are linked to the frequency of the biases. Those biases can be related to the investigators, the questionnaire structure, the nature of environmental goods and the credibility of the hypothetical market. Thus we must limit sources of bias in order to ensure the reliability of data.

To value an environmental good we can resort to several methods. As illustration we can cite the open questions, the technique of card, the method of successive auction, the issue closed and double closed questions. The use of closed question in the first place and the question open in a second-time allows respondents to understand the hypothetical market and to reveal more honestly their WTP.

2.1. Assessment preferences of individuals from a hypothetical scenario

The CVM consists to directly question individuals, from a survey. The goal is to know, from an appropriate questionnaire, the amount that individuals are meadows to pay, ex-ante, for consumption, improvement or protection of environmental goods. In this case individuals are placed in a hypothetical situation and the responses are considered as intentions. This occurs in the form of a transaction on a hypothetical market between an individual and a decision maker (generally public).

In the practical case we construct a scenario that describes all the information necessary for the individuals which allowing them to report effective and just responses. Also the environmental asset, should be accurately describes (quantity, quality, the measures to increase its quantity or improve its quality). Thus, to make the transaction, we should inform individuals surveyed how the amount to pay will be charged (mandatory levy or right of access). The work of Tversky and Kahmenan (1981) shows that individual responses can be changed depending on the scenario structure or the form of the questionnaire itself.

2.2. Evaluation methodology and preference analysis

As mentioned above the absence of prices does not allow identifying priorities for improvement of the environment together to the risks generated by resource wastage. Thus, the decision maker faces a dualism in which a trade-off must be made: first the importance of environmental goods for the community and secondly the risk of wastage due to the absence of price mechanism allowing an optimal allocation of resources.

To overcome this problem and in the absence of market several methods have been proposed to estimate the economic value of an environmental asset. In practice two methods were used: the first is that related to hypothetical situations and the second is the method of preferences. The CVM belongs to this latter logic based on the economic well-being where individuals' preferences constitute the basis of the assessment.

To determine the optimal value of the environmental goods (often considered as public) economic theory has proposed a number of models based on the individual utilities. For this reason, two methods are used. The indirect method is based on the observed actions of individuals while the direct method is based on individual declarations .In other terms, the indirect method consists to reveal the individual utilities from to their observed behavior, whereas the direct method consists to interview's them using the technic of questionnaire (usually when the individual actions are difficult to observe). Among all the works who have tried to assess environmental assets we can refer to the work of Bonnieux et al (1995) who has evaluated a WTP of consumers for the improvement the water quality in "Rade de Brest", by the estimation of its value of use. Furthermore, Letheux Anne Stenger (1997) determined a WTP to preserve groundwater quality by estimating the values of use and non-use of this environmental asset. Freeman (1979) has shown that non-use values represent 60% to 80% of the economic value of an environmental good.

3. Contingent valuation and determination of WTP

To evaluate the WTP for improvement or preservation of environmental assets, it is necessary to identify their determinants. For this reason, series econometric regressions were used. Therefore, in the case of open questions the revelation of WTP generally leads to zero or to the consumer refusal to reveal their level of WTP.
In addition, some respondents stated a zero level of WTP because their utility level remains constant, regardless of, change in their state of environmental assets use. However; even if the quality and availability of the resource can be increased, the WTP still poses some problems which are justified in most of the time by the consumer income insufficiency to support such a payment. Indeed, the observed zero values are considered as true zeros by against the answers of respondents who reported a null WTP are considered false zeros. In these cases their WTP does not actually correspond to the true value for a proposed contingent valuation. To overcome these difficulties, several methods are used to make a reliable estimate of the WTP. Terra (2005) has shown that if the proportion of true zero is low (10% threshold), the proposed model is that of Heckman (1976) if not the Tobit model should be used.

3.1. Determination of the value of environmental products from WTP

Economic theory shows that it is possible to give monetary values to environmental goods for which are not valued by market mechanisms. To assess environmental goods, Stephane Luchini (2002) presented a formal framework in which he highlights the essential principles of economic analysis. He considered (n) commodity and (l) environmental goods considered as public. The principle is to identify the value of individual satisfaction which depends on their

consumption of commodities and of environmental goods. $U(X_i, Z)$

Where;

X_i : Vector of *n* commodities.

Z : Vector of *l* environmental products

It is assumed that the consumer maximizes his utility as follows:

$\text{Max } U(X_i, Z)$

U/C $PX_i = Y_i$

Where; P is a vector of prices and Y_i the income vector of individual *i*.

The individual optimization program leads to define the classic demand functions as follows:

$X_i^k = h_i^k(P, Z, Y_i) \qquad k: 1.....K$

where; *k* indicates the k-th commodity.

On the basis of the demand functions, indirect utility function of a representative individual *i* is defined by:

$V_i(P, Z, Y_i) = U_i[h_i(P, Z, Y_i), Z]$

In the practical case we construct a scenario that describes all the information necessary for the individuals allowing them to report effective and just responses. Also the environmental good must, be accurately describes (quantity, quality, measures to increase its quantity or improve its quality). Also, to make the transaction, we should inform individuals surveyed how the amount to pay will be charged (mandatory levy or right of access). The work of Tversky and Kahmenan (1981) show that individual responses can be changed depending on the scenario structure or the form of the questionnaire itself.

Recall that environmental goods are offered, in general, outside market. Therefore, the absence of prices can generate some problems, as the no improvement of the environment and the risk linked to waste of resources. Thus, the decision maker faces a dualism in which a trade-off must be made: first the importance of environmental assets for the community and secondly the waste of resources that may be due to the absence of price mechanism which allows, in general, an optimal allocation of resources.

If it is assumed that Z^0 is the initial vector environmental goods and Z^1 is a vector for which there has been an increase at least in one of its elements ($Z^1 > Z^0$)

Thus we will have:

$U_i^1 = V_i(P, Z^1, Y_i) > U_i^0 = V_i(P, Z^0, Y_i)$

Therefore, the measurement of the compensating variation of the modification of well- being is defined by:

$V_i(P, Z^1, Y_i - WTP_i) = V_i(P_i, Z^0, Y) = U_i^0$

This compensating variation is the amount of WTP collected from the individuals after change in the vector of environmental products (from the state Z^0 to Z^1). The WTP is considered as a reduction of individuals incomes, after the evolution of the quantity or the improvement of quality of environmental goods. The benefits associated with the evolution of environmental components are obtained by the sum of WTP.

3.2. Econometric formalization of WTP

The econometric analysis aims to estimate a WTP model taking into account the explanatory variables from the questionnaire. In the case of an open question, the econometric specification is a model whose dependent variable is the WTP. In the case of the technical of referendum, the econometric specification obtained is a binary choice model (Hanemam 1984, Fadden and Leonard 1993). Thus, the dependent variable (WTP) is said qualitative on two modalities (yes and no). The specific econometric model for the WTP must be compatible with the usual assumptions of economic theory. Fadden and Leonard (1993) proposed a model that proceeds to a transformation on the type of Box-Cox, of the variable to explain. Indeed, for an individual i, the model is written as follows:

$$G(WTP_i, Y_i, \alpha) = Z(X_i, \varepsilon_i, \gamma)$$

with:

WTP_i: the willingness to pay of individual i

Y_i: the level of its income

(α, γ): A parameter vector

ε_i : Term of error associated to individual i

In addition, the function G (.) is defined by:

$$G(WTP_i, Y_i, \alpha) = \begin{cases} WTP_i & \text{si } \alpha = 0 \\ \dfrac{Y_i^{1-\alpha} - (Y_i - WTP_i)^{1-\alpha}}{1-\alpha} & \text{si } \alpha \neq 0 \\ -\log(1 - WTP / Y_i) & si\ \alpha = 1 \end{cases}$$

The Box-Cox transformation of the dependent variable allows great flexibility in the relationship between income and WTP. Then, if $\alpha = 0$ the econometric model becomes a simple linear model and if the value of α is equal to 1we obtain a logarithmic model. Therefore, the parameter α is interpreted as the share of WTP relative to household income. The function $Z_i = Z(X_i, \varepsilon_i, \gamma)$ takes in consideration individual heterogeneity; based on the observable characteristics of individuals. Thus, in this case we simply deduct the WTP_i.

Indeed,

$$Z_i = Z(X_i, \varepsilon_i, \gamma) = G(WTP_i, Y_i, \alpha) = \frac{Y_i^{1-\alpha} - (Y_i - WTP_i)^{1-\alpha}}{1-\alpha}$$

$$\Rightarrow Y_i^{1-\alpha} - (Y_i - WTP_i)^{1-\alpha} = (1-\alpha) Z_i$$

$$\Rightarrow (Y_i - WTP_i)^{1-\alpha} = Y_i^{1-\alpha} - (1-\alpha) Z_i$$

$$\Rightarrow Y_i - WTP_i = \left[Y_i^{1-\alpha} - (1-\alpha) Z_i \right]^{\frac{1}{1-\alpha}}$$

$$\Rightarrow WTP_i = Y_i - \left[Y_i^{1-\alpha} - (1-\alpha) Z_i \right]^{\frac{1}{1-\alpha}}$$

In addition, if the WTP of individual (*i*) is positive, then the WTP_i has density:

$$f_{WTP_i}(WTP_i, Y_i, \alpha, \gamma) = \frac{f_Z(G(WTP_i, Y_i, \alpha), \gamma)}{(Y_i - WTP_i)^{\alpha}}$$

This density is used to estimate the WTP model by the method of maximum likelihood, by making assumptions about the law of error term based on this density. In the case of a continuous discrete choice question, the distribution of WTP is treated from a censored model at the right. Thus, if an individual i declare a zero level of WTP then its distribution function

will be $F_Z(G(M,Y_i,\alpha),\gamma)$; and if he accepts to pay the amount M its distribution function is $1-F_Z(G(M,Y_i,\alpha),\gamma)$.

3.3. Measure of the surplus change

As the environment has no price, the WTP and surplus are confused, ie that the measure of the surplus returns to measure the WTP. In the case of an improvement; the surplus measures the maximum amount an individual is near to pay. However, in case of deterioration, surplus measures the minimum amount that an individual will accept to pay. For consumers, the WTP is represented by the market price and the surplus they can have. For a producer WTP is equal to the market price (cost of production) plus the surplus he can have.

Consequently, the economic assessment is based on the principle of measuring the change in consumer and producer surplus. Indeed the surplus is the amount of welfare lost by the agent in the event of loss of environmental assets. However, when the environmental asset is conserved the surplus is maintained at its initial level. So, when an individual is asked to raise its WTP to protect or improve an environmental product; its response is considered as surplus variation.

According Mishan (1988), the normative economic theory states that the maximum amount an individual is near to pay for a property, is equivalent to the benefit and to satisfaction that he hopes to have from it. In this regard, if an environmental asset became available, the benefits associated to it are the sum of the willingness to pay of all the agents concerned by the supply of that asset.

The price that individuals accept to pay is an indicator of the value of perceived benefits and satisfactions. Therefore, if the price matches the production costs, there is no real gain to society, but only a resource transfers from consumers to producers. In contrast, there is a real gain if consumers are willing to pay a higher amount relatively to market price. The revealed amount constitutes the compensatory surplus. To describe this surplus, Mitchell and Carson 1989 have used the following equation:

Surplus offset = $(e(p_0q_0u_0)=y_0)-(e(p_0q_1u_0)=y_1)=y_0-y_1$

Where ;

e : The expenditure function

p : The price of the public product

q : The quantity of product

u : Utility level

y :The minimum amount of income needed to maintain the level of utility.

3.4. The mean WTP

As cited above, the MEC is an estimation technique of the value of an environmental good or service, through an investigation in which individuals are requested to reveal their WTP for a given change, in the provision of an environmental good. The maximum value of WTP for this changes (improvement of the environment); reflects the level and degree of attachment of the individual to such a change. To calculate the WTP mean, Vincont Millot (2007) assumed that the choice is dichotomous: the individual reaches the utility level U_1 if he accepts a given offer and pays a given amount while he reaches the utility level U_0 if he refuses the offer. Indeed,

$U_1(1, r-t, s) = V(1, r-t, s) + \varepsilon_1 = a_1 + b(r-t) + \varepsilon_1$

And,

$U_0(0, r, s) = V(0, r, s) + \varepsilon_0 = a_0 + br + \varepsilon_0$

with;

1: If the individual accepts the offer

0: if the individual refuses the offer

r: the individual income

s: the level of subsidization

t: the amount to pay

Suppose;

$\Delta U = U_1(1, r-t, s) - U_0(0, r, s)$

$= (a_1 - a_0) - bt + (\varepsilon_1 - \varepsilon_0)$

$= \beta_0 + \beta_1 t + \varepsilon$

With; $\beta_0 = a_1 - a_0$

$\beta_1 = -b$

$\varepsilon = \varepsilon_1 - \varepsilon_0$

To calculate the WTP we equalize ΔU to zero. To determine the amount ultimately payable, we will have then $t = \dfrac{-\beta_0 - \varepsilon}{\beta_1}$

Thus, the mean WTP is given by:

$E(t) = \dfrac{-\beta_0}{\beta_1}$ since $E(\varepsilon) = 0$

4. Change in the utility function of an environmental product

4.1. Jean Tirole Model

The realization of a social pricing of environmental assets requires a change in the utility function of consumers. In this context, Jean Tirole (1988) assumed that consumers have the following preferences;

$U = \theta_i V(q) - T$ if the consumers consume *q* and pay *T* (linear tariff)

$U = 0$ if not

with:

V(.) is concave function, similar for all consumers and verifies the following conditions: $V(0)=0$; $V'(q)>0$; and $V''(q)<0$

θ_i: is a parameter of taste that varied from one consumer to another.

In our analysis we assume that there are two types of consumers. Those having taste parameter θ_1 represent the proportion λ while those who having taste parameter θ_2 represent the proportion $1-\lambda$ (with $\theta_1 < \theta_2$)

We also assume that the marginal cost (c) of the monopoly is constant.

For mathematical development, Tirole assumes that; $V(q) = \frac{1-(1-q)^2}{2}$ (which satisfies the above properties). The consumer will maximize:

$\theta_i V(q) - T = \theta_i V(q) - pq$

The first order condition gives:

$\theta_i V'(q) = p$

⇨ $q = 1 - \frac{p}{\theta_i} = D_i(p)$

The consumer surplus will be:

$S_i(p) = \int_0^{D_i(p)} p(q)dq - D_i(p)\,p$

$= \frac{(\theta i - p)^2}{2\theta_i}$

The price of monopoly is to maximize its profit (Pc) D(P), with D(P) is defined by the aggregate demand:

$D(P) = \lambda D_1(P) + (1-\lambda) D_2(P)$

$= \lambda (1 - \frac{p}{\theta_1}) + ((1-\lambda)(1 - \frac{p}{\theta_2})$

$= 1 - P(\frac{\lambda}{\theta_1} + \frac{(1-\lambda)}{\theta_2}) = 1 - \frac{p}{\theta}$

Then the monopoly program returns to:

Max $\pi = (P - c)\,D(P) = (P - c)(1 - \frac{p}{\theta})$

The first order condition gives us;

$\frac{\partial \pi}{\partial p} = 0 \Rightarrow (1 - \frac{p}{\theta}) - \frac{1}{\theta}(P - c) = 0$

$\Rightarrow \quad p^m = \frac{\theta + c}{2}$ (monopoly price)

thus, the profit of the monopoly is given as follows;

$\pi^m = (p^m - c)(1 - \frac{p^m}{\theta})$

$= \frac{(\theta - c)^2}{4\theta}$

4.2. Expansion in the utility function

Until now all models proposed, suggest that the rate *T* is linear. This specification is not, often, able to describe the reality because many goods are characterized by heterogeneity in their physical natures; causing differentiation in consumer behavior due to their consumption of such goods. If we assume that the environmental asset is perceived differently by consumers (the existence of several types of their physical quality). In this situation and for social equity reasons, the price cannot be linear. In this case consumer preferences become:

$U = \theta_i V(q) - T$ *if* $T = (P + \alpha t)q$

$U = 0$ if not

Where; t is a tax on the nature of the quality of a product and α is a coefficient proportional to the parameter of taste in this situation:

$U = \theta_i V(q) - (P + \alpha t)q$

The first order condition gives us;

$\theta_i V'(q) = P + \alpha t$

⇨ $q = 1 - \frac{P + \alpha t}{\theta_i} = D_i(p)$

In this case, the consumer surplus is:

$S_i(P) = \int_0^{D_i(P)} P(q)dq - Di(P)(P + \alpha t)$

⇨ Si(P)= $\frac{(\theta_i - P - 2\alpha t)^2 - (\alpha t)^2}{2\theta_i}$

And the program of monopoly becomes:
Max $\pi^m = (P + \alpha t - c)D(P)$
Where

$$D(P) = 1 - \frac{(p + \alpha t)}{\theta}$$

Max $\pi \Rightarrow (P + \alpha t - c)(1 - ((p + \alpha t))/\theta)$; thus we deduce the monopoly price :

$\Longrightarrow P^m = (\frac{\theta + c}{2}) - \alpha t;$ which give us the monopoly profit

$\pi^m = \frac{(\theta - c - 2\alpha t)^2}{4\theta}$ (Monopoly profit)

Discussion and implications:

- If the consumer has a bad taste he should pay T=(p–t)*q (the consumer recovers the tax, ie α= –1).

Indeed, the new surplus $S_i(P) = \frac{(\theta i - p + t)(\theta i - p + 3t)}{2\theta i} > \frac{(\theta i - p)^2}{2\theta i}$ (Jean Tirole model)

and,

the new profit $\pi^m = \frac{(\theta - c + 2t)^2}{4\theta} > \frac{(\theta - c)^2}{4\theta}$ (Jean Tirole model). In this case it is evident that an improvement in the social well-being will be done (W=S+ π)

- If the consumer has a good taste he should pay T=(p+t)*q (the consumer support and pay the tax and ie α= +1)

The new surplus $S_i(P) = \frac{(\theta i - p - 2t)^2 - t^2}{2\theta i} < \frac{(\theta i - p)^2}{2\theta i}$ (Jean Tirole model)

The new profit $\pi^m = \frac{(\theta - c - 2t)^2}{4\theta} < \frac{(\theta - c)^2}{4\theta}$ (Jean Tirole model). Thus, in this case we observe a decrease in the social surplus. However, the pricing policy is part of solidarity, and social altruism. Indeed, a social assistance principle can be built by creating a social policy of crossover subsidy within consumer groups. Indeed, the integration of quality factor in the pricing model seems to be important since it allows providing some measure of social equity within consumers of an environmental asset. This is justified by the variations which have affected consumer surplus, the price and the profit of monopoly.

models	Surplus d'un consommateur	Prix de monopole	Profit de monopole
Jean Tirole model	$\frac{(\theta i - p)^2}{2\theta i}$	$\frac{(\theta + c)}{2}$	$\frac{(\theta - c)^2}{4\theta}$
Extension	$\frac{(\theta i - p - 2\alpha t)^2 - (\alpha t)^2}{2\theta i}$	$P^m = (\frac{\theta + c}{2}) - \alpha t$	$\pi^m = \frac{(\theta - c - 2\alpha t)^2}{4\theta}$

5. Conclusion

The objective of the environmental assessment method is the ease of public decision making. This is through the estimation of the benefits from the implementation of environmental projects (Carson 2000), or by an increase in social welfare. And the CVM has the ability to estimate the economic value of a product or an environmental project for which there is no price market.

In addition, the valuation of environmental products intended to ensure the sustainability of its property and followed an ecosystem. In other words this valuation must keep the objectives of economic efficiency and social equity in the consumption of its environmental assets. Indeed, the environmental quality of a property shall be included in the utility function of consumers as the physical quality of environmental products is unevenly distributed among households. Examples include the consumption of drinking water, and in this area a quality problem in the quantities offered was made. Finally the integration of the concept of quality in the utility function in a proportional tax has therefore change the consumer surplus and the price and profit of the monopoly.

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