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A model for evaluating recreation benefits with reference dependent preference

Tadahiro Okuyama[1*] and Yasuhisa Hayashiyama[2]

[1]Department of Regional Policy, Faculty of Economics, University of Nagasaki, 123 Kawashimo-cho, Sasebo-Shi, Nagasaki, 858-8580; Japan.
[2]Faculty of Economics and Management, Tohoku University, 980-8576, Aoba-ku, Sendai, Miyagi, Japan.

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In environmental valuation studies, it is commonly assumed that a utility arises from an absolute amount of environmental quality. This criterion, called absolute evaluation, is used in methods including the travel cost method and the contingent valuation method. Studies in experimental economics, however, have indicated that an individual's criterion depends on reference dependent preference (RDP)—a relative evaluation—rather than absolute evaluation. This criterion is used mainly in analysis of biases such as framing effects or brand choice. The purpose of this paper is to construct a model for evaluating recreational benefit with RDP. The model focuses mainly on RDP for an environmental quality so as not to conflict with the axiom of choices, and the travel cost method is used as the model's basis. First, a structure of utility function is discussed and the benefit with RDP is defined and analyzed based on the relation between the level of RDP and the magnitude of the benefit. Second, the calculating formula of the benefit is derived by the integrating-back method and tests for consistency between the results of static analysis and the numerical example are performed.

Key words: Benefit analysis, environmental quality, reference dependent preference, travel cost method.

INTRODUCTION

In environmental economics, it is a common assumption that a utility arises from the amounts of consuming a good and of an environmental quality (Freeman III et al., 2014). For example of the environmental quality, nitrogen or sulfur dioxide is used as index of air quality; biochemical oxygen demand or phosphorus as water quality; area or a number of spices as forest or wetland qualities. Here, the weak complementarity assumption that the increment of an environmental quality leads to the increment of the amount of demand enables researchers to measure the positive or negative benefit of the environmental quality change (Mäler, 1974). Thus, most environmental valuation studies have employed this assumption for valuation methods (Bockstael and McConnell, 2007; Freeman III et al., 2014). The travel cost method (hereafter TCM) is representative of this

*Corresponding author. E-mail: okuyama@sun.ac.jp. Tel./Fax: +08-956-47-6121.

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tendency because it relies on the assumption that there is a closed relationship between the amount of the recreational demand and the level of recreation site's environmental quality (Shrestha et al., 2002; Herriges et al. 2004; Phaneuf and Siderelis, 2003; Whitehead et al., 2009).

However, some experimental studies in economics and psychology pointed out that an individual's decision making is influenced by reference dependent preference (RDP), which has three characteristics. First, a visitor's behavior is influenced by facts including the reference point constructed by that visitor's previous purchase, knowledge, or initial endowment of a good. Second, a visitor's utility (value) function may enter the negative dimension (this is called a loss). Therefore, a visitor's preference is non-transitive. Third, a visitor's utility function is convex in the negative dimension. This is called loss aversion.

The purposes of this paper are 1) to formulate a recreation behavior model with RDP for environmental quality and 2) to formulate an application model for benefit calculation. As for the base model, the travel cost method is employed.

This form of preference was presented in the prospect theory by Kahneman and Tversky (1979) and Tversky and Kahneman (1991). In environmental valuation studies, RDP is a plausible cause of biases such as a framing effect [i], a status quo bias [ii], and an endowment effect [iii]. These biases occur most often when a stated preference method (SPM) is used for valuing an environmental quality [iv].

As for the theoretical studies, Munro and Sugden (2003) improved the (prospect) theory of Tversky and Kahneman (1991) and added restrictions to the preference condition to express an exogenous reference point. Bowman et al. (1999) used a gain-loss function to express RDP and analyzed the effect when the reference point is endogenously determined. Kőszegi and Rabin (2006) analyzed the effect of the reference level of consumption under uncertainty in the case that the reference points are exogenously determined. In empirical studies, Bateman et al. (1997) tested the impact of reference dependent preference on the exchange of private goods by experimental methods, and Herne (1998) estimated the property of loss aversion. Peters (2012), Zeisberger et al. (2012), and Li and Ling (2015) did recent empirical or theoretical studies on the RDP. Barberis (2013) describes the review on the prospect theory. These studies assumed RDP for the goods, discussed the form (preference structure) of individuals' utility (value) function, and performed empirical tests by experimental methods.

Some empirical studies on the visitor behavior with RDP in markets have examined RDP on prices. The reference point of this RDP is called a reference price, and a visitor purchases an item as the result of comparing the prices of goods with the reference prices. A fundamental discussion on visitor behavior with RDP is offered by Winer (1986). It is called the reference price model (RPM) and is based on the assimilation contract theory (Sherif, 1963) and the adaptation level theory (Helson, 1964). A visitor gets a utility from the difference between the actual price and the reference price. A visitor's demand is also influenced by this difference. Winer (1986), Mayhew and Winer (1992), Lattin and Bucklin (1989), Greenleaf (1995), Ren et al. (2014) and Kumar (2014) conducted empirical studies and confirmed the reference price effect for purchasing a good.

Putler (1992) considered a visitor behavior theory for the RPM by using Kalman's (1968) utility function, which includes the prices of goods as a RDP variable (reference price) in its function. Putler (1992) considered the formulation of reference price effect in utility function and analyzed the substitution and income effect of reference price for the Marshallian and Hicksian demand functions. Putler's (1992) formulation of RPM has not been applied for bundles of goods. Thus, at least, it can be assumed that a visitor's preference satisfies the transitivity for the amount of goods.

Mayhew and Winer (1992, 62) explained the formulations of the internal and external reference prices; The internal reference price is the "prices stored in memory on the basis of perceptions of actual, fair, or other price concepts," thus, "people adapt to the level of past stimuli and judge new stimuli in comparison with the adaptation level." The external reference point is the one "provided by observed stimuli in the purchase environment." For example, "Point of purchase shelf tags that contain information about suggested retail price or the actual or unit price of another product against which a price can be compared."

The argument on the reference point of RPM relates to the discussion on RDP in experimental studies in the sense that the internal or external reference points are formed whether they are determined exogenously or endogenously. As the structures of a reference price in RPM, Bell and Bucklin (1999) assumed the (internal) reference price as a reference price from a visitor's previous purchase occasion; Emery (1970), Hardie et al. (1993), and Kalyanaram and Little (1994) assumed that the *present* reference point is the weighted average of the *past* prices of the item and/or the weighted average between the *past* price and the individual's *past* reference point.

The above arguments can be summarized as follows. The first is that although RDP has been confirmed in SPM or experimental studies, few have considered revealed preference methods (e.g., TCM) even if RDP is observed in RPM. The second is that although the reference price effect has been empirically indicated, few studies have considered the effect of RPD for the qualities of goods in a visitor's behavior [v]. In environmental valuation studies, because a main focus point is how changes in quality influence benefits, it is useful for another analysis to consider recreation behavior with RDP.

The main hypothesis of this study is that a reference point (similar to RDP) for an environmental quality exists and relates closely to recreation behavior. Let us imagine a visitor's decision making when he or she chooses between recreation sites A and B (e.g., river A and river B), and the sites have similar qualities as Q_a and Q_b. Traditional recreation model assuming a single trip states that if an individual prefers Q_a to Q_b, he or she will choose to go to site A; his or her utility is defined as $u(Q_a)$. However, visitors can often be heard complaining 1) "This place was not as good as the last one", or, 2) "I have already been to that place, so let's go to a different one." These situations mean that the visitor does not judge the quality of sites in absolute terms. It is possible to consider that there is a reference point in the visitor's preference structure, e.g., the first case would relate the case that utility arises from $u(Q_a - Q')$ where Q' is the quality of the previous site, and the second case would relate the case that utility arises from $u(Q_a, Q_b - Q')$, where Q_b is the previously visited site and $Q' = Q_b$.

The organization of this study is as follows. Firstly, a visitor behavior model with the RDP is considered and analysis focuses on the relationship between RDP and demand, followed by the analysis of the benefits of RDP defined following the concept of welfare measures, and static analyses for the relationship between RDP and benefit. These analyses focus on the relationship between the position of the RDP (gain or loss) and the magnitude of the benefit because it is a fundamental consideration similar to price or income in empirical welfare studies. Also, an estimation model is considered and the total value is derived by an integrating-back approach (Larson 1992, Eom and Larson 2006, and von Haefen 2007), and numerical examples are performed to confirm consistency of the estimation model with the static analysis. Finally, the results and the unresolved issues of this study are discussed.

MATERIALS AND METHODS

Utility maximization problem with reference dependent preference

Formulation of reference dependent preference on environmental quality

In this section, a visitor's recreation activity with RDP is considered by following the consumer behavior model formulated by Putler (1992). A Main difference is that RDP consists of price in Putler (1992)'s model but quality in this model. First, the formulations of RDP are considered. Let z be the amount of a composite good and x be the number of recreation activities for a recreation site. Respectively, the prices of these goods are p_z and p_x. Let Q be an environmental quality in a site in which a political project is assumed to be implemented. Finally, a reference point (exactly to say, reference quality) to be compared with Q be considered. In this study, let RQ be the reference quality, and the value gained from comparing Q and RQ is the relative value.

Putler (1992), who also modeled the reference price effect [vi], broke the visitor's judgment on RDP into three stages. In the first stage, the visitor judges the level of relative value by comparing Q and RQ. In the second stage, the visitor evaluates the level. This means that the visitor evaluates the degree of relative value before evaluating it as his or her utility. In the third stage, the evaluated relative value is reflected in the visitor's utility function.

As for the first stage, let $DR = (-\infty, +\infty)$ be the domain of relative values and RE be an element of DR. RE is a gain when $RE \in DR^+$, and this means that a visitor judges $RE = Q - RQ > 0$. RE is a loss when $RE \in DR^-$, and this means that a visitor judges $RE = Q - RQ < 0$. Finally, RE is zero when $RE = Q - RQ = 0$. Let "zero" be included in gains for the sake of simplicity. In formulations, the notation g means $RE \in DR^+$, the notation l means $RE \in DR^-$, and the notation 0 means $RE = 0$.

In this study, RQ is assumed to be endogenously determined. For example, RQ consists of the average of all (homogeneous) environmental qualities (e.g., quality indicators of a river) that the visitor already knows. Thus, $Q - RQ > 0$ means that the environmental quality (Q) is judged to be *relatively* better than the (aggregate) qualities which this visitor has experienced or knows about. Otherwise, $Q - RQ < 0$ means that the environmental quality (Q) is judged to be relatively worse than the visitor's experience or knowledge.

Equation (1) represents gain, equation (2) represents loss, and equation (3) represents a dummy function for gain and loss because the visitor cannot experience gain and loss at the same time.

$$g = I \cdot (Q - RQ) \quad if \quad Q - RQ \geq 0 \tag{1}$$

$$l = (1 - I) \cdot (Q - RQ) \quad if \quad Q - RQ < 0 \tag{2}$$

$$I = \begin{cases} 1 & Q \geq RQ \\ 0 & Q < RQ \end{cases} \tag{3}$$

For the second stage, the evaluation for gain and loss, let $E(\cdot)$ be an evaluation function. The evaluation functions for gain and loss are represented as equation (4).

$$E(g, l) = \begin{cases} E_g(g) & Q > RQ \\ 0 & Q = Q \\ E_l(l) & Q < RQ \end{cases} \tag{4}$$

$$E_g(g) > 0, \lim_{g \downarrow 0} E_g(g) = 0, E_l(l) < 0, \lim_{l \uparrow 0} E_l(l) = 0 \tag{5}$$

Equation (4) implies that the evaluation would be different for gain and loss. Equation (5) is the conditions on the limit in which case

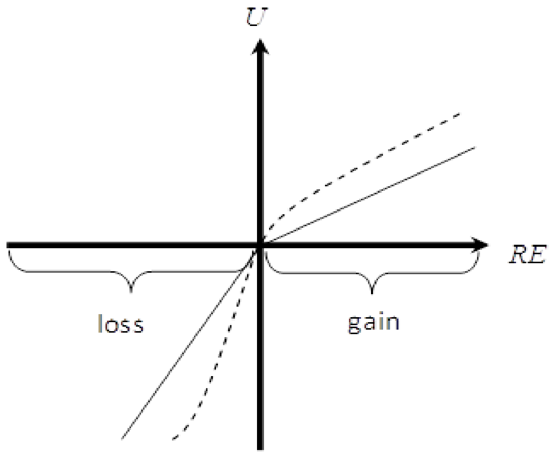

Figure 1. Example of the utility function with RDP.

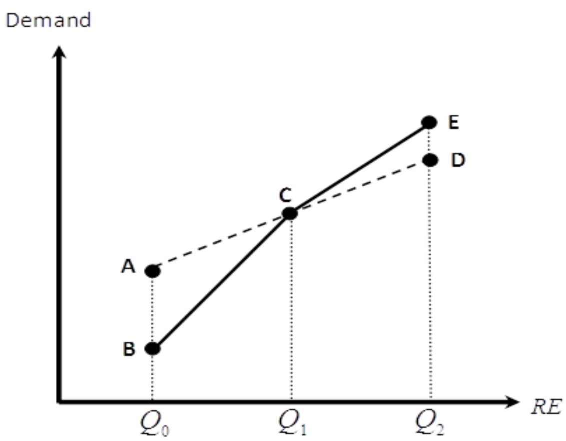

Figure 2. Recreation demand and reference dependent preference.

the utility function considered below becomes a traditional utility function that includes the absolute value of environmental quality only when the relative level is equal to zero [vii].

Here the recreation demand is x. So if a visitor uses the environmental quality x times, then he or she acquires the $x \cdot E(\cdot)$ amount of relative value. Let G be total gain and L be total loss defined as $G = x \cdot E_g(\cdot)$ and $L = x \cdot E_l(\cdot)$. Then, a visitor's utility function is defined as equation (6) [viii]. Equation (6) implies that a visitor has preferences based on both absolute evaluation (Q) and relative evaluation (G, L). Thus, the visitor's utility function becomes the traditional one from equation (5) when $G = L = 0$.

$$U \equiv u(z, x, Q, G, L) \tag{6}$$

Here, $\partial^n U / \partial \omega^n$ denotes the n-times differentiation for variable $\omega \in \{z, x, Q, G, L, RQ, g, l\}$. As for the first and second differentiations, the notations U_ω and $U_{\omega\omega}$ are also used for simplicity. The differentiated condition is a general one for z, x, Q, and G Twice differentiable; first differentiation is positive, and second one is negative or zero [ix] (i.e. $\partial U / \partial z \equiv U_z > 0$, $\partial^2 U / \partial z^2 \equiv U_{zz} \leq 0$). The notations of differentiations on other functions follow these notations.

The property of loss (l) is considered by following an example of utility function that has the property of loss aversion (Figure 1). The dotted line is the utility function (value function) illustrated in Tversky and Kahneman (1991) and the solid line is the simplified case of the dotted line for an empirical analysis (of demand function) discussed above. In Figure 1, the first derivatives for losses in both cases are the same as the gain ($U_l > 0$). The second derivative for losses is summarized as $u_{ll} \geq 0$ [x]. Finally, differential conditions of a reference quality from the utility function are that $\partial U / \partial RQ \big|_{RE \in DR^+} = -u_g < 0$ and $\partial^2 U / \partial RQ^2 \big|_{RE \in DR^+} = u_{gg} \leq 0$ for the area of gains, and $\partial U / \partial RQ \big|_{RE \in DR^-} = -u_l < 0$ and $\partial^2 U / \partial RQ^2 \big|_{RE \in DR^-} = u_{ll} \leq 0$ for the area of losses. Figure 1 also illustrates that the increase of RQ correlates with the decrease of RE.

Utility maximization problem

From equation (6), the utility maximization problem is defined as equation (7). The Marshallian demand function for recreation activity is derived as equation (8). Notice that the demand is zero if a visitor's utility is negative when RE is a loss. Thus, the utility is assumed not to be negative even in the case of loss and the demand is a positive value [xi].

$$\underset{z,x}{Max} \ u(z, x, Q, G, L) \ \ s.t. \ \ y = p_z z + p_x x \tag{7}$$

$$x^m = x^m(p_z, p_x, y, Q, g, l) \tag{8}$$

As for the Marshallian demand function, the weak complementarity defined below is assumed to hold for the environmental quality (Q), RE (even at gains and losses), and the recreation demand. From the complementarity, the Marshallian demand function increases when the environmental quality or RE increases. Otherwise the demand decreases when the reference quality increases.

To observe the difference between traditional demand functions and this model, Figure 2 illustrates a relation between the demand and the quality. Let the line from A to D be the line in which RDP is zero, namely, $Q - RQ = 0$ for all points on the line (this demand function is equivalent to the one from traditional economic theory since it is equivalent to assume $Q - RQ = 0$ with the absolute value of environmental quality only from equation (5)).

Next, let C be the point at which $Q_1 - RQ = 0$, and let B be the other point at which the quality is less than the point C ($Q_0 < Q_1 = RQ$). $Q_0 < RQ = 0$ implies that RE is at loss. Thus, the demand at point B is less than at point A because point A is the point at which RE is zero. Similarly, let E be the point at which the quality is greater than point C ($Q_1 < Q_2$). This implies that RE is at gain. Thus, the demand at E is greater than the one at point D because point D is the point at which RE is zero. As a result, the demand function with RDP is the line BCE. As for the case in which Q is fixed and RQ increases, the change of the demand is symmetrical to the case of Figure 2 because the increase of RQ implies RE decreases (goes to loss) from the definition. As a result, the first derivatives of the demand function for RE are $\partial x^m(\cdot)/\partial g > 0$ and $\partial x^m(\cdot)/\partial l > 0$, and the second derivatives $\partial^2 x^m(\cdot)/\partial g^2 \le 0$ and $\partial^2 x^m(\cdot)/\partial l^2 \ge 0$ are supposed (See Appendix A). So, the properties of RDP in the demand function are assumed to be equivalent to those of RDP in the utility function. In empirical studies, Winer (1986) and Putler (1992) employed the linear form and Suzuki et al. (2001) employed the logistic form to estimate demand functions. In addition, Suzuki et al. (2001) set $(\partial x^m(\cdot)/\partial g)/(\partial x^m(\cdot)/\partial l) < 1$ to test the loss aversion in the demand function [xii].

Finally, the indirect utility function is derived as $V = u\left(z^m(\cdot), x^m(\cdot), Q, g, l\right) \quad = v(p_z, p_x, y, Q, g, l)$ and the expenditure function is derived as $y = e(p_z, p_x, U, Q, g, l)$.

Utility minimization problem and the Slutsky equation

Utility minimization problem

By a similar process, the utility minimization problem is defined as equation (9) and the Hicksian demand function is derived as $x^h = x^h(p_z, p_x, U, Q, g, l)$ [xiii]. Equation (10) is assumed to hold for $x^m(\cdot)$, $x^h(\cdot)$, and $e(\cdot)$. Finally, Shephard's Lemma ($\partial y/\partial p_x = x^h(\cdot)$) is assumed to hold.

$$\underset{z,x}{Min}\; p_z z + p_x x \;\; s.t.\; \bar{U} = u(z, x, Q, g, l) \tag{9}$$

$$x^h = x^m\left(p_z, p_x, Q, g, l, e(\cdot)\right) \tag{10}$$

Let the first derivative of environmental quality for the Marshallian demand function be equation (11), that for the Hicksian demand function be equation (12), and that for the expenditure function be equation (13). In equation (13), $\partial e(\cdot)/\partial Q < 0$ is assumed (Mäler, 1974). The Slutsky equation is derived from equation (10) as equation (14). In equation (14), the first term is the substitute effect; the second term is the income effect; and the third and fourth terms are the gain/loss effects. In this study, the gain/loss effect is assumed to be positive.

$$\frac{\partial x^h}{\partial Q} = \frac{\partial x^m(\cdot)}{\partial Q} + I\frac{\partial x^m(\cdot)}{\partial g} + (1-I)\frac{\partial x^m(\cdot)}{\partial l} \tag{11}$$

$$\frac{\partial x^h}{\partial Q} = \frac{\partial x^h(\cdot)}{\partial Q} + I\frac{\partial x^h(\cdot)}{\partial g} + (1-I)\frac{\partial x^h(\cdot)}{\partial l} \tag{12}$$

$$\frac{\partial y}{\partial Q} = \frac{\partial e(\cdot)}{\partial Q} + I\frac{\partial e(\cdot)}{\partial g} + (1-I)\frac{\partial e(\cdot)}{\partial l} \tag{13}$$

$$\begin{aligned}\frac{\partial x^h}{\partial Q} &= \frac{\partial x^m(\cdot)}{\partial Q} + \frac{\partial x^m(\cdot)}{\partial y}\frac{\partial e(\cdot)}{\partial Q} + I\left[\frac{\partial x^m(\cdot)}{\partial g} + \frac{\partial x^m(\cdot)}{\partial y}\frac{\partial e(\cdot)}{\partial g}\right] \\ &\quad + (1-I)\left[\frac{\partial x^m(\cdot)}{\partial l} + \frac{\partial x^m(\cdot)}{\partial y}\frac{\partial e(\cdot)}{\partial l}\right]\end{aligned} \tag{14}$$

Static analysis on the Slutsky equation

Next the derivatives of RE for each function are considered. As for the indirect utility function, the first derivatives are $\partial V/\partial g > 0$, $\partial V/\partial l > 0$ and the second derivatives assume $\partial^2 V/\partial g^2 \le 0$, $\partial^2 V/\partial l^2 \ge 0$. Those lead to the first derivatives of the expenditure function as $\partial y/\partial g < 0$, $\partial y/\partial l < 0$ and to the second derivatives as $\partial^2 y/\partial g^2 \le 0$, $\partial^2 y/\partial l^2 \ge 0$ (See Appendix B). Therefore, equation (15) holds. Equation (15) indicates that the amount of expenditure at a loss is greater than at zero, and the expenditure at zero is greater than at a gain.

$$e(\cdot, l) > e(\cdot, 0) > e(\cdot, g) \tag{15}$$

Next, the derivatives of the reference quality are considered. The first derivative of the Marshallian demand function is equation (16); it is negative because $\partial x^m(\cdot)/\partial g > 0$ and $\partial x^m(\cdot)/\partial l > 0$. The first derivative of the expenditure function is equation (17); it is positive because $\partial e(\cdot)/\partial g < 0$ and $\partial e(\cdot)/\partial l < 0$. The first derivative of the Hicksian demand function is equation (18); whether it is positive or negative depends on the gain/loss effect. If the gain/loss effect is assumed to be positive, equation (18) is negative.

$$\frac{\partial x^m}{\partial RQ} = -I\frac{\partial x^m(\cdot)}{\partial g} - (1-I)\frac{\partial x^m(\cdot)}{\partial l} \tag{16}$$

$$\frac{\partial y}{\partial RQ} = -I\cdot\frac{\partial e(\cdot)}{\partial g} - (1-I)\cdot\frac{\partial e(\cdot)}{\partial l} \tag{17}$$

$$\begin{aligned}\frac{\partial x^h}{\partial RQ} &= -I\cdot\left[\frac{\partial x^m(\cdot)}{\partial g} + \frac{\partial x^m(\cdot)}{\partial y}\frac{\partial e(\cdot)}{\partial g}\right] \\ &\quad -(1-I)\cdot\left[\frac{\partial x^m(\cdot)}{\partial l} + \frac{\partial x^m(\cdot)}{\partial y}\frac{\partial e(\cdot)}{\partial l}\right]\end{aligned} \tag{18}$$

Finally, the total effects on the demands and the expenditure from the increase of environmental quality and the reference point are calculated by equation (19) from equations (11), (13), (14), (16), (17) and (18). Then, it is summarized as equation (20).

$$\begin{aligned}&\frac{\partial x^m}{\partial Q} + \frac{\partial x^m}{\partial RQ} = \frac{\partial x^m(\cdot)}{\partial Q}, \\ &\frac{\partial y}{\partial Q} + \frac{\partial y}{\partial RQ} = \frac{\partial e(\cdot)}{\partial Q}, \\ &\frac{\partial x^h}{\partial Q} + \frac{\partial x^h}{\partial RQ} = \frac{\partial x^m(\cdot)}{\partial Q} + \frac{\partial x^m(\cdot)}{\partial y}\frac{\partial e(\cdot)}{\partial Q}\end{aligned} \tag{19}$$

$$\frac{\partial y}{\partial Q}+\frac{\partial y}{\partial RQ}=\frac{\left[\partial x^h/\partial Q+\partial x^h/\partial RQ\right]-\left[\partial x^m/\partial Q+\partial x^m/\partial RQ\right]}{\partial x^m(\cdot)/\partial y} \quad (20)$$

Corollary 1. If the increase of both the environmental quality and the reference point is equivalent, then the increase of (Hicksian) demands and the expenditure are equal to the increase of both function in which assume only absolute value of Q. That is, the marginal benefit with RDP is equivalent to the marginal benefit without RDP (the traditional benefit).

Equation (19) implies that RDP does not influence the amount of demand and expenditure if the environmental quality and the reference quality increase or decrease by the same degree. Equation (20) summarizes the total effect for the marginal benefit. The values of the first and the second parentheses on the right side are equal to the value without RDP. Thus, the benefit with RDP is equivalent to the benefit without RDP.

Finally, the choke price and the weak complementarity are considered. The choke price p_x^* is defined as equation (21), which implies that the choke price is the price at which the Hicksian demand is zero. Notice that the Hicksian demand includes a gain and a loss. Next, the weak complementarity is generally defined as $\partial e(\cdot)/\partial Q|_{p_x^*}\equiv 0$. However, the expenditure function of this model includes the gain and loss effect as equation (13). The modified version of the weak complementarity is defined as equation (22).

$$p_x^*\equiv \min\left\{p_x|x^h(\cdot)=0\right\} \quad (21)$$

$$\left.\frac{\partial e(\cdot)}{\partial Q}\right|_{p_x^*}+I\cdot\left.\frac{\partial e(\cdot)}{\partial g}\right|_{p_x^*}+(1-I)\cdot\left.\frac{\partial e(\cdot)}{\partial l}\right|_{p_x^*}\equiv 0 \quad (22)$$

Definition of benefit and static analysis

Definition of total value

It is necessary to differentiate between situations in which a project is implemented and those in which no project is implemented to define the benefit from the change of an environmental quality with RDP [xiv]. Let $s=wo$ be the superscript representing the quality level at which a project is implemented and $s=w$ be the one at which no project is implemented. Using the notation, the utility function (and other variables) are rewritten as $U^s=u\left(z^s,x^s,Q^s,G^s,L^s\right)$. Note that a visitor does not experience a gain and a loss at the same time, so RE differs based on whether or not the project is implemented. For example, in one case, RE gains when $s=wo$ and it will also gain when $s=w$; however, in another case, RE decreases when $s=wo$ and will be at zero when $s=w$.

The benefit from quality change is defined by equivalent variation (EV) as equation (27) and compensating variation (CV) as equation (29). EV and CV can be decomposed into three kinds of benefit from income change (equations (25) and (29)), and benefit from quality change (equations (26) and (30)). This study examines only the benefit from quality change [xv]. Thus, the total value of environmental quality (hereafter TV) is summarized as equation (31) [xvi]. Equation (31) implies EV when $s=w$ and CV when $s=wo$.

$$EV=e(p_z^{wo},p_x^{wo},U^w,Q^{wo},g^{wo},l^{wo})-e(p_z^{wo},p_x^{wo},U^{wo},Q^{wo},g^{wo},l^{wo}) \quad (23)$$

$$=\left\{e(p_z^{wo},p_x^{wo},U^w,Q^{wo},g^{wo},l^{wo})-e(p_z^{w},p_x^{w},U^w,Q^{wo},g^{wo},l^{wo})\right\} \quad (24)$$

$$+\left\{e(p_z^{w},p_x^{w},U^w,Q^{w},g^{w},l^{w})-e(p_z^{wo},p_x^{wo},U^{wo},Q^{wo},g^{wo},l^{wo})\right\} \quad (25)$$

$$+\left\{e(p_z^{w},p_x^{w},U^w,Q^{wo},g^{wo},l^{wo})-e(p_z^{w},p_x^{w},U^w,Q^{w},g^{w},l^{w})\right\} \quad (26)$$

$$CV=e(p_z^{w},p_x^{w},U^w,Q^{w},g^{w},l^{w})-e(p_z^{w},p_x^{w},U^{wo},Q^{w},g^{w},l^{w}) \quad (27)$$

$$=\left\{e(p_z^{wo},p_x^{wo},U^{wo},Q^{w},g^{w},l^{w})-e(p_z^{w},p_x^{w},U^{wo},Q^{w},g^{w},l^{w})\right\} \quad (28)$$

$$+\left\{e(p_z^{w},p_x^{w},U^w,Q^{w},g^{w},l^{w})-e(p_z^{wo},p_x^{wo},U^{wo},Q^{wo},g^{wo},l^{wo})\right\} \quad (29)$$

$$+\left\{e(p_z^{wo},p_x^{wo},U^{wo},Q^{wo},g^{wo},l^{wo})-e(p_z^{wo},p_x^{wo},U^{wo},Q^{w},g^{w},l^{w})\right\} \quad (30)$$

$$TotalValue=e(p_z^{s},p_x^{s},U^s,Q^{wo},g^{wo},l^{wo})-e(p_z^{s},p_x^{s},U^s,Q^{w},g^{w},l^{w}) \quad (31)$$

Equation (31) includes the quality itself (Q),the gain (g), and the loss (l). Equation (31) is thus a comprehensive formulation including the absolute evaluation (the evaluation for $Q^{wo}\to Q^w$) and the relative evaluation (the evaluation for $(g^{wo},l^{wo})\to(g^w,l^w)$).

Influence of RDP for total value

Let p_z, p_x, y, and Q (the part of absolute evaluation in utility function) be fixed when $s=wo$ and $s=w$. As for locations of RE, there are three possible areas: gain, zero, and loss. Thus, there are 3×3 patterns to determine the value of TV (e.g., $TV=e(\cdot,g^{wo})-e(\cdot,g^w)$, $TV=e(\cdot,0^{wo})-e(\cdot,l^w)$). Figure 3 shows these cases with a possible expenditure function. Let the origin of the arrow line correspond to the amount of expenditure when the project is not implemented (i.e., $e(\cdot,g^{wo},l^{wo})$ in equation (31)) and the end point of the arrow line correspond to the amount of expenditure when the project is implemented (i.e., $e(\cdot,g^w,l^w)$). For example, the third case indicates the amount of expenditure change from $e(\cdot,l^{wo})$ to $e(\cdot,l'^w)$, and the eighth case indicates the amount of change from $e(\cdot,l^{wo})$ to $e(\cdot,g^w)$.

In these cases, the second and fourth, third and fifth, sixth and eighth, and seventh and ninth cases mean the same changes of TV because each condition differs only in terms of whether the RE benefits: benefit from price change (equations (23) and (28)), goes from low to high or from high to low. Thus, the first, fourth, fifth, sixth, and seventh cases are considered. The case of zero to zero (first case) means there is no effect on the RE. The case of zero to gain (fourth case) means the increase of the benefit, and the case of zero to loss (fifth case) means the decrease of the benefit. The case of loss to zero (sixth case) means the increase of the benefit, and the case of gain to zero (seventh case) means the decrease of

Table 1. Benefit and positions of RE

With \ Without	Gain	Zero	Loss
Gain	Increase	Increase	Increase
Zero	Decrease	No Effect	Increase
Loss	Decrease	Decrease	Decrease

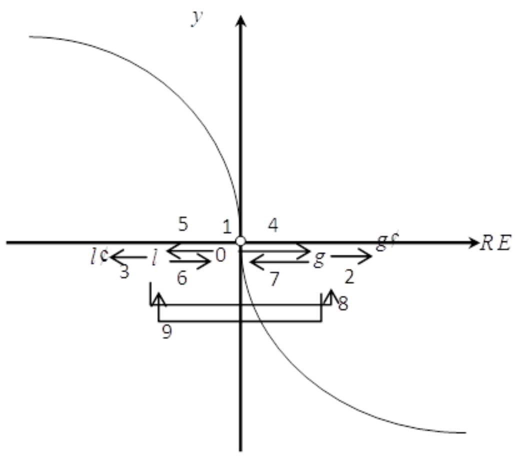

Figure 3. Nine cases of relative evaluation.

the benefit. These results are summarized in Table 1.

Let us consider the implications of these benefits. In the cases in which the benefit increases, TV increases most in the case in which RE changes from a loss when $s = wo$ to a gain when $s = w$ since the difference of expenditure is biggest (that is, the eighth case in Figure 3). This case is interpreted to be a situation in which a visitor judges an objective environmental quality to be worse than other qualities (which are comprehensively denoted by RQ) when $s = wo$, and judges it to be better when $s = w$. In short, the impact of environmental quality change on a visitor's RDP is very big. The benefit is denoted by TV_{LG} and defined as equation (32).

$$TV_{LG} \equiv e(p_z^s, p_x^s, U^s, Q^{wo}, l^{wo}) - e(p_z^s, p_x^s, U^s, Q^w, g^w) \quad (32)$$

The case in which RE is zero when $s = wo$ and $s = w$ is interpreted to be a situation in which a visitor judges the quality to be equivalent to other qualities when $s = wo$ and $s = w$ because the visitor's reference quality (RQ) changes to the same degree as the quality change (Corollary 1). One example of such a situation would be of another project being implemented for other environmental quality at the same time. The benefit from this situation is denoted by TV_{00} and defined as equation (33).

$$TV_{00} \equiv e(p_z^s, p_x^s, U^s, Q^{wo}, 0) - e(p_z^s, p_x^s, U^s, Q^w, 0) \quad (33)$$

In cases in which TV decreases, TV decreases most in the case in which RE changes from a gain when $s = wo$ to a loss when $s = w$ since the difference of expenditure is smallest (i.e., the ninth case in Figure 3). This case is interpreted to be a situation in which a visitor judges an objective environmental quality to be better than other qualities when $s = wo$, and judges it to be worse when $s = w$. One reason that a visitor might judge the quality to be worse despite environmental improvement could be that if other qualities are also improved at same time and those are more impressive to the visitor, the reference quality would increase more than the objective quality would increase. Another reason for such a judgement could be a gap between the quality change achieved by the project and the quality change the visitor imagines when $s = wo$. Therefore, the result of the project would have a negative impact for the visitor. The benefit from this situation is denoted by TV_{GL} and defined as equation (34).

$$TV_{GL} \equiv e(p_z^s, p_x^s, U^s, Q^{wo}, g^{wo}) - e(p_z^s, p_x^s, U^s, Q^w, l^w) \quad (34)$$

These results are summarized in equation (35). In addition, in the case of environmental deterioration, these inequalities became reverse (i.e. $TV_{LG} < TV_{00} < TV_{GL}$). Equation (35) implies that 1) the total value that is defined only by the absolute value of quality (TV_{00}) would be a part of the values and 2) there is a possibility that the total value can be negative even if the project aims to improve quality because there is no restriction on the reference quality change.

$$TV_{LG} > TV_{00} > TV_{GL} \quad (35)$$

Decomposition of use and non-use values and an interpretation of non-use value

The decomposition of use and non-use value is performed to investigate the relation between non-use value and RDP. Equation (31) decomposes TV into use value (equation (36)) and non-use value (equation (37)) by using the choke price (Neil, 1988; Larson, 1992).

$$TV = e(p_z^s, p_x^s, U^s, Q^{wo}, g^{wo}, l^{wo}) - e(p_z^s, p_x^s, U^s, Q^w, g^w, l^w)$$

$$= \left\{ \begin{array}{l} \left\{ e(p_z^s, p_x^*, U^s, Q^w, g^w, l^w) - e(p_z^s, p_x^s, U^s, Q^w, g^w, l^w) \right\} \\ -\left\{ e(p_z^s, p_x^*, U^s, Q^{wo}, g^{wo}, l^{wo}) - e(p_z^s, p_x^s, U^s, Q^{wo}, g^{wo}, l^{wo}) \right\} \end{array} \right\} \quad (36)$$

$$+\left\{ e(p_z^s, p_x^*, U^s, Q^{wo}, g^{wo}, l^{wo}) - e(p_z^s, p_x^*, U^s, Q^w, g^w, l^w) \right\} \quad (37)$$

Let us consider the definition of non-use value. Generally, the non-use value is defined from the properties of uniqueness and irreversibility (Krutilla, 1967). Regarding uniqueness, equation (37)

Table 2. Parameters.

α	β	γ_Q	γ_g	γ_l	δ	p_x	y	Q^{wo}	Q^w
-0.9534	-0.0163	0.0235	0.003	0.007	0.0526	29.91	2.384	14	17

includes the reference point so that the environmental quality is compared with others. There is a possibility that the uniqueness will not hold. However, Krutilla (1967) stated that uniqueness is not necessary condition for his argument. One reason is that there is a possibility that a similar environmental quality exists in another market which is difficult to access. Thus, a visitor can compare the objective environmental quality [xviii] of one place with others even if the other places are out of reach. If the existence value defined only by absolute evaluation (in this study, it is the case in which $RE = 0$) is the "pure" existence value, equation (37) would interpret the "impure" existence value.

Integrating-back approach

Von Haefen (2007) presented three methods to estimate the total value of environmental quality by market data. In this paper, the integrating-back approach is employed [xviii]. This approach is useful for obtaining the total value from a demand function. The central idea is to derive the quasi-expenditure function, which was developed by LaFrance (1985). Recently, Eom and Larson (2006) presented an estimation model based on the integrating-back approach. This method can calculate the use and non-use value from market data such as the formulations derived below.

Let the demand function be equation (38). Here $\tilde{Q} = \gamma_Q \cdot Q + I \cdot \gamma_g \cdot g + (1-I) \cdot \gamma_l \cdot l$. As for the estimation, visit number (x), travel cost (p_x), income (y), and environmental quality (Q) are observed in the recreation market. In addition, other environmental qualities must be accounted for to determine the reference quality. It is necessary to research the data of visitors' knowledge about other qualities, or their experience of sites they have visited. Then the reference quality is constructed as shown above and the data of gain (g) or loss (l) are calculated [xix].

$$\ln[x(\cdot)] = \alpha + \beta p_x + \delta y + \tilde{Q} \quad (38)$$

The quasi-expenditure function is equation (39), where the constant of integration is $U \exp\left(\delta \tilde{Q}\right)$ [xx]. The (indirect) utility function is equation (40). Let the price and the income be fixed for simplicity, and the notation s be omitted in these variables. Then the total value is derived as equation (41), where $x\left(\tilde{Q}^s\right) = \exp\left(\alpha + \beta p_x + \delta y + \tilde{Q}^s\right)$. TV consists of the demand ($x(p_x^s, y^s, \tilde{Q}^s)$) and the quality (Q^s). Finally, TV is decomposed into non-use value (NUV) as in equation (42) and use value (UV) as in equation (43).

$$e\left(p_x, U, \tilde{Q}\right) = -\frac{1}{\delta} \ln\left[\begin{array}{l} -(\delta/\beta)\exp\left(\alpha + \beta p_x + \tilde{Q}\right) \\ -\delta U \exp\left(\delta \tilde{Q}\right) \end{array}\right] \quad (39)$$

$$U = \left[-(1/\delta)\exp(-\delta y) - (1/\beta)\exp(\alpha + \beta p_x + \tilde{Q})\right]\exp(-\delta \tilde{Q}) \quad (40)$$

$$TV = \frac{1}{\delta}\ln\left[\begin{array}{l} -\frac{\delta}{\beta} x\left(\tilde{Q}^w\right) + \left[1 + \frac{\delta}{\beta} x\left(\tilde{Q}^{wo}\right)\right] \\ \times \exp\left(\delta\left(\tilde{Q}^w - \tilde{Q}^{wo}\right)\right) \end{array}\right] \quad (41)$$

$$NUV = \tilde{Q}^w - \tilde{Q}^{wo} \quad (42)$$

$$UV = TV - UV = \frac{1}{\delta}\ln\left[-\frac{\delta}{\beta} x\left(\tilde{Q}^w\right) + \left[1 + \frac{\delta}{\beta} x\left(\tilde{Q}^{wo}\right)\right]\right] \quad (43)$$

Parameters for benefit calculation

A project concerning quality improvement is assumed. The simulation is focused only on the total value because non-use value is defined as merely the difference of quality change [xxi].

Parameters are specified in Table 2. The parameters α , β , γ_Q , δ , p_x , and y are the same as those in Tables 1 and 2 of Eom and Larson (2006) (the results of estimation model for non-use value). The variables γ_g and γ_l are originally designed so as to satisfy the property of RDP of demand function ($(\partial x^m / \partial g)/(\partial x^m / \partial l) < 1$)). For the quality level, Eom and Larson (2006) used biochemical oxygen demand (BOD) [xxii] for the estimation; $Q^{wo} = 14$ and $Q^w = 17$ are designed as these levels. Since positive utility does not arise for values (Q) under 10 in this model, the quality levels and reference qualities are set at values over than 10. Therefore, this formation cannot be used for arbitrary values of parameters. The simulation is thus performed for reference quality (RQ) ranging from 10 to 20 in one-point increases.

RESULTS AND DISCUSSION

The simulations were performed by each functions (equations (38) to (41)). The main focus of the discussion is to examine the differences between the traditional benefit calculation model and the model of this paper by analyzing the relations between RQ and TV.

Demand function

Figure 4 shows the change of the demand corresponding

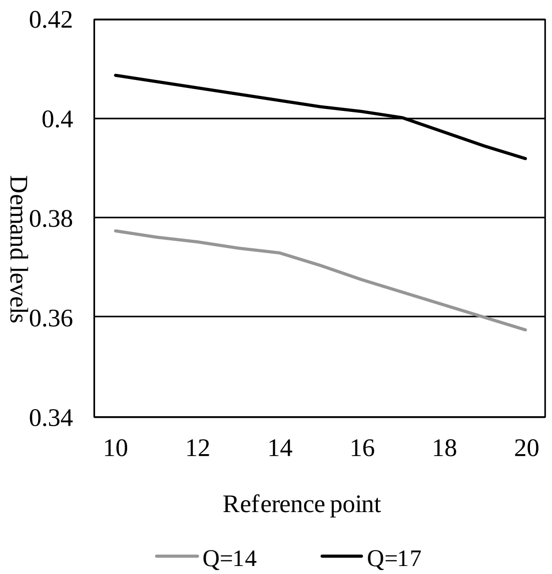

Figure 4. Reference quality and demand function.

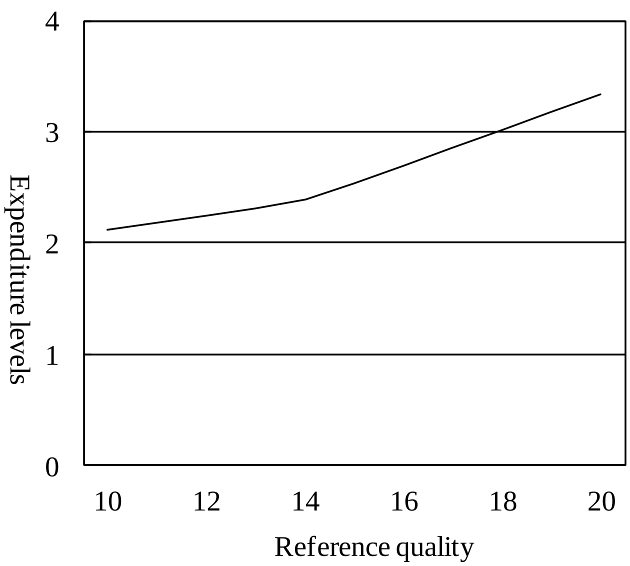

Figure 5. Reference quality and expenditure function.

to each reference point. The gray line is the demand function when the quality level is Q^{wo} and the black line is the demand function when the quality level is Q^{w}. The point 14 for the gray line and the point 17 for the black line are the points at which $RE=0$ (i.e., the inflection points for each function). The inflection points are not discussed in previous section. However, this formulation is employed because it is commonly used in RPM models (for the formulation of demand function) and experimental studies (for the formulation of value function). In previous

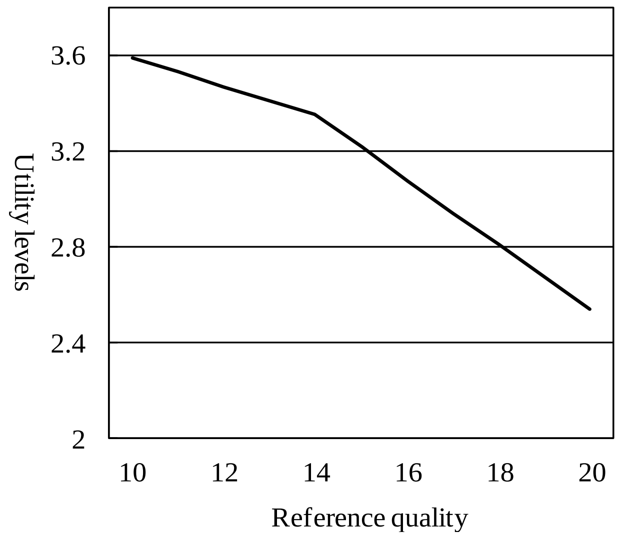

Figure 6. Reference quality and utility function.

section, the relation between the demand and RE was analyzed. The demand decreases when RE becomes negative in Figure 2. Figure 4 shows both demand levels decrease corresponding to the increase of RQ (the increase of RQ means that RE becomes negative).

This feature is the same in Figure 2.

Expenditure and utility function

The expenditure function (equation (39)) is shown in Figure 5. In previous section, the condition $\partial y / \partial RQ > 0$ is discussed (equation (17)) and it is reflected in Figure 5. Here, the U in the expenditure function is the utility at point 14 in Figure 6. As for the property of RDP, the gradient at the loss is greater than the gradient at the gain.

Similarly, the condition $\partial U / \partial RQ < 0$ for the (indirect) utility function is reflected in Figure 6. Especially, the properties of loss aversion $(\lim_{g \downarrow 0} u_g)/(\lim_{l \uparrow 0} u_l) < 1$ are observed. That is, the properties of loss aversion in the demand function (e.g., $\gamma_g = 0.03$ and $\gamma_l = 0.07$) are also reflected in the utility function.

Benefit calculation

Figure 7 shows the change of TV corresponding to each level of reference point. The black line shows the case in which RE in the second term of equation (31) is fixed at zero and RE in the first term of equation (31) changes (exactly to say, RQ in the first term of equation (31) changes) [xxiii]. As a result, the total value decreases

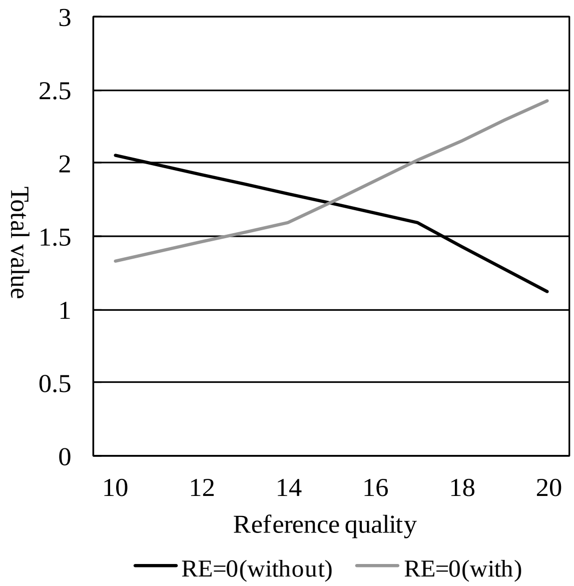

Figure 7. Reference quality and total value.

Table 3. Example for Table 1 from Figure 5.

Without / With	Gain	Zero	Loss
Gain	[8,10]	[7,10]	[5,10]
Zero	(1,3)	(3,3)[7,7]	[5,7]
Loss	(1,6)	(3,6)	(6,9)

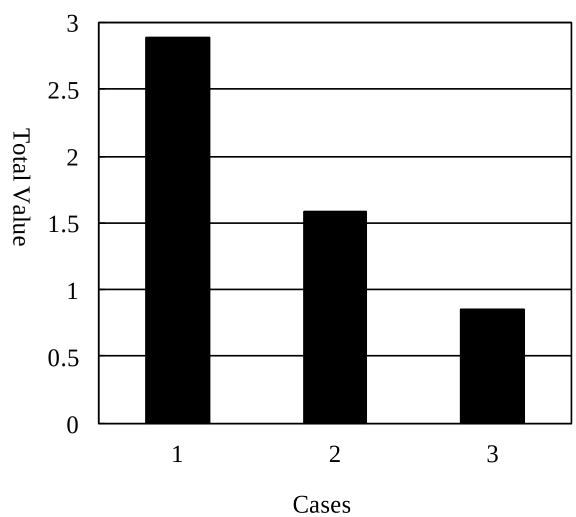

Figure 8. Relative evaluations and size of total value.

following the increase of RQ. This case corresponds to the fourth case in Figure 3. The increase of RQ in the first term means that the value (the amount of expenditure) of the first term of equation (31) decreases, so the difference between the first and second terms of equation (31) is a decrease.

The black line also shows the relation between RE and the total value in Table 1. Let (row, column) be the element in the matrix corresponding to the row and column of Table 1. (e.g., (zero, loss) means "decrease" in Table 1). In Figure 5, for example, the difference between the value at point 3 and that at point 6 (hereafter abbreviated as (3, 6)) corresponds to (zero, loss) if the value at 3 is the one when $Q = Q^{wo}$ and the value at 6 is the one when $Q = Q^{w}$. Similarly, other situations can be considered (e.g., (6, 9) corresponds to (loss, loss)). Other examples are listed in Table 3.

The gray line in Figure 7 shows that RE in the first term of equation (31) is fixed and RE in the second term of equation (31) changes. As a result, the total value increases following the decrease of RQ. This case corresponds to the sixth case in Figure 3. The increase of RQ in the second term of equation (31) means that the value of the second term decreases, so the difference between the first and second terms of equation (31) is an increase (the total value increases).

The gray line also shows the relation in Table 1. Let [row, column] [xxiv] be the element in the matrix corresponding to the row and column of Table 1 (e.g., [zero, gain] means "increase" from Table 1). In Figure 5, for example, the difference between the values at point 7 and point 10 (abbreviated as [7, 10] below) corresponds to [zero, gain] if the value (the amount of expenditure) at 7 is the one when $Q = Q^{wo}$ and the value at 10 is the one when $Q = Q^{wo}$. Similarly, other situations can be considered (e.g., [8, 10] corresponds to [gain, gain]). Other examples are listed in Table 3.

Figure 8 shows the relation in equation (35). The situations (the amount of demand and environmental qualities when $Q = Q^{wo}$ and $Q = Q^{w}$) are given in Figure 7. Case 1 indicates the value of TV_{LG} when the first term of equation (32) is set as point 20 on the gray line and the second term of equation (32) is set as point 10 on the black line in Figure 7. Similarly, Case 2 indicates the value of TV_{00} when the first term of equation (33) is set as point 14 on the gray line and the second term of equation (33) is set as point 17 on the black line. Case 3 indicates the value of TV_{GL} when the first term of equation (34) is set as point 20 on the gray line and the second term of equation (34) is set as point 10 on the black line. The result of equation (35) is confirmed.

Figure 9 shows the price change and the total value. The black line is the same as in Figure 7, the gray line is the line when the price of the black line set 20, and the dotted line is the line when the price of the black line set 40. The total value decreases when the price increases.

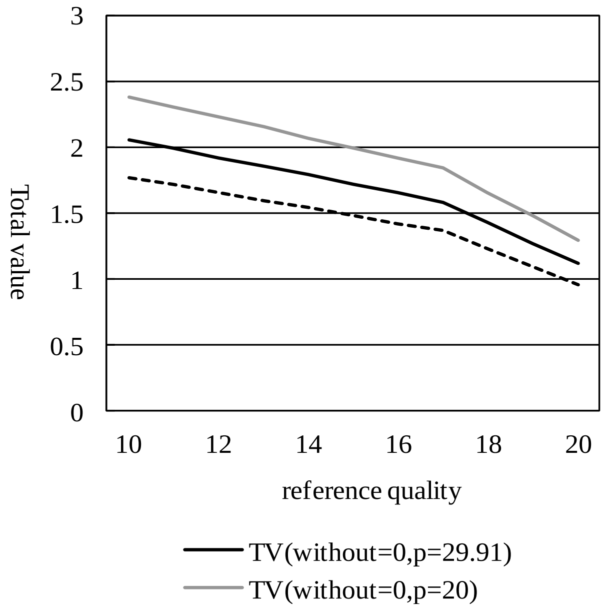

Figure 9. Price change and total value.

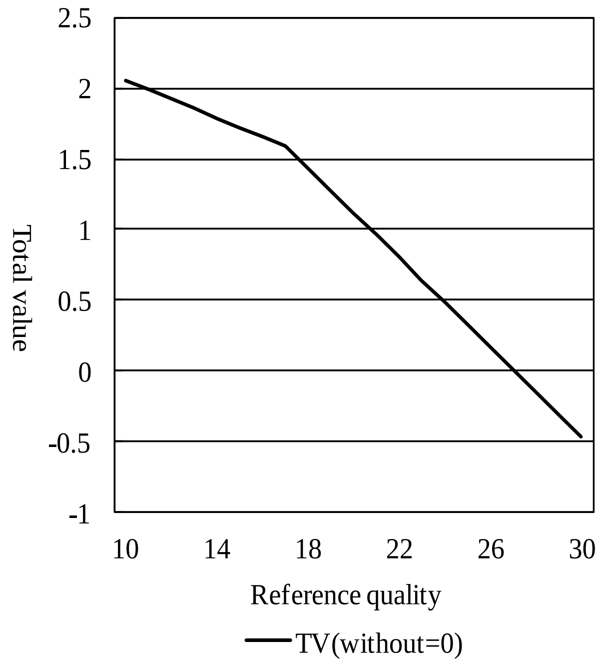

Figure 10. Extreme case of reference quality.

Finally, a problem on calculation is discussed. It is called the extreme moving to loss. Figure 10 shows the case (by using the black line from Figure 7) in which the reference quality changes extremely to loss. In this case, the value goes to negative such as at point 30 despite the project's aim of environmental improvement. This happens because there is no restriction on the value of reference quality for $s = wo$ and $s = w$ (therefore, this case occurs in the case of the gray line, e.g., if RQ goes below 10). Thus, a boundary condition should be set for the reference quality or preference structures.

Estimation of demand function

Final section described how to estimate the demand function represented as equation (38). In estimating, an independent variable is the visit number (x); dependent variables are the travel cost (p_x) and household income (y) observed in the recreation market (or collected by a survey). The data on environmental quality (Q) in recreational sites are also used for a dependent variable. Here, the reference quality data (RQ) would be collected by asking respondents; For example, how much quality level (RQ) of the environment do you need? If $RQ < Q$, the respondents would be categorized as "gain-respondents". In the inverse case, "loss-respondents". Researchers would arbitrarily decide how to categorize the case of $RQ = Q$; either include it in gain-respondents or loss-respondents. Whether respondents' preferences are the absolute or relative valuation would be examined by comparing the demand functions; $x^m = x^m(p_z, p_x, y, Q)$ and $x^m = x^m(p_z, p_x, y, Q, g, l)$.

Conclusion

Most environmental valuation studies have employed absolute evaluation assumption for valuation methods. However, some experimental studies in economics and psychology pointed out that an individual's decision making is influenced by reference dependent preference, namely relative evaluation.

The purposes of this paper are 1) to formulate a recreation behavior model with RDP for environmental quality and 2) to formulate an application model for benefit calculation.

As for the base model, the travel cost method is employed as discussed below. First, the modeling of RDP in a visitor's utility function and the properties of RDP on demand and expenditure functions were examined. The analysis for the demand function revealed that the simultaneous changes of the environmental quality and the reference quality are equivalent to the condition in which only the absolute evaluation is considered. This implies that some effects (e.g., a framing effect) of RDP for the value of the benefit arise only when the quality and the reference point change in different directions.

Second, the definitions of the benefits and static analysis were considered. The finding was that the total value defined only by absolute evaluation is one of the benefits that include RDP. Thus, it is necessary to determine whether the benefit (or, in terms of this study, visitor behavior) includes RDP or not. If the benefit includes RDP, then the benefit can change depending on the reference points. This paper compare the benefits 1) relative evaluation is loss before implementing a project and relative evaluation is gain after implementing a project, 2) relative evaluation is zero before implementing a project and relative evaluation is zero after implementing a project, 3) relative evaluation is gain before implementing a project and relative evaluation is loss after implementing a project. As a result, the benefit of first case is bigger that the second case and the second is bigger than the third case (equation (35)).

Third, this property was confirmed though simulations. Since the computable formulation reflects the theoretical findings, this model can be used to estimate the recreation demand function with RDP and to calculate the benefit.

Finally, some problems for empirical study should be mentioned. First, the recreation demand for a single site is assumed in this paper. However, the structure of reference quality needs the aggregation of other qualities that a visitor has already experienced or knows about. Thus, it is natural to assume there are multiple sites for recreation demand. One solution could be to use the multiple-site trip for travel cost method, e.g., the Kuhn-Tucker Model. Second, the loss effect cannot be estimated if there is no reservation utility (discussed in theoretical analysis). Since the loss effect means that the utility is at a negative value, it is possible for a visitor not to select such recreation sites. Third, if the influence of RDP is confirmed, there is a possibility that the benefit will change over a long period of time due to the change of the reference quality. Thus it may be necessary to consider the structures of RDP for a dynamic model.

Notes

i. The framing effect is a phenomenon in which an individual's preference changes depending on how options are presented (framed) in a questionnaire (Tversky and Kahneman, 1991).

ii. The status quo bias is a phenomenon in which an individual tends to prefer to remain at the status quo due to an aversion toward loss (Kahneman et al., 1991).

iii. The endowment effect is a phenomenon in which an individual feels that a good has a higher value once he or she has become the owner of the good. This effect has been explained as being equivalent to status quo bias (Kahneman et al., 1991). However, since it is not clear in these studies whether or not the property right is the main component of the "status quo," these two biases are explained separately.

iv. These biases are discussed extensively in the problem of the disparity between willingness to pay and willingness to accept. Mitchell and Carson (1989) present cases of this disparity, and RDP is one of them. Hanemann (1991) demonstrated the cause theoretically without RDP. However, recent studies indicate RDP as the main cause of endowment effect (Horowitz and McConnell, 2002; Plott and Zeiler, 2005; Brow, 2005).

v. Suzuki et al. (2001) estimated the demand function with RDP for services' qualities in the airline market.

vi. Putler (1992) modeled the reference price effect as follows: let p be the price of a good, p^{ref} be the reference price of the good. Then the gain is $p^{ref} - p > 0$, and the loss is $p^{ref} - p < 0$. This implies that a visitor gains a utility if the price is more inexpensive than the reference point.

vii. Putler (1992) set $E(\cdot) > 0$. However, it is generally assumed that $E_g(g) > 0$ and $E_l(l) < 0$ in the utility function with RDP. Thus, those conditions are employed in such studies as Munro and Sugden (2003).

viii. In addition, since G and L are directly involved in the utility function, it may be useful to construct a utility function to assume functions F_g and F_l such as $G = F_g(x)E_g(g)$ and $L = F_l(x)E_l(l)$. An example of the Utility function is, where $F_g(x) = x^{1/2}, E_g(g) = 0.5 \cdot g$ and $F_l(x) = x^{1/2}, E_l(l) = 2 \cdot l$.

ix. As for the notation, the first derivatives are denoted as $\partial U / \partial z = u_z$, the second derivatives are denoted as $\partial^2 U / \partial z^2 = u_{zz}$, and the cross derivatives are denoted as $\partial^2 U / \partial z \partial x = u_{zx}$. Note that u_{gl} is not defined.

x. Formal conditions are based on a modified version of Bowman et al. (1999). The first is that U is strictly increasing in RE. The second is to express the relation between the marginal utility of a loss and the marginal utility of a gain, defined as $U(RE') + U(-RE') < U(RE) + U(-RE)$ for $0 < RE < RE'$. The third is to represent an assumption of diminishing marginal sensitivity defined as RE is strictly concave in $RE > 0$ and RE is strictly convex in $RE < 0$. The fourth is to represent that a person can evaluate losses even when comparing very small losses to very small gains, given that there exists a value M s.t. $\lim_{RE \to 0}(u_{RE}|_{RE \in DR^-}) / (u_{RE}|_{RE \in DR^+}) \equiv M$. In addition, if RE is the linear form, a simple condition to express loss aversion is $\lim_{g \downarrow 0} u_g / \lim_{l \uparrow 0} u_l < 1$.

xi. It is natural to think there is a value of RE' at which the value of the utility becomes positive if RE exceeds the value ($RE' < RE \to U > 0$). This implies that it is necessary to assume a reservation utility for a recreation activity (x) if a recreation activity occurs even in the case that RE is at loss. This study assumes that the absolute value of Q in the utility function will perform the role.

Thus, $u(\cdot,Q,L)>0$ for $RE>RE'$ is assumed.
xii. Let β be each parameter. For examples, a linear form is $x=\beta+\beta_p p+\beta_y y+\beta_Q Q+\beta_g g \ +\beta_l l$ and a logistic form is $x=1/\{1+\exp(\beta+\beta_p p+\beta_y y+\beta_Q Q+\beta_g g+\beta_l l)\}$ in the notation of this paper. The condition to express the loss aversion as $\beta_g/\beta_l<1$ for the linear form and $-\beta_g x^m(\cdot)\big/-\beta_l x^m(\cdot) \ =\beta_g/\beta_l<1$ for the logistic form. This implies that these demand functions must reflect the properties of utility function (although those would not be reflected exactly).
xiii. In addition, the expenditure function is defined as $y=p_z z^h+p_x x^h$ by using the Hicksian demand function.
xiv. Whether the project is for environmental improvement or for environmental deterioration does not matter. The difference corresponds to the definition of willingness to pay and willingness to accept. However, the project is mainly assumed to be an environmental improvement project in this study, as discussed below.
xv. An additional decomposition is shown in Appendix C.
xvi. In empirical studies, equation (31) would be rewritten as $TV=\int_{\varepsilon=Q^w}^{Q^{wo}}\partial e(\cdot)/\partial Q d\varepsilon$. It would be necessary to consider the kink at $RE=0$ if the domain of RE changes between $s=wo$ and $s=w$. Thus, equation (31) is the definition when $e(\cdot)$ is differentiable at $RE=0$.
xvii. He also cannot access to the objective environmental quality in the definition of equation (37). The reason why he cannot access is due to employing the choke price to define the equation. See equation (21). The choke price is defined as the price at which (Hicksian) demand is zero. This interpreted as being a situation in which a visitor cannot visit the recreation site because of high travel costs.
xviii. The related papers concerning this method are Neil (1988) and Bullock and Minot (2006). The problems are 1) there is no guarantee to derive the choke price from arbitrary functional form to determine the use value and non-use value, and 2) it is difficult to apply the method to the case of multi-site trips.
xix. For example, assume that the reference quality comes from the average of the qualities that a visitor has known. If visitor A—who plans to go to site 1, which has quality=2—knows site 2’s quality=3, site 3’s quality=1, and site 4’s quality=5, then the visitor’s reference quality is 11/4=2.75 and RE =2-2.75=-0.75. Thus, visitor A’s RDP is at loss. If visitor B, who plans to go to site 5, has RE =5-2.75=2.25, the RDP is at gain. For a data set, it is simple to set if a visitor’s RE is at gain, then his or her data of loss is zero (Suzuki et al., 2001).
xx. Eom and Larson (2006) assumed the constant of integration as $U\exp\left(\delta\psi\tilde{Q}\right)$. ψ is used to estimate the existence of non-use value. Thus, the model in this study assumes $\psi=1$ and adds RE to their model.
xxi. In addition, the result of analysis for existence value are similar one for the total value since the difference of both definition (total value and the non-use value) are only the definition of price and the prices are fixed in each definition (See equation (31) and equation (37)).
xxii. BOD is an indicator of water pollution levels and it is generally assumed to have a negative effect on recreation demand. However, Eom and Larson (2006) used negative values of BOD for estimation. Thus, the estimated parameter is positive and is directly used for γ_Q in this study.
xxiii. In this case, the absolute value of the environmental quality is the value at point 14 because RE of the second term is fixed at zero. Similarly, the absolute value of the environmental quality is the value at point 17 in the gray bars.
xxiv. Note that parentheses ( ) is used for black line and brackets [ ] is used for gray line.

Conflict of Interests

The authors have not declared any conflict of interest.

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Appendix A. Demand function

Let λ be the undetermined multiplier and the Lagrange equation be defined by equation (A.1). The first derivatives of equation (A.1) are summarized as equation (A.2). Let dp_z, dp_x, dy, and dQ be zero, and p_z be equal to 1. Then, the total derivative of the demand function is derived as equation (A.3) by using Cramer's rule. Here, $|A|$ is the determinant of the matrix (the first parenthesis of the left side of equation (A.2)).

$$\Omega \equiv u(z,x,Q,g,l) - \lambda(p_z z + p_x x - y) \qquad \text{(A.1)}$$

$$\begin{bmatrix} u_{zz} & u_{zx} & p_z \\ u_{xz} & u_{xx} & u_{xQ} \\ p_z & p_x & 0 \end{bmatrix} \begin{bmatrix} dz \\ dx \\ d\lambda \end{bmatrix} = \begin{bmatrix} \lambda dp_z - (u_{zQ}dQ + u_{zg}dg + u_{zl}dl) \\ \lambda dp_x - (u_{xQ}dQ + u_{xg}dg + u_{xl}dl) \\ dy - (zdp_z + xdp_x) \end{bmatrix} \qquad \text{(A.2)}$$

$$dx = \frac{1}{|A|}\{(u_{xg}dg + u_{xl}dl) - u_{xQ}(u_{zg}dg + u_{zl}dl)\} \qquad \text{(A.3)}$$

The first derivatives are equation (A.4) from equation (A.3). It is necessary to hold $u_{xg} - u_{xQ}u_{zg} > 0$ for gains and $u_{xl} - u_{xQ}u_{zl} > 0$ for losses to satisfy the first differential condition discussed above. The second derivatives are equations (A.5) and (A.6). It is necessary to hold equation (A.5) as non-positive for gains and equation (A.6) as non-negative for losses to satisfy the second differential condition. These conditions are summarized as equation (A.7).

$$\frac{\partial x}{\partial g} \approx \frac{dx}{dg} = \frac{u_{xg} - u_{xQ}u_{zg}}{|A|}, \frac{\partial x}{\partial l} \approx \frac{dx}{dl} = \frac{u_{xl} - u_{xQ}u_{zl}}{|A|} \qquad \text{(A.4)}$$

$$\frac{\partial^2 x}{\partial g^2} = \frac{\{\partial(u_{xg} - u_{xQ}u_{zg})/\partial g\}|A| - (u_{xg} - u_{xQ}u_{zg})(\partial|A|/\partial g)}{|A|^2} \qquad \text{(A.5)}$$

$$\frac{\partial^2 x}{\partial l^2} = \frac{\{\partial[u_{xl} - u_{xQ}u_{zl}]/\partial l\}|A| - (u_{xl} - u_{xQ}u_{zl})(\partial|A|/\partial l)}{|A|^2} \qquad \text{(A.6)}$$

$$|A| \geq \frac{\{\partial(u_{xg} - u_{xQ}u_{zg})/\partial g\}}{(u_{xg} - u_{xQ}u_{zg})(\partial|A|/\partial g)}, |A| \geq \frac{(u_{xl} - u_{xQ}u_{zl})(\partial|A|/\partial l)}{\{\partial(u_{xl} - u_{xQ}u_{zl})/\partial l\}} \qquad \text{(A.7)}$$

Finally, an example of demand function and the derivatives are illustrated by using the example of utility function in footnote 8; $U = z^{1/2} + x^{1/2}(Q + 0.5\cdot g + 2\cdot l)$. From the first derivatives of the Lagrange equation, the demand function is derived as equation (A.8), and the first and second derivatives for gains and losses are equations (A.9) and (A.10), where $B = p_x + C^{-2}p_x^2 > 0$ and $C = \{Q + 0.5\cdot g + 2\cdot l\} > 0$. $C = \{Q + 2\cdot l\} > 0$ is assumed to ensure the utility is positive even if RE is at loss and the demand would be positive(see footnote 10). The first derivatives are satisfied in both gains and losses; however, the second derivatives need the conditions $p_x^2 B^{-1} C^{-2} - 1.5 \leq 0$ for gains and $4p_x^2 B^{-1} C^{-2} - 3 \geq 0$ for losses. This implies that the demand function satisfies the conditions when $3/4 \leq p_x^2 B^{-1} C^{-2} \leq 9/4$ holds.

$$x = \frac{y}{p_x + (Q + 0.5\cdot g + 2\cdot l)^{-2} p_x^2} \qquad \text{(A.8)}$$

$$\frac{\partial x}{\partial g} = 0.25 p_x^2 y B^{-2} C^{-3} > 0, \ \frac{\partial^2 x}{\partial g^2} = 0.125 p_x^2 y \left[p_x^2 B^{-1} C^{-2} - 1.5 \right] B^{-2} C^{-4} \qquad \text{(A.9)}$$

$$\frac{\partial x}{\partial l} = 4 p_x^2 y B^{-2} C^{-3} > 0, \ \frac{\partial^2 x}{\partial l^2} = 8 p_x^2 y \left[4 p_x^2 B^{-1} C^{-2} - 3 \right] A^{-2} B^{-4} \qquad \text{(A.10)}$$

Appendix B. Indirect utility and expenditure functions

The derivations of indirect utility function and expenditure function are considered. For simplicity, let the total gain and total loss be decomposed into (x, g) and (x, l), respectively, in the utility function as in the example above. Let V be defined as equation (B.1) ,where * indicates the demands and the undetermined multiplier are at optimal level.

$$V \equiv u(z^*, x^*, Q, g, l) + \lambda^*(y - p_z z^* - p_x x^*) \qquad \text{(B.1)}$$

Then, $\partial V / \partial g$ and $\partial V / \partial l$ are equivalent to u_g and u_l by the envelope theorem. Thus, the second derivatives of the indirect utility function for losses also follow the condition of the utility function. Next, let us consider the expenditure function. As for the total differential equation of V, let the variables except for l and y be fixed. Then, $dy/dl = -u_l / \lambda^* < 0$ is derived due to $u_l > 0$, where the marginal utility of income (λ^*) is positive. The second derivative is $d(dy/dl)/dl = -u_{ll} / \lambda^* \leq 0$ due to $u_{ll} \geq 0$. By a similar process, the first derivative for gains is $dy/dg < 0$ and the second derivative is $d(dy/dg)/dg = -u_{gg} / \lambda^* \geq 0$ due to $u_{gg} \leq 0$.

Appendix C. Decomposition of total value

The decomposition of the benefits from RE and Q is considered by using equation (31). Equation (31) is decomposed into equation (C.1) and equation (C.2) by using additional expenditure $e(p_z^s, p_x^s, U^s, Q^w, g^{wo}, l^{wo})$ for (C.1) and $e(p_z^s, p_x^s, U^s, Q^w, g^w, l^w)$ for (C.2). The first term of each equation is defined as the benefit from environmental quality change since other variables are constant. Similarly, the second term of each equation is defined as the benefit from RE change. There are two ways to decompose TV.

$$TotalValue = \begin{bmatrix} e(p_z^s, p_x^s, U^s, Q^{wo}, g^{wo}, l^{wo}) \\ -e(p_z^s, p_x^s, U^s, Q^w, g^{wo}, l^{wo}) \end{bmatrix} + \begin{bmatrix} e(p_z^s, p_x^s, U^s, Q^w, g^{wo}, l^{wo}) \\ -e(p_z^s, p_x^s, U^s, Q^w, g^w, l^w) \end{bmatrix} \qquad \text{(C.1.)}$$

$$TotalValue = \begin{bmatrix} e(p_z^s, p_x^s, U^s, Q^{wo}, g^w, l^w) \\ -e(p_z^s, p_x^s, U^s, Q^w, g^w, l^w) \end{bmatrix} + \begin{bmatrix} e(p_z^s, p_x^s, U^s, Q^{wo}, g^{wo}, l^{wo}) \\ -e(p_z^s, p_x^s, U^s, Q^{wo}, g^w, l^w) \end{bmatrix} \qquad \text{(C.2)}$$

The conditions are that the first term of (C.1) is equal to the first term of (C.2) and the second term of (C.1) is equal to the second term of (C.2) is $\partial e(\cdot)/\partial Q\big|_{RE^{wo}} = \partial e(\cdot)/\partial Q\big|_{RE^w}$. As for non-use value, this condition holds due to the choke price. For example, the decomposition is performed in equation (42) as the following equation.

$$NUV = \left[\gamma_Q \cdot Q^{wo} - \gamma_Q \cdot Q^w\right] + \begin{bmatrix} \left[I \cdot \gamma_g \cdot g^{wo} + (1-I) \cdot \gamma_l \cdot l^{wo}\right] \\ -\left[I \cdot \gamma_g \cdot g^w + (1-I) \cdot \gamma_l \cdot l^w\right] \end{bmatrix}$$

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Banking sector reforms and output growth of manufacturing sector in Nigeria (1970-2011)

Olanrewaju, Oluwagbenga Gideon[1*], Aremo, Adeleke Gabriel[2] and Aiyegbusi Oluwole Oladipo[2]

[1]Department of Economics, Babcock University, Ilisan, Remo, Ogun State, Nigeria.
[2]Department of Economics, Obafemi Awolowo University, Ile-Ife Nigeria.

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The study investigated empirically the effect of banking sector reforms on the output of manufacturing sector in the Nigerian economy between 1970 and 2011 with a view to examining the extent of the impact of banking sector reforms on the manufacturing sector. The study employed annual secondary time series data from 1970-2011, sourced from the Central Bank of Nigeria's statistical bulletin and annual report and statement of accounts, National Bureau of Statistics final accounts and IMF International Financial Statistics (IFS) using the methodology of Cointegration analysis and Error Correction Mechanism (ECM). The empirical results showed that the effects of Bank assets, Lending rate, Exchange rate and real rate of interest on manufacturing output were positively significant but with very low impact. On the other hand, the financial deepening and interest rate spread negatively and significantly impacted on the output growth of manufacturing sector in Nigeria. Overall, the conclusion that emerged from the findings suggests that the effects of banking sector reforms on the output growth of manufacturing sector were significantly low in the Nigerian economy. However, the findings indicated that the impacts of the various banking reforms could vary widely on the economy depending on the time lags involved. Consequently, the policymakers must be prepared to initiate proper counter-cyclical banking reforms that will serve as buffer measures to lessen or abort the negative impacts of any banking reforms on the manufacturing output growth. Thus a flexible accommodating banking reform regime is advocated for Nigeria.

Key words: Banking sector reforms, Error Correction Mechanism (ECM), manufacturing sector, and Cointegration analysis.

INTRODUCTION

The banking sector represents the nucleus of the financial system in an economy; thus it constitutes a potent and frontline economic policy tool in the hand of the monetary authorities for realizing key macroeconomic policy objectives. A well-functioning banking sector is sufficient to jump-start a sustainable economic growth. Hamilton (1781) opined that "banks were the surest engines that ever were invented for spurring economic growth." The recent experience in Eastern Europe and Asia has shown that countries that moved quickly to fix

*Corresponding author. E-mail: golarenwaju@yahoo.com

their banking industry were able to achieve a sustainable growth rate than those that did not. This indicates that there is a causation that runs from banking sector development through the manufacturing sector to economic growth. Banks originate and facilitate financing which are fundamentally necessary for carrying out productive investments (Akingbola, 2001; Bukhari, 2005; Carbo; 2007)

A large body of the literature on development reveals that the services provided by well – developed financial intermediaries such as banks are essential drivers for innovation and growth (Bencivenga and Smith, 1991; King and Levine, 1993; Levine, 1997; Levine and Zervos, 1998; Loayza et al., 2000; Graff and Karmann, 2001) among others. In contrast, explanation initiated by Robinson (1952) posited that finance does not exert a causal impact on growth and that the findings of causations are somewhat misleading. Rather than this, banking development may follow real sector growth as a result of higher demand for financial services; hence the financial system grows in response to economic expansion. As economic activities grow, there will be more demand for both physical and liquid capital, such that the growth in manufacturing sector induces the financial sector to expand, and thereby increasing competition and efficiency in the financial intermediaries.

Based on the above controversies related to the causal impact of banking reforms on growth, the study examined the impact of banking reforms on manufacturing sector growth considered as a crucial subsector of the real sector. The need to examine this impact is borne out of the following reasons: First, it will enable the policy makers to assess the contribution of the extant banking reforms to real sector growth and to overall growth of the economy. Second, it enables the policy makers to predict when best to reshuffle and substitute any unproductive banking reforms strategies that are not meeting the desired goal of achieving the pre-determined output growth in the economy. Third, there is the likelihood that variants of reform strategies making up a menu of reforms may not likely have the same effects on real sector output growth. The present study therefore contributes to the literature by examining the individual effects of each of the banking sector reform instruments to manufacturing output growth.

The remaining presentation is organized into four sections. The theoretical and empirical issues are examined in section 2. The methodology is contained in section 3. Section 4 provides the empirical results while the last section contains the concluding remarks and policy implications

THEORETICAL AND EMPIRICAL ISSUES

The evolutionary theory of debt-intermediation claims that bankers were actually big merchants or firms which evolved from loaning their excess funds to other merchants or firms, to discounting bills of exchange and to issuing their own bills. These merchant bankers relied on their own equity to perform banking operations. They do not only enable the economic transactions but also anticipate them by creating their own bills for the future economic transactions. Thus, as more equity capital is built via retained profits, the merchant bankers begin to lend and then learnt the skills of screening, selecting and monitoring. “They start mobilizing deposits and accumulating increasingly diversified loan portfolios as their quality skills and capabilities of screening, selection and monitoring improved” (Winkler, 1998). The popular view underlying these theories is that in a world of information asymmetry, high transaction costs and moral hazard (which result in adverse selection), banks not only have to mobilize and allocate savings but they also have to exert corporate control manage risks to lower the cost of researching potential investments (Levine, 1997).

Fama (1980) applied the Modigliani-Miller (MM) theorem of irrelevance pure financing decision to banking sector. He found that portfolio management activity of banks under strong MM theorem is irrelevant to economic activities. However, the role of a competitive banking sector in a general equilibrium is passive. Johnson (1986) in a similar study observed the same line of argument by assuring that a competitive banking system would be under constant incentive to expand the nominal money supply and thereby initiating inflation. Thus if finance is money, and money is a veil financial development is a neutral factor in real economic development since increase in banking operations leads to increases in money supply, and so, inflationary prices. By implication, increasingly better resource allocation depresses saving rates such that growth is retarded (Levine et al., 2000).

In a response to the question “does finance cause economic growth?” King and Levine (1993) explored the Schumpeter’s statement that “banker authorizes people in the name of society as it were to innovate”. They used various measures of financial development in 12 regression equations and found that all the indicators of intermediation development are strongly associated with real per capita GDP growth, the rate of physical capital accumulation and improvements in the efficiency with which economies employ physical capital. They also show that commercial banks advance credits better than any other financial institutions and this is due to the risk sharing information services provided by commercial banks. However, their findings are not tantamount to the conclusion that finance causes growth; but it may be that finance is only a leading factor.

Levine and Zervos (1998) extend the work of King and Levine to include the independent impact of stock markets, as well as banks, on real economic growth. They found that stock market liquidity and banking sector development are independently and positively correlated with both current and future rates of capital accumulation and economic growth. Similarly, Bencivenga and Smith (1991) assert that “the introduction of financial development in any economy shifts the composition of savings towards capital, causing intermediation to be growth promoting”. However, the major objection to the views of King and Levine (1993) and Levine and Zervos (1998) is that of unobserved differences in industrial composition across countries which tend to explain both the variance observed in financial development and the variance observed in growth.

Greenwood and Javanovic (1990) in their study employed an endogenous growth model to demonstrate that there is a positive two-way causal relationship between output growth and financial sector development. They opined that, the process of growth stimulate higher borrowing requirements for working capital and investments, thereby necessitating the entry and expansion of more banking institutions. While the process of financial intermediation by banks, encourages investment projects to be financed more efficiently, thereby stimulating investment and output growth.

In explaining the causality evidence whether finance is an engine of growth or not Jayaratne and Strahan (1996) observed that rates of real per capital growth in income and output increased significantly following interstate bank reforms in USA. They also note that improvements in the quality of bank lending via branch banking and not increased volume of bank lending are responsible for growth changes. However, the causality direction seems to depend on the studied countries.

Jayaratne and Strahan (2002) investigated the methods to estimate the impact of changes in laws governing bank competition on entrepreneurial behaviour. They found that countries with more concentrated local banking markets have lower rates of incorporation, and when these countries opened their banking markets to external competition, the rate of incorporation increased. Thus, the removal of regulatory barriers increased bank competition, which in turn, caused higher rates of business incorporation.

Beck et al. (2000) also take advantage on the questions of unobserved heterogeneity and spurious casuality; though without considering industries as well as countries, but applying novel econometric techniques. They use a dynamic Generalized-Method-of Moment (GMM) panel estimator that allows simultaneously the exploitation of time series variation in the data to account for unobserved country-specific effects for the inclusion of lagged variables as regressors, and controls for endogeneity of all the explanatory variables. They also use an instrumental variable estimator in order to extract the exogenous component of financial intermediary development and found a positive effect of the financial development.

In Nigeria, several empirical attempts have been made to assess more generally the relationship between financial liberalization and economic performance (Soyibo and Adekanye, 1992; Ikhide and Alawode, 2001; Akpan, 2004). There exist other studies which examine the performance of financial sector reforms on economy across some sub – Sahara African countries (Soyibo, 1994; 1997; Emenuga, 1998; Aryeetey and Sebnet 1998; Aryeetey, 2000 among others).

For instance, Soyibo and Adekanye (1992) examine the links between interest rates, savings, investment and money supply in Nigeria. They found that there exists positive relationship between returns on financial assets and the rate of savings. They also showed that bank deposits are important in the level of productive investment in Nigeria. However, they cautiously noted that the general expectation in terms of the link between savings, investment and economic growth is ambiguous due to structural imperfections such as information asymmetries, moral hazards, and the likes.

Pradhan et al. (2013) examined the causal nexus between economic growth, banking sector development, stock market development, and other macroeconomic variables in ASEAN countries between 1961 and 2012 using panel vector auto-repression. The study showed that banking sector development Granger-causes economic growth. This result conforms with findings of Mezioghu and Walde-Rafael (2014) and Bojanic (2012) and Chaiechi (2012). Also, Dwyer et al. [2013] examined the relationship among banking crises, economic growth and recession covering 21 countries. They found evidence of mixed effects of either negative or positive on economic growth during the economic crisis but evidence of mixed results after the crisis.

METHODOLOGY

Model specification

Based on the arguments presented in the theoretical framework and the intuition from the reviewed literature, the model adopted in this study is the Schumpeterian Circular flow of creditary production (1934).The popular view underlying this theory is that a sectoral output of the entrepreneur will depend on banking reform measures, lending capacity of the banking system, and other conditioning variables that are capable of influencing the productivity of capital (A). Therefore, the relationship between banking sector reforms and output growth of the manufacturing sector via investible funds can be expressed as:

$$MFGO_t = f(BF_t, LC_t, A_t) \quad (1)$$

Where MFGO is the manufacturing sector output growth; BF is the measure of banking reforms that is proxied by real interest rates (RR); interest rate spread (IRS); lending rates (LR); ratio of broad money (M_2) to nominal GDP as a measure Deposit Money Banks’ liquid liabilities (M_2/GDP). The lending capacity of the banking system is measured by ratio of Deposit Money Banks’ assets to total banking assets (BA). A, in the model one represents those conditioning variables which could also determine the productivity of the invested capital. These variables include: power infrastructure (ENG); manufacturing capacity utilisation (MCU); trade openness as the degree to which the banking system is able to intermediate funds across borders, measured by ratio of imports plus exports to nominal GDP (TO) and exchange rate (EXR).

Therefore, in order to assess the effects of the banking reforms on the output growth of manufacturing sector in Nigeria, the following relationship was investigated:

$$MFGO_t = f(LR_t,\ RR_t,\ IRS_t,\ BA_t,\ TO_t,\ ENG_t,\ M_2/GDP_t,\ EXR_t,\ MCU_t) \quad (2)$$

This technique allows different measures of banking development to be expressed in terms of a single index (Stock and Watson, 2002 a, b). Thus, the new proxy for the banking development, as denoted by BF, is able to capture most of the information from the original dataset which consists of the three financial development proxies. In order to test the links between the output growth of manufacturing sector and banking variables as well as those conditioning variables, we partially log-transformed equation (2) to have:

$$\log(MFGO_t) = \beta_0 + \beta_1 LR_t + \beta_2 RR_t + \beta_3 IRS_t + \beta_4 \log BA_t + \beta_5 \log TO_t + \beta_6 \log ENG_t + \beta_7 \log M_2/GDP_t + \beta_8 EXR_t + \beta_9 MCU_t + \mu_t \quad (3)$$

Where: log MFGO is denoted as LnMFGO, measured by the index of manufacturing output; BF is proxied as a banking reforms variable; and is subdivided into: LR, LnBA, LnM_2/GDP, EXR, IRS which is the spread between deposit and lending rates; and RR, which is the real deposit interest rate less the rate of inflation measured by GDP deflator, or lending rate less the interest rate spread; Log TO is the log sum of imports and exports measured as a share of GDP; Log ENG is the log of physical infrastructure proxied as industrial energy consumption index; EXR is the log of real effective exchange rate index; Log MCU is the log of manufacturing capacity utilization measured by the average capacity utilisation rates of the manufacturing sector.

The a priori expectations of the model in equation 3 is that we expect the banking variables LR, RR, IRS and EXR with an exception of M_2/GDP, to have inverse relationship with the output growth of manufacturing sector. But on the other hand, M_2/GDP and all other conditioning variables such as BA, ENG, and MCU and TO in the model should have a positive relationship with the dependent variable, MFGO. β_0, is the constant and β1 to β_9 are the coefficients, while ε_t is the stochastic error term. Thus, β_1, β_2, β_3 and β_8 <0; β_4, β_5, β_6, β_7, and β_9 >0. However, the intercept values (β_0,) could either be positive or negative.

Sources of data

In order to investigate the relationship between banking reforms and output growth in manufacturing sector in the period 1970 to 2011, the study made use of secondary data to obtain values for the variables in the model. Data were sourced from the publications of Central Bank of Nigeria Statistical Bulletin and Annual Report and Statement of Accounts (various issues). Data on manufacturing output were obtained from the publications of National Bureau of Statistics (NBS) and International Financial Statistics (IFS).

Techniques of data analysis

Engle and Granger (1987), demonstrated that co-integration variables must have an error correction representation in which an error correction term (ECM) must be incorporated into the model as in equation 4:

$$\Delta \text{Ln } MFGO_t = \lambda_0\mu_{t-1} + \lambda_1\Delta \text{Ln } BF_t + \lambda_2\Delta \text{Ln } TO_t + \lambda_3 \Delta\text{Ln } ENG_t + \lambda 4\Delta EXR_t + \lambda_5 \Delta\text{Ln } MCU_t + \varepsilon_t \quad (4)$$

Here, Δ denotes first difference operator. μ_{t-1} is the one period lagged value of the residual from the co-integration regression. The λ_0 coefficient of the error correction term captures the adjustment towards the long-run equation. ε_t represents white noise with usual assumed zero mean and constant variance. Thus, Model 4 becomes the Error Correction Model.

EMPIRICAL RESULTS

It is pertinent to examine the statistical properties of the data series. All the time series data employed in the analysis were subjected to stationarity test. The two conventional tests employed are Augmented Dickey Fuller (ADF) and Philips-Perron (PP) tests. The results of the two tests are reported in Table 1.

As shown in the table, we use both the argumented Dickey-Fuller (ADF) and the Phillips-Perron Statistics. It was found that all the variables except the interest rate (RR) exhibit non-stationarity at their levels but stationary at their first differences.

The ADF and Phillips –Perron tests are carried out against the null hypothesis that there is unit root, that is, I (1), non-stationary of the series. With a sample size of 39, the critical values for the ADF and Phillips-Perron (without trend) at 1% and 5% significance levels are -3.62 and -2.94 respectively. Absolute values of ADF and Phillips-Perron values are less than critical values indicate a rejection of the null hypothesis. The results of the test as reported above indicates that both the ADF and Phillips-Perron test Statistics confirmed that differencing the variables once will guarantee their stationarity. Since the series were integrated of order one or I (1) in the terminology of Engel and Granger (1987), and their first differences were stationary, consequently the presence of significant cointegrating relationships among the variables were thereby determined.

Test of Cointegration

Cointegration analysis helps to clarify the long-term relationships between the integrated variables. A major defect of the unit root test is that it cannot discriminate between true and near true random walks processes. Thus, it became necessary to perform additional tests to show that the variables of the model are cointegrated. The establishment of long-term convergence, i.e, long-run equilibrium between the variables enables us to carry out estimations using cointegration and error correction model

Table 1. Unit Root test- of the series -without trend (1970-2008).

	At Levels		At First Differences		
Variable	**ADF**	**Philips-Peron**	**ADF**	**Philips Peron**	**Order of Integration**
LMFGO	-0.957334	-0.798496	-3.68888	-6.363431	I(1)
LR	-1.414182	-1.818578	-6.573497	-9.413967	I(1)
LBA	-2.174196	-2.250320	-4.86379	-5.696275	I(1)
LENG	0.048759	0.152184	-4.34274	-6.073509	I(1)
IRS	-1.238686	-1.791809	-6.53241	-9.649741	I(1)
MCU	-1.637037	-1.450511	-5.27572	-3.703099	I(1)
LM_2/GDP	-2.178290	-1.980600	-4.01854	-5.722682	I(1)
RR	-4.071365	-3.627312	-	-	I(0)
EXR	-1.342729	-1.367673	-3.67031	-5.330762	I(1)
LTO	-1.733006	-2.455093	-5.04045	-9.388213	I(1)

Source: Compiled by the author.

Table 2. Johansen cointegration test assumption of linear deterministic trend in the data series : EXR, LBA, LENG, IRS. LR, LM2/GDP, MCU, LMFGO, LTO, RR.

Eigen value	Likelihood ratio	5% critical value	1% critical value	Hypothesized No. of CE (s)
0.986403	479.9538	233.13	247.18	None**
0.934444	329.5270	192.89	204.95	At most 1**
0.794641	234.1573	156.00	168.36	At most 2**
0.727961	178.7525	124.24	133.57	At most 3**
0.651693	133.18991	94.15	103.18	At most 4**
0.635612	96.27568	68.52	76.07	At most 5**
0.529476	60.94195	47.21	54.46	At most 6**
0.418618	34.55514	29.68	35.65	At most 7 *
0.333348	15.57299	15.41	20.04	At most 8
0.038687	1.380936	3.76	6.65	At most 9

*(**) denotes rejection of the hypothesis at 5% (1%) significance level. Likelihood ratio test indicates 9 co-integrating equation(s) at 5 per cent significance level.

(ECM), estimate our models. The Johansen Maximum Likelihood procedure was therefore employed and the results are presented in Table 2. As stated in Table 2, the result shows that 9 co- integrating equations are found to exist among the variables. By implication, there is a long run relationship among the variables because there is at least the presence of one cointegrating vector, which suffices to confirm cointegrating relations. Specifically, the results of the cointegration test suggest that banking reform and conditioning variables at first differences converge in the long run.

It was important to note that the existence of cointegration vectors among a group of variables might not imply that there was causal influence or relationship between pairs of variables included in the model involving cointegrated variables. Consequently, the existence of equilibrium between a group of variables should not be interpreted to mean that equilibrium exist between all pairs of variables in the model. Thus, the changes in the banking reform variables might not have had significant impact on manufacturing sector's output growth which perhaps might have been induced by other variables included in the models which might be responsible for the possible long run relationship.

The result from the normalized equation with respect to MFGO is:

$$LMFGO = 7.849^{*} LR + 0.2056 ^{*}RR - 0.738 ^{*} IRS + 1.0350^{*} LBA + 10.4408 ^{*} LTO - 0.2643 ^{*} LENG - 8.4888^{*} LM2/GDP + 0.03452 ^{*}EXR - 0.1015 ^{*} MCU$$

None of the banking variables has the a*priori* signs except interest rate spread (IRS). A decrease of 1 per cent in the interest rate spread (IRS) leads to an increase in manufacturing output (MFGO) by about 0.7 per cent. But on the other hand, a decrease of 1 per cent in the real rate of interest will result in 0.2 per cent decrease in manufacturing output growth. Similarly, a reduction in lending interest rate (LR) by 1 per cent will also lead to a decrease in manufacturing output (MFGO) by about 8 per cent. Moreover, a 1 per cent increase in the financial is deepening indicator (M2/GDP) leads to a decrease in MFGO by about 8 per cent. The effects of exchange rate (EXR) on MFGO also do not conform to the a*priori negative* signs. This is an indication of weak effects of banking sector reforms experience in Nigeria.

The lending capacity of the banking system measured by the ratio of DMBs' assets to aggregate banking assets (BA) does not have the expected positive sign. It has coefficient value of –1.03. This implies that an increase of 1 per cent in banks' assets leads to 1 per cent increase in MFGO. This is not to say that lending capacity of banks is not important in determining the quantity of bank credits to the manufacturing sector, but it probably reflects a case of credit diversion from the real sector to consumer credit markets.

In the same vein, the signs of the coefficients of most of the conditioning variables on manufacturing sector output are negative and thus do not conform to the a*priori* expectations. A 1 per cent increase in the ratio of net exports to GDP (TO) results in about 10 per cent increase in MFGO. The effects of power infrastructure on output of manufacturing sector which shows a negative sign does not conform to the expected positive sign. This confirms the evidence that in Nigeria, over the years, power infrastructure plays insignificant role in bringing about increased output. Thus, an increase of 10 per cent in manufacturing capacity utilization will brings about an increase of only 0.1 per cent in output growth of manufacturing sector.

The focus in this section is to present the over parameterised version of the error correction model as well as the parsimonious version. The contemporaneous as well as the lag variables presented are in their log-linear form which implies that the coefficient estimates in all the models are elasticities showing the percentage changes in the exogenous variables that condition the percentage change in the endogenous variable (manufacturing output growth).

The over parameterised banking sector reform model is simplified until theory-consistent and data-coherent results are achieved by one by one deleting of the insignificant variables. Both Schwarz and Akaike information criteria show that the parsimonious model is a better model than the over parameterised model because of the reduction in their values from -1.738979 and -3.190138 to 0.737941 and -0.305079. This is an indicative of the robustness of the parsimonious model.

To ensure the validity of the estimates of the parsimonious model in table 3, tests to verify the extent of the violations of the assumptions of Ordinary Least Squares estimates were carried out.

The first test is the Breusch-Godfrey Serial Correlation LM test presented in Table 4.

The probably of F-statistic at 5 per cent significance level shows that the null hypothesis of no serial correlation cannot be rejected.

The second test carried out is the Autoregressive Conditional Heteroskedasticity (ARCH) test to verify the presence of Heteroskedasticity in the error term. This is presented in Table 5.

The ARCH result in Table 5 shows that the null hypothesis of the absence of ARCH effects cannot be rejected at 5 per cent significance level. On the basis of the two tests presented in tables 4 and 5, the parsimonious model results could largely be relied upon.

A critical look at the parsimonious model results presented in table 3 shows that the past values of manufacturing output were positively related to its current value, and equally significant. As a result a 1 per cent increase in a year lagged period value of manufacturing output will bring about 44 per cent increase in the current value of manufacturing output. Similarly,1 per cent increase in the two year lagged periods will equally result in 69 per cent increase in the current value of manufacturing output.

While the a priori expectation of the signs was met in a year lagged period values of lending rate and interest rate spread, other variables like exchange rate, current bank assets, two-year lagged value of interest rate spread, two-year lagged value of power infrastructure, financial depth indicator at level, past and current values of interest rates were not properly signed even though significant. In fact, the positive signs on lending rate and real interest rate contradict the theoretical prediction according to which a higher cost of capital would discourage productive activity by entrepreneurs. However, the current value of power infrastructure, a year lagged period value of interest rate spread and two-year lagged period value of financial depth indicator met the apriori expectations of the sign.

The Dummy variable introduced into our regression model in order to capture the effect of the regime shift from financial regulation to deregulation of the banking sector in 1986 was found to be positive but not significant. However, the Dummy variable was still left in the parsimnious model even though its effect on the robustness of our analysis was marginal.

The overall regression is significant. All the variables, besides current interest rate are significant at 5 per cent significance level. The results also show that the error correction term (ECM) is negative and at the same time significant with a very low probability value of 0.0229. In other words, the negative coefficient of ECM signifies that there is an adjustment in the system in case of any disequilibrium. Thus, about 23 per cent of the

Table 3. The parsimonious error correction model of DLMFGO.

Variable	Coefficient	Std.Error	t-statistics	Prob.
DLMFGO(-1)	1.263013	0.327758	3.853496	0.0032
DLBA	0.768793	0.316803	2.426723	0.0356
DLTO	0.733921	0.277698	2.642880	0.0246
DLTO(-1)	1.095502	0.452477	2.421124	0.0360
DLTO(-2)	1.633461	0.444211	3.677217	0.0043
DIRS(-1)	-0.223427	0.069048	-3.235835	0.0089
DIRS(-2)	0.116227	0.060301	1.627436	0.0828
DLENG	0.294257	0.088106	3.339816	0.0075
DLENG(-2)	-0.171697	0.110078	-1.559775	0.1499
DLM2/GDP	-3.366537	0.694231	-4.849304	0.0007
DLM2/GDP(-2)	-1.456169	0.374284	-3.890546	0.0030
DLR(-1)	0.184419	0.051895	3.553726	0.0052
DLR(-2)	-0.105693	0.051011	-2.071962	0.0651
DLR	0.166217	0.056040	2.966060	0.0141
DRR(-2)	0.022400	0.006413	3.492748	0.0058
DIRS	-0.259540	0.078882	-3.290240	0.0080
DEXR(-1)	0.028514	0.006099	4.674815	0.0009
DEXR(-2)	0.011534	0.003461	3.332300	0.0076
DUM	0.179034	0.127227	1.407208	0.1897
ECM(-1)	-0.2394704	0.891977	-0.2684714	0.0229

R^2=0.84; S.E=0.19; F =2.3503 DW=1.915; RSSl=0.3533; S.C=0.7379; AK INFO=-0.3050.
Source: Compiled by the authors

Table 4. Breusch-Godfrey Serial Correlation LM Test.

F-statistic	1.320974	Probability	0.283576
Obs*R-squared	3.385340	Probability	0.184027

Table 5. Autoregressive conditional Heteroskedasticity (ARCH) result.

F-statistic	1.415501	Probability	0.253710
Obs*R-squared	5.553867	Probability	0.235035

disequilibrium in the output growth of manufacturing sector in the previous year is automatically corrected in the current year. This also appears significant demonstrating the fact that domestic and endogenous factors go a long way in explaining output growth of manufacturing sector in Nigeria.

The implication of the above analysis is that the contemporaneous values of the banking variables used in the study appear not to impact positively on the output growth of manufacturing sector during the period under review. Thus, it becomes evident that the banking industry is inefficient and uncompetitive given the negligible impact the sector had on the manufacturing activity. However, the results show that the past (lags 1 & 2) values of both banking variables and manufacturing output, as well as the values of other conditioning variables were responsible for the growth of manufacturing output in Nigeria during the period. The finding contradicts the position of Ikhide and Alowode (2001) which supported the positive role of financial development in banking sector growth in Nigeria.

CONCLUSION AND POLICY IMPLICATIONS

Overall, the study found that the expectations of increased output growth of the manufacturing sector in Nigeria in the wake of banking reforms are still far from being realized. The coefficients of banking development indicators show a negative impact of banking reforms on output growth of manufacturing sector. The results of the Nigeria-specific study confirmed that the Nigerian banking industry has not been efficient in ameliorating informational asymmetries, reducing transaction costs and allocating resources to the manufacturing sector. This indicates that the Nigerian banking sector has not considerably played its legitimate role of channeling financial credits to the manufacturing sector regarded as an engine of growth.

It is therefore pertinent to suggest that the extant banking sector reforms in Nigeria need to be carefully reviewed and closely monitored. This calls for sound institutional and legal framework and sound corporate governance aimed at reducing structural lapses and corruption level. This steps will create an enabling environment for banking sector to operate and ensure that the sector positively impact on the manufacturing sector output growth.

In addition, the policymakers must be prepared to initiate proper alternative banking reforms that will serve as counter measures to lessen or abort the negative impacts on the manufacturing output growth caused by any banking reforms. Thus a flexible accommodating banking reform regime is advocated for Nigeria.

Conflict of Interests

The authors have not declared any conflict of interest.

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Appendix A:

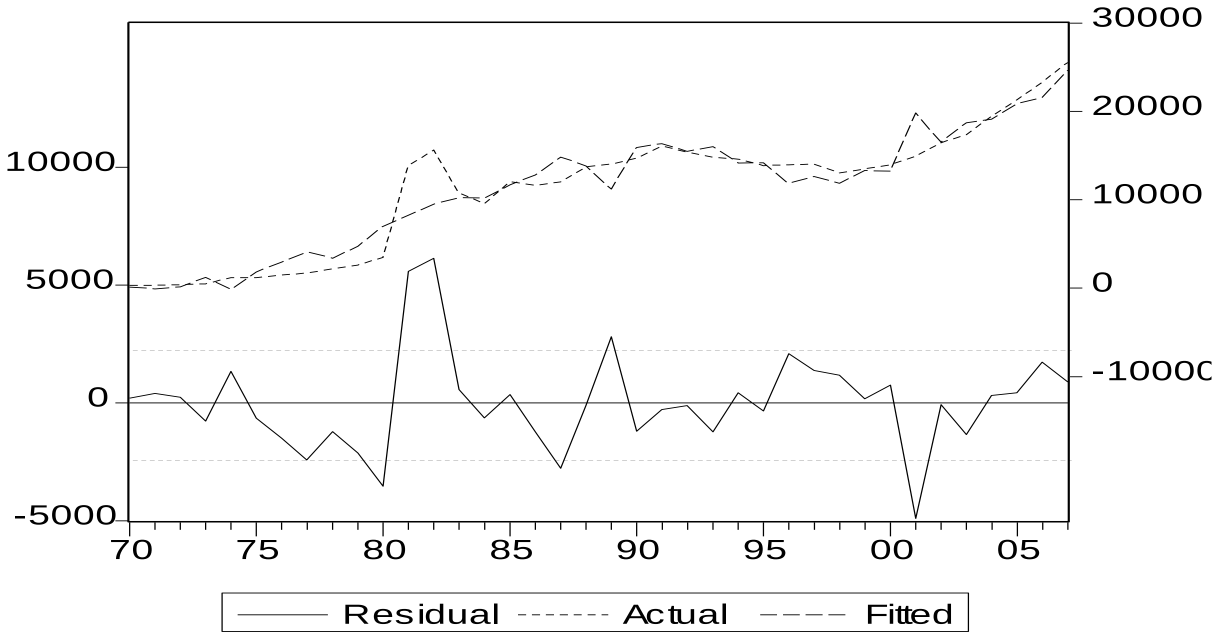

Figure 1. Actual and Fitted graphs of MFGO model

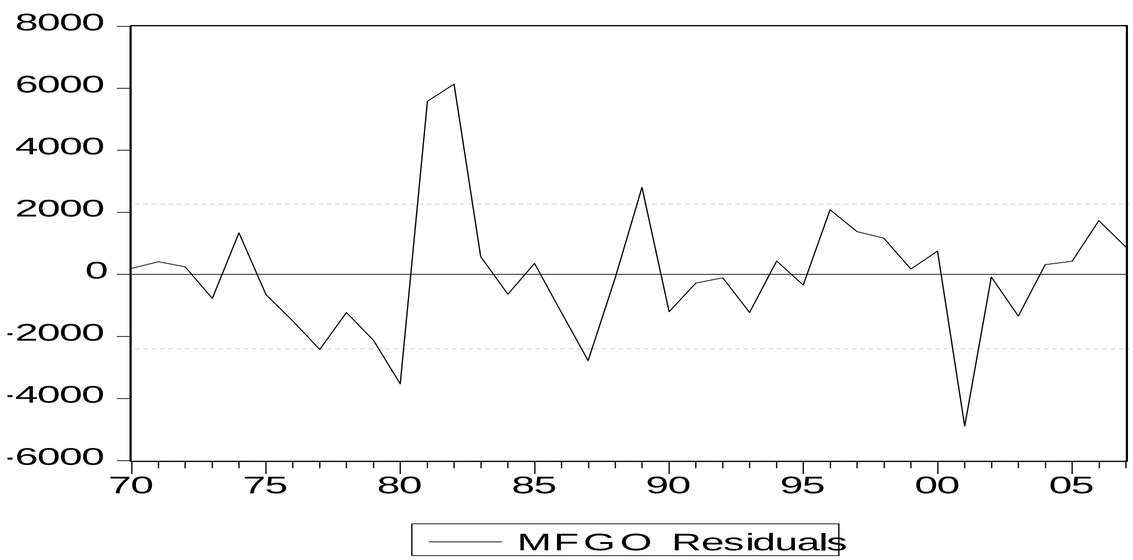

Figure 2. The residual graph of the MFGO model.


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