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Some random fixed point theorems for random multivalued operators on polish space

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ABSTRACT : The objective of this paper is to obtain some fixed point theorems for one and two multivalued operators defined on a Polish space.

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I. INTRODUCTION/PRELIMINARIES

Let (X, d) be a polish space that is a separable complete metric space and (Ω, q) be measurable space. Let 2^x be a family of all subsets of X and CB (X) denote the family of all non-empty bounded closed subsets of X. A mapping $T : \Omega \to 2^X$ is called measurable if for any open subset C of X, $T^{-1}(C) = \{\omega \in \Omega : T(\omega) \cap C \neq \phi\} \in q$. A mapping $\xi : \Omega \to X$ is said to be measurable selector of a measurable mapping $T : \Omega \to 2^X$, if ξ is measurable and for anyof X, T for any open subsetsny open subsets X) denote the family of all non-empty bounded closed subsets of A $\omega \in \Omega$, $\xi(\omega) \in T(\omega)$. A mapping $f : \Omega \times X \to X$ is called random operator, if for any $x \in X$, $f(; x)$ is measurable. A mapping $T : \Omega \times X \to CB(X)$is a random multivalued operator, if for every $x \in X$, $T(; x)$is measurable. A measurable mapping $\xi : \Omega \to X$ is called random fixed point of a random multivalued operator $T : \Omega \times X \to CB(X)$ $(f : \Omega \times X \to X)$, if for every $\omega \in \Omega$, $\xi(\omega) \in T(\omega, \xi(\omega))$ $(f(\omega, \xi(\omega)) = \xi(\omega))$. Let $T : \Omega \times X \to CB(X)$ be a random operator and $\{\xi_n\}$ a sequence of measurable mappings $\xi_n : \Omega \to X$.

II. MAIN RESULT

Theorem 2.1. Let X be a Polish space. Let $T : \Omega \times X \to$ CB(X) be a continuous random multivalued operator. If there exists measurable mapping $a, b : \Omega \to (0, 1)$ such that

$$H(T(\omega, x), T(\omega, y)) \leq \frac{a(\omega) d(y, T(\omega, y))[1 + d(x, T(\omega x))]}{1 + d(x, y)}$$

$$+ b(w)[d(x, T(w, x)) + d(y, T(w, y))] + c(w)d(x, y) \qquad \text{...(A)}$$

for each $x, y \in X$, $\omega \in \Omega$ & $a, b, c \in R^+$ with $a(\omega) + 2b(\omega) + c(\omega) < 1$, then there exists a common random fixed point of T (Here H represents the Hausdroff metric on CB (X) introduced by the metric d).

Proof: Let $\xi_0 : \Omega \to X$ be an arbitrary measurable mappings and choose a measurable mapping $\xi : \Omega \to X$ such that $\xi_1(\omega) \in T(\omega, \xi_0(\omega))$ for each $\omega \in \Omega$. Then for each $\omega \in \Omega$,

$$H(T(\omega, \xi_0(\omega), T(\omega, \xi_1(\omega)))$$

$$\leq \frac{a(\omega) d(\xi_1(\omega), T(\omega, \xi_1(\omega)))[1 + d(\xi_0(\omega), T(\omega, \xi_0(\omega)))]}{1 + d(\xi_0(\omega), \xi_1(\omega))}$$

$$+ b(\omega)[d(\xi_0(\omega), T(\omega, \xi_0(\omega))) + d(\xi_1(\omega), T(\omega, \xi_1(\omega)))]$$

$$+ c(\omega) d(\xi_0(\omega), \xi_1(\omega))$$

It further implies [2 & 1, Lemma 2.3] then there exists a measurable mapping $\xi_2 : \Omega \to X$ such that for any $\omega \in \Omega$, $\xi_2(\omega) \in T(\omega, \xi_1(\omega))$ and

$$d(\xi_1(\omega), \xi_2(\omega)) = H(T(\omega, \xi_0(\omega)), T(\omega, \xi_1(\omega)))$$

$$d(\xi_1(\omega), \xi_2(\omega))$$

$$\leq \frac{a(\omega) d(\xi_1(\omega), T(\omega, \xi_1(\omega)))[1 + d(\xi_0(\omega), T(\omega, \xi_0(\omega)))]}{1 + d(\xi_0(\omega), \xi_1(\omega))}$$

$$+ b(\omega)[d(\xi_0(\omega), T(\omega, \xi_0(\omega))) + d(\xi_1(\omega), T(\omega, \xi_1(\omega)))]$$

$$+ c(\omega) d(\xi_0(\omega), \xi_1(\omega))$$

$$= \frac{a(\omega) d(\xi_1(\omega), \xi_2(\omega))[1 + d(\xi_0(\omega), \xi_1(\omega))]}{1 + d(\xi_0(\omega), \xi_1(\omega))}$$

$$+ b(\omega)[d(\xi_0(\omega), \xi_1(\omega)) + d(\xi_1(\omega), \xi_2(\omega))]$$

$$+ c(\omega) d(\xi_0(\omega), \xi_1(\omega))$$

$$= [a(\omega) + b(\omega)] d(\xi_1(\omega), \xi_2(\omega)) + [b(\omega)$$

$$+ c(\omega)] d(\xi_0(\omega), \xi_1(\omega))$$

$$\Rightarrow [1-(a(\omega)+b(\omega))]d(\xi_1(\omega),\xi_2(\omega))$$

$$\leq [b(\omega)+c(\omega)]d(\xi_0(\omega),\xi_1(\omega))$$

$$\Rightarrow d(\xi_1(\omega),\xi_2(\omega)) \leq \frac{[b(\omega)+c(\omega)]}{1-[a(\omega)+b(\omega)]} d(\xi_0(\omega),\xi_1(\omega))$$

$$d(\xi_1(\omega),\xi_2(\omega)) \leq K d(\xi_0(\omega),\xi_1(\omega))$$

$$where K = \frac{[b(\omega)+c(\omega)]}{1-[a(\omega)+b(\omega)]}$$

$$< 1\ [As\ a(\omega)+2b(\omega)+c(\omega)<1]$$

By above lemma in the same manner, there exists a measurable mapping $\xi_3 : \Omega \to X$ such that for any $\omega \in \Omega$, $\xi_3(\omega) \in T(\omega, \xi_2(\omega))$ and

$$d(\xi_2(\omega),\xi_3(\omega)) = H(T(\omega,\xi_1(\omega)),T(\omega,\xi_2(\omega)))$$

$$d(\xi_2(\omega),\xi_3(\omega))$$

$$\leq \frac{a(\omega)d(\xi_2(\omega),T(\omega,\xi_2(\omega)))[1+d(\xi_1(\omega),T(\omega,\xi_1(\omega)))]}{1+d(\xi_1(\omega),\xi_2(\omega))}$$

$$+b(\omega)[d(\xi_1(\omega),T(\omega,\xi_2(\omega)))+d(\xi_2(\omega),T(\omega,\xi_1(\omega)))]$$

$$+c(\omega)d(\xi_1(\omega),\xi_2(\omega))$$

$$= \frac{a(\omega)d(\xi_2(\omega),\xi_3(\omega))[1+d(\xi_1(\omega),\xi_2(\omega))]}{1+d(\xi_1(\omega),\xi_2(\omega))}$$

$$+b(\omega)[d(\xi_1(\omega),\xi_2(\omega))+d(\xi_2(\omega),\xi_3(\omega))]$$

$$+c(\omega)d(\xi_1(\omega),\xi_2(\omega))$$

$$= [a(\omega)+b(\omega)]d(\xi_2(\omega),\xi_3(\omega))$$

$$+[b(\omega)+c(\omega)]d(\xi_1(\omega),\xi_2(\omega))$$

$$\Rightarrow [1-(a(\omega)+b(\omega))]d(\xi_2(\omega),\xi_3(\omega))$$

$$\leq [b(\omega)+c(\omega)]d(\xi_1(\omega),\xi_2(\omega))$$

$$\Rightarrow d(\xi_2(\omega),\xi_3(\omega)) \leq \frac{[b(\omega)+c(\omega)]}{[1-(a(\omega)+b(\omega))]} d(\xi_1(\omega),\xi_2(\omega))$$

$$\Rightarrow d(\xi_2(\omega),\xi_3(\omega)) \leq K d(\xi_1(\omega),\xi_2(\omega))$$

$$\Rightarrow d(\xi_2(\omega),\xi_3(\omega)) \leq K^2 d(\xi_0(\omega),\xi_1(\omega)),$$

Similarly proceeding in the same way: by induction we produce sequence of measurable mapping $\xi_n : \Omega \to X$ such that for any $\omega \in \Omega$,

$$\xi_{n+1}(\omega) \in T(\omega,\xi_n(\omega))\ where\ n = 0,1,2\ldots and$$

$$d(\xi_n(\omega),\xi_{n+1}(\omega)) \leq K d(\xi_{n-1}(\omega),\xi_n(\omega)) \leq \ldots\ldots$$

$$\leq K^n d(\xi_0(\omega),\xi_1(\omega))$$

Now we shall prove that for $\omega \in \Omega$, $\{\xi_n\}$ is a Cauchy sequence. Further more $m > n$

$$d(\xi_n(\omega),\xi_m(\omega)) \leq d(\xi_n(\omega),\xi_{n+1}(\omega)) + d(\xi_{n+1}(\omega),\xi_{n+2}(\omega)) + \ldots\ldots$$
$$+d(\xi_{m-1}(\omega),\xi_m(\omega))$$

$$\leq K^n d(\xi_0(\omega),\xi_1(\omega)) + K^{n+1} d(\xi_0(\omega),\xi_1(\omega)) + \ldots\ldots\ldots$$

$$+K^{m-1} d(\xi_0(\omega),\xi_1(\omega))$$

$$= (K^n + K^{n+1} + \ldots\ldots\ldots\ldots K^{m-1}) d(\xi_0(\omega),\xi_1(\omega))$$

$$= (1 + K + K^2 + \ldots\ldots\ldots\ldots + K^{m-n-1}) K^n d(\xi_0(\omega),\xi_1(\omega))$$

$$\Rightarrow d(\xi_n(\omega),\xi_m(\omega)) \leq \frac{K^n}{1-K} d(\xi_0(\omega),\xi_1(\omega))$$

as $n, m \to \infty$, $d(\xi_n(\omega),\xi_m(\omega)) \to 0$ it follows that for $\omega \in \Omega$, $\{\xi_n(\omega)\}$ is a Cauchy sequence and there exists a measurable mapping $\xi : \Omega \to X$ such that $\xi_n(\omega) \to \xi(\omega)$ for each $\omega \in \Omega$. It further implies that

$$\xi_n(\omega) \to \xi(\omega) \text{ and } \xi_{n+1}(\omega) \to \xi(\omega)$$

Existence of random fixed point. For $\omega \in \Omega$

$$d(\xi(\omega),T(\omega,\xi(\omega))) \leq d(\xi(\omega),\xi_{n+1}(\omega))$$
$$+d(\xi_{n+1}(\omega),T(\omega,\xi(\omega)))$$

$$= d(\xi(\omega),\xi_{n+1}(\omega)) + d(T(\omega,\xi_n(\omega)),T(\omega,\xi(\omega)))$$

$$\leq d(\xi(\omega),\xi_{n+1}(\omega))$$

$$+\frac{a(\omega)d(\xi(\omega),T(\omega,\xi(\omega)))[1+d(\xi_n(\omega),T(\omega,\xi_n(\omega)))]}{1+d(\xi_n(\omega),\xi(\omega))}$$

$$+b(\omega)[d(\xi_n(\omega),T(\omega,\xi(\omega)))+d(\xi(\omega),T(\omega,\xi_n(\omega)))]$$

$$+c(\omega)d(\xi_n(\omega),\xi(\omega))$$

$$= d(\xi(\omega),\xi_{n+1}(\omega))$$

$$+\frac{a(\omega)d(\xi(\omega),T(\omega,\xi(\omega)))[1+d(\xi_n(\omega),\xi_{n+1}(\omega))]}{1+d(\xi_n(\omega),\xi(\omega))}$$

$$+b(\omega)[d(\xi_n(\omega),\xi_{n+1}(\omega))+d(\xi(\omega),T(\omega,\xi(\omega)))]$$

$$+c(\omega)d(\xi_n(\omega),\xi(\omega))$$

$$d(\xi(\omega), T(\omega, \xi(\omega))) \le d(\xi(\omega), \xi(\omega))$$

$$+ \frac{a(\omega)\, d(\xi(\omega), T(\omega, \xi(\omega)))[1 + d(\xi(\omega), \xi(\omega))]}{1 + d(\xi(\omega), \xi(\omega))}$$

$$+ b(\omega)[d(\xi(\omega), \xi(\omega)) + d(\xi(\omega), T(\omega, \xi(\omega)))]$$

$$+ c(\omega)\, d(\xi(\omega), (\xi(\omega)) \text{ [As n } \to \infty]$$

$$= a(\omega)\, d(\xi(\omega), T(\omega, \xi(\omega))) + b(\omega)\, d(\xi(\omega), T(\omega, \xi(\omega)))$$

$$\Rightarrow [1 - (a(\omega) + b(\omega))] d(\xi(\omega), T(\omega, \xi(\omega))) \le 0$$

$$\Rightarrow d(\xi(\omega), T(\omega, \xi(\omega))) = 0 \text{ [As } a(\omega) + b(\omega) < 1]$$

Hence $\xi(\omega) \in T(\omega, \xi(\omega))$ for $\omega \in \Omega$.

This completes the proof of the theorem.

Theorem: 2.2 Let X be a Polish space. Let $T, S : \Omega \times X \to CB(X)$ be two continuous random multivalued operators. If there exists measurable mapping δ : $\Omega \to (0, 1)$ such that

$$H(S(\omega, x), T(\omega, y)) \le \delta \max\{d(x, y),$$
$$[d(x, S(\omega, x)) + d(y, T(\omega, y))],$$

$$[d(x, T(\omega, y)) + d(y, S(\omega, x))]\} \ldots\ldots\ldots\ldots(1)$$

for each then $x, y \in X, \omega \in \Omega$ and $0 < \delta < \frac{1}{2}$ S, T have a common fixed point on X (Here H represents the Hausdroff metric on CB (X) introduced by the metric d)

Proof : Let $\xi_0 : \Omega \to X$ be an arbitrary measurable mapping $\xi : \Omega \to X$ & choose a measurable mapping such that $\xi_1(\omega) \in S(\omega, \xi_0(\omega))$ for each $\omega \in \Omega$,

$$H(S(\omega, \xi_0(\omega)), T(\omega, \xi_1(\omega)) \le \delta \max\{d(\xi_0(\omega), \xi_1(\omega)),$$
$$[d(\xi_0(\omega), S(\omega), \xi_0(\omega)) + d(\xi_1(\omega), T(\omega, \xi_1(\omega))],$$

$$[d(\xi_0(\omega), T(\omega), \xi_1(\omega)) + d(\xi_1(\omega), S(\omega, \xi_0(\omega))]\}$$

It further implies [2 & 1, Lemma 2.3] then there exists a measurable mapping $\xi_2 : \Omega \to X$ such that for any $\omega \in \Omega$, $\xi_2(\omega) \in T(\omega, \xi_1(\omega))$ and

$$d(\xi_1(\omega), \xi_2(\omega)) = H(S(\omega), \xi_0(\omega)), T(\omega, \xi_1(\omega)))$$
$$d(\xi_1(\omega), \xi_2(\omega)) \le \delta \max\{d(\xi_0(\omega), \xi_1(\omega)),$$
$$[d(\xi_0(\omega), \xi_1(\omega)) + d(\xi_1(\omega), \xi_2(\omega))],$$
$$[d(\xi_0(\omega), \xi_2(\omega)) + d(\xi_1(\omega), \xi_1(\omega))]\}$$

$$= \delta \max\{d(\xi_0(\omega), \xi_1(\omega)), [d(\xi_0(\omega), \xi_1(\omega))$$

$$+ d(\xi_1(\omega), \xi_2(\omega))], [d(\xi_0(\omega), \xi_2(\omega))]\}$$

$$= \delta [d(\xi_0(\omega), \xi_1(\omega)) + d(\xi_1(\omega), \xi_2(\omega))]$$

$$\Rightarrow (1 - \delta) d(\xi_1(\omega), \xi_2(\omega)) \le \delta\, d(\xi_0(\omega), \xi_1(\omega))$$

$$\Rightarrow d(\xi_1(\omega), \xi_2(\omega)) \le \frac{\delta}{(1-\delta)} d(\xi_0(\omega), \xi_1(\omega))$$

$$\Rightarrow d(\xi_1(\omega), \xi_2(\omega)) \le K d(\xi_0(\omega), \xi_1(\omega))$$

$$\text{where } K = \frac{\delta}{(1-\delta)} < 1$$

By above lemma in the same manner there exists measurable mapping $\xi_3 : \Omega \to X$ such that for any $\omega \in \Omega$, $\xi_3(\omega) \in S(\omega, \xi_2(\omega))$ and

$$d(\xi_2(\omega), \xi_3(\omega)) = d(\xi_3(\omega), \xi_2(\omega))$$
$$= H(S(\omega, \xi_2(\omega)), T(\omega, \xi_1(\omega)))$$

$$\le \delta \max\{d(\xi_2(\omega), \xi_1(\omega)), [d(\xi_2(\omega), S(\omega, \xi_2(\omega))$$

$$+ d(\xi_1(\omega), T(\omega, \xi_1(\omega))],$$

$$[d(\xi_2(\omega), T(\omega, \xi_1(\omega)) + d(\xi_1(\omega), S(\omega, \xi_2(\omega)))\}$$

$$\Rightarrow d(\xi_2(\omega), \xi_3(\omega)) \le \delta \max\{d(\xi_1(\omega), \xi_2(\omega)),$$

$$[d(\xi_2(\omega), \xi_3(\omega)) + d(\xi_1(\omega), \xi_2(\omega))],$$

$$[d(\xi_2(\omega), \xi_2(\omega)) + d(\xi_1(\omega), \xi_3(\omega))]\}$$

$$= \delta \max\{d(\xi_1(\omega), \xi_2(\omega)), [d(\xi_1(\omega), \xi_2(\omega)) + d(\xi_2(\omega), \xi_3(\omega))],$$

$$[d(\xi_1(\omega), \xi_3(\omega))]\}$$

$$= \delta [d(\xi_1(\omega), \xi_2(\omega)) + d(\xi_2(\omega), \xi_3(\omega))]$$

$$\Rightarrow (1 - \delta) d(\xi_2(\omega), \xi_3(\omega)) \le \delta\, d(\xi_1(\omega), \xi_2(\omega))$$

$$\Rightarrow d(\xi_2(\omega), \xi_3(\omega)) \le \frac{\delta}{1-\delta} d(\xi_1(\omega), \xi_2(\omega))$$

$$= K d(\xi_1(\omega), \xi_2(\omega))$$

$$\text{where } K = \frac{\delta}{1-\delta} < 1 \text{ [As } 2\delta < 1]$$

$$\Rightarrow d(\xi_2(\omega), \xi_3(\omega)) \le K^2 d(\xi_0(\omega), \xi_1(\omega))$$

Similarly, proceeding in the same way: by induction, we produce a sequence of measurable mapping $\xi_n : \Omega \to X$ such that for $\gamma > 0$ and any $\omega \in \Omega$,

$$\xi_{2\gamma+1}(\omega) \in S(\omega, \xi_{2\gamma}(\omega)), \xi_{2\gamma+2}(\omega) \in T(\omega, \xi_{2\gamma+1}(\omega))$$
$$\text{and } d(\xi_n(\omega), \xi_{n+1}(\omega)) \le K d(\xi_{n-1}(\omega), \xi_n(\omega)) \le \ldots.$$
$$\le K^n d(\xi_0(\omega), \xi_1(\omega))$$

Now we shall prove that for $\omega \in \Omega$, $\{\xi_n(\omega)\}$ is a Cauchy sequence, further more for $m > n$

$$d(\xi_n(\omega),\xi_m(\omega)) \le d(\xi_n(\omega),\xi_{n+1}(\omega)) + d(\xi_{n+1}(\omega),\xi_{n+2}(\omega)) + \dots + d(\xi_{m-1}(\omega),\xi_m(\omega))$$

$$\le K^n d(\xi_0(\omega),\xi_1(\omega)) + K^{n+1} d(\xi_0(\omega),\xi_1(\omega)) + \dots\dots + K^{m-1} d(\xi_0(\omega),\xi_1(\omega))$$

$$= (K^n + K^{n+1} + \dots\dots K^{m-1}) d(\xi_0(\omega),\xi_1(\omega))$$

$$= (1 + K + K^2 + \dots\dots + K^{m-n-1}) K^n d(\xi_0(\omega),\xi_1(\omega))$$

$$\Rightarrow d(\xi_n(\omega),\xi_m(\omega)) \le \frac{K^n}{1-K} d(\xi_0(\omega),\xi_1(\omega))$$

as $n, m \to \infty$, $d(\xi_n(\omega),\xi_m(\omega)) \to 0$ it follows that for $\omega \in \Omega$, $\{\xi_n(\omega)\}$ is a Cauchy sequence and there exists a measurable mapping $\xi : \Omega \to X$ such that $\xi_n(\omega) \to \xi(\omega)$ for each $\omega \in \Omega$ it further implies that $\xi_{2\gamma+1}(\omega) \to \xi(\omega)$ and $\xi_{2\gamma+2}(\omega) \to \xi(\omega)$

Existence of fixed point. For $\omega \in \Omega$

$$d(\xi(\omega), S(\omega,\xi(\omega))) \le d(\xi(\omega),\xi_{2\gamma+2}(\omega)) + d(\xi_{2\gamma+2}(\omega), S(\omega,\xi(\omega)))$$

$$= d(\xi(\omega),\xi_{2\gamma+2}(\omega)) + H(T(\omega,\xi_{2\gamma+1}(\omega)), S(\omega,\xi(\omega)))$$

$$\le d(\xi(\omega),\xi_{2\gamma+2}(\omega)) + \delta \max\{d(\xi_{2\gamma+1}(\omega),\xi(\omega)),$$

$$[d(\xi_{2\gamma+1}(\omega), T(\omega,\xi_{2\gamma+1}(\omega))) + d(\xi(\omega), S(\omega,\xi(\omega)))]$$

$$[d(\xi_{2\gamma+1}(\omega), S(\omega,\xi(\omega))) + d(\xi(\omega), T(\omega,\xi_{2\gamma+1}(\omega)))]\}$$

$$= d(\xi(\omega),\xi_{2\gamma+2}(\omega)) + \delta \max(d(\xi_{2\gamma+1}(\omega),\xi(\omega)),$$

$$[d(\xi_{2\gamma+1}(\omega),\xi_{2\gamma+2}(\omega)) + d(\xi(\omega), S(\omega,\xi(\omega)))],$$

$$[d(\xi_{2\gamma+1}(\omega), S(\omega,\xi(\omega))) + d(\xi(\omega),\xi_{2\gamma+2}(\omega))]\}$$

As $\{\xi_{2\gamma+1}(\omega)\}, \{\xi_{2\gamma+2}(\omega)\}$ are sub sequences of $\{\xi_{2\gamma}(\omega)\}$ as $\gamma \to \infty$ $\xi_{2\gamma+1}(\omega) \to \xi(\omega), \xi_{2\gamma+2}(\omega) \to \xi(\omega)$

$$\Rightarrow d(\xi(\omega), S(\omega,\xi(\omega))) \le d(\xi(\omega),\xi(\omega)) + \delta \max\{d(\xi(\omega),\xi(\omega)),$$

$$[d(\xi(\omega),\xi(\omega)) + d(\xi(\omega), S(\omega,\xi(\omega)))],$$

$$[d(\xi(\omega), S(\omega,\xi(\omega))) + d(\xi(\omega),\xi(\omega))]\}$$

$$\le \delta d(\xi(\omega), S(\omega,\xi(\omega)))$$

$$\Rightarrow (1-\delta) d(\xi(\omega), S(\omega,\xi(\omega))) \le 0$$

$$\Rightarrow d(\xi(\omega), S(\omega,\xi(\omega))) = 0 \text{ [As } \delta < \tfrac{1}{2}]$$

Hence $\xi(\omega) \in S(\omega,\xi(\omega))$ for $\omega \in \Omega$.

Similarly we can prove that

$\xi(\omega) \in T(\omega,\xi(\omega))$ for $\omega \in \Omega$.

This completes the proof of the theorem.

Corollary 2.3. Let X be a Polish space. Let T, S : $\Omega \times X \to$ CB (X) be two continuous random multivalued operators. If there exists measurable mapping $a, b : \Omega \to (0, 1)$ such that

$$H(T(\omega,x),T(\omega,y)) \le \delta \max\{d(x,y),$$
$$[d(x,T(\omega,x)) + d(y,T(\omega,y))],$$
$$[d(x,T(\omega,y)) + d(y,T(\omega,x))]\}$$

for each $x, y \in X, \omega \in \Omega$ and $0 < \delta < \frac{1}{2}$ then T has a common fixed point on X (Here H represents the Hausdroff metric on CB (X) introduced by the metric d)

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