

ON THE q -ANALOGUES FOR SOME KANTOROVICH TYPE LINEAR OPERATORS

NAZLIM DENİZ ARAL* AND ZEYNEP SEVINÇ

Abstract. In this paper, we present some Kantorovich type positive linear operators and we introduce the new modification q -Baskakov-Kantorovich operators. We prove the convergence of the new operators using the Korovkin criterion and establish the rate of convergence involving the modulus of continuity. Also, some numerical results to illustrate the convergence of these operators.

Mathematics subject classification (2020): 05A30, 47B38, 47B65.

Keywords and phrases: q -Baskakov-Kantorovich operators, q -integers, modulus of continuity, Korovkin-type theorem, rate of convergence.

REFERENCES

- [1] T. ACAR, A. ARAL AND S. A. MOHIUDDINE, *On Kantorovich modification of (p, q) -Baskakov operators*, J. Inequal. Appl., (2016), Article ID 98.
- [2] P. N. AGRAWAL AND M. GOYAL, *Generalized Baskakov Kantorovich Operators*, Filomat, **31**, 19 (2017), 6131–6151.
- [3] A. ARAL AND V. GUPTA, *On q -Baskakov type operators*, Demons. Math., **42**, 1 (2009), 109–122.
- [4] A. ARAL AND V. GUPTA, *On the Durrmeyer type modification of the q -Baskakov type operators*, Nonlinear Anal.: Theor. Meth. Appl., **72**, 3–4 (2010), 1171–1180.
- [5] A. ARAL AND V. GUPTA, *Generalized q -Baskakov operators*, Math. Slovaca, **61**, 4 (2011), 619–634.
- [6] A. ARAL, V. GUPTA AND R. P. AGARVAL, *Applications of q -calculus in Operator Theory*, Springer, New York, (2013).
- [7] V. A. BASKAKOV, *An instance of a sequence of the linear positive operators in the space of continuous functions*, Docl. Akad. Nauk SSSR, **113**, (1957), 249–251.
- [8] K. BOGALSKA, *The Voronovskaya type theorem for the Baskakov-Kantorovich operators*, Fasc. Math., **30**, (1999), 5–13.
- [9] F. CAO AND C. DING, *L_p approximation by multivariate Baskakov-Kantorovich operators*, J. Math. Anal. Appl., **348**, 2 (2008), 856–861.
- [10] R. A. DEVORE AND G. G. LORENTZ, *Constructive Approximation*, Springer, Berlin, (1993).
- [11] Z. DITZIAN AND V. TOTIK *Moduli of smoothness*, Springer-Verlag, Berlin/New York, (1987).
- [12] O. DOĞRU AND O. DUMAN, *Statistical approximation of Meyer-König and Zeller operators based on the q -integers*, Publ. Math. Debrecen, **68**, (2006), 190–214.
- [13] O. DOĞRU AND K. KANAT, *On statistical approximation properties of the Kantorovich type Lupas operators*, Math. Comput. Model., **55**, (2012), 1610–1621.
- [14] A. ERENCIN AND S. BÜYÜKDURAKOĞLU, *A modification of generalized Baskakov-Kantorovich operators*, Stud. Univ. Babeş-Bolyai Math., **59**, 3 (2014), 351–364.
- [15] T. ERNST, *A new notation for q -calculus and new q -Taylor formula*, U.U.D.M. Report 1999:25, ISSN 1101-3591, Department of Mathematics, Uppsala University, 1999.
- [16] I. GADJEV, *Approximation of Functions by Baskakov-Kantorovich Operator*, Results. Math., **70**, (2016), 385–400.
- [17] V. GUPTA AND C. RADU, *Statistical approximation properties of q -Baskakov-Kantorovich operators*, Cent. Eur. J. Math., **7**, 4 (2009), 809–818.

- [18] Z. FINTA AND V. GUPTA, *Approximation properties of q -Baskakov Operators*, Cent. Eur. J. Math., **8**, 1 (2010), 199–211.
- [19] W. HEPING, *Properties of convergence for the q -Meyer-König and Zeller operators*, J. Math. Anal. Appl., **335**, 2 (2007), 1360–1373.
- [20] F. H. JACKSON, *On q -functions and a certain difference operator*, Transactions of the Royal Society Edinburgh, **46**, 2 (1909), 253–281.
- [21] L. V. KANTOROVICH, *Sur certain développements suivant les polynômes de la forme de S. Bernstein, I, II.*, C.R. Acad. Sci. USSR A, (1930), 563–568, 595–600.
- [22] A. LUPAS, *A q -analogue of the Bernstein operator*, In Seminar on Numerical and Statistical Calculus, University of Cluj-Napoca, **9**, (1987), 85–92.
- [23] N. I. MAHMUDOV, *Statistical approximation of Baskakov and Baskakov-Kantorovich operators based on the q -integers*, Cent. Eur. J. Math., **8**, 4 (2010), 816–826.
- [24] N. I. MAHMUDOV AND P. SABANCIGIL, *Approximation Theorems for q -Bernstein-Kantorovich Operators*, Filomat, **27**, 4 (2013), 721–730.
- [25] S. OSTROVSKA, *q -Bernstein polynomials and their iterates*, J. Approx. Theory, **123**, 2 (2003), 232–255.
- [26] G. M. PHILLIPS, *Bernstein polynomials based on the q -integers*, Ann. Numer. Math., **4**, (1997), 511–518.
- [27] C. RADU, *On statistical approximation of a general class of positive linear operators extended in q -calculus*, Math. Comput., **215**, 6 (2009), 2317–2325.
- [28] E. ŞİMŞEK, *On a New Type of q -Baskakov Operators*, Süleyman Demirel Üniversitesi Fen Bil. Derg., **22**, 1 (2018), 121–125.
- [29] E. ŞİMŞEK AND T. TUNÇ, *On the construction of q -analogues for some positive linear operators*, Filomat, **31**, 13 (2017), 4287–4295.
- [30] E. ŞİMŞEK AND T. TUNÇ, *On approximation properties of some class positive linear operators in q -analysis*, J. Math. Inq., **12**, 2 (2018), 4287–4295.
- [31] A. WAFI AND S. KHATOON, *The Voronovskaya theorem for generalized Baskakov-Kantorovich operators in polynomial weight spaces*, Mat. Vesnik, **57**, 3–4 (2005), 87–94.
- [32] C. ZHANG AND Z. ZHU, *Preservation properties of the Baskakov-Kantorovich operators*, Comput. Mat. Appl., **57**, 9 (2009), 1450–1455.