

MONOTONIC PROPERTIES FOR RATIO OF THE GENERALIZED (p,k) -POLYGAMMA FUNCTIONS

LI YIN

Abstract. In this paper, we show monotonic properties for ratio of the generalized (p,k) -polygamma functions by using Mehrez-Sitnik method. The new inequalities extend the known result obtained by Feng Qi.

Mathematics subject classification (2020): 33B15.

Keywords and phrases: Generalized (p,k) -polygamma functions, monotonicity, inequality.

REFERENCES

- [1] H. ALZER, *On some inequalities for the gamma and psi functions*, Math. Comp., **66** (1997), 373–389.
- [2] H. ALZER AND G. JAMESON, *A harmonic mean inequality for the digamma function and related results*, Rend. Sem. Mat. Univ. Padova, **137** (2017), 203–209.
- [3] H. ALZER AND J. WELLS, *Inequality for the polygamma functions*, SIAM J. Math. Anal., **29**, No. 6, (2017), 1459–1466.
- [4] C. BERG AND H. L. PEDERSEN, *A completely monotone function related to the gamma function*, J. Comp. Appl. Math., **133** (2001), 219–230.
- [5] M. C. COFFEY, *On one-dimensional digamma and polygamma series related to the evaluation of Feynman diagrams*, J. Comp. Appl. Math., **183** (2005), 84–100.
- [6] R. DIAZ AND E. PARIGUAN, *On hypergeometric functions and Pachhammer k -symbol*, Divulg. Math., **15**, No. 2 (2007), 179–192.
- [7] P. J. DOELDER, *On some series containing $\psi(x) - \psi(y)$ and $(\psi(x) - \psi(y))^2$ for certain values of x and y* , J. Comp. Appl. Math., **37** (1991), 125–141.
- [8] D. K. LIM AND F. QI, *Increasing property and logarithmic convexity of two functions involving Dirichlet eta function*, J. Math. Inequal., **16**, No. 2 (2022), 463–469.
- [9] M. R. MURTY AND N. SARADHA, *Transcendental values of the digamma function*, J. Number Theory, **125** (2007), 298–318.
- [10] M. MEHREZ AND S. M. SITNIK, *Proofs of some conjectures on monotonicity of ratios of Kummer, Gauss and generalized hypergeometric functions*, Analysis, **36**, No. 4 (2016), 263–268, Available online at <http://arxiv.org/abs/1411.6120>.
- [11] K. NANTOMAH, *Convexity properties and inequalities concerning the (p,k) -gamma function*, Commun. Fac. Sci. Univ. Ank. Series A1, **66**, No. 2 (2017), 130–140.
- [12] K. NANTOMAH, F. MEROCVCI AND S. NASIRU, *Some monotonic properties and inequalities for the (p,q) -gamma function*, Kragujevac J. Math., **42**, No. 2, (2018), 287–297.
- [13] K. NANTOMAH, E. PREMPEH AND S. B. TWUM, *On a (p,k) -analogue of the gamma function and some associated inequalities*, Moroccan. J. Pure and Appl. Anal., **2**, No. 2 (2016), 79–90.
- [14] O. M. OGREID AND P. OSLAND, *Some infinite series related to Feynman diagrams*, J. Comp. Appl. Math., **140** (2002), 659–671.
- [15] F. QI, *Lower bound of sectional curvature of Fisher–Rao manifold of beta distributions and complete monotonicity of functions involving polygamma functions*, Results Math. **76** (2021), no. 4, Article 217, 16 pages.
- [16] F. QI, *Decreasing properties of two ratios defined by three and four polygamma functions*, Comptes Rendus Mathématique, **360** (2022), 89–101.

- [17] F. QI AND C.-P. CHEN, *A complete monotonicity property of the gamma function*, J. Math. Anal. Appl., **296** (2004), 603–607.
- [18] F. QI AND B.-N. GUO, *Complete monotonicities of functions involving the gamma and digamma functions*, RGMIA Res. Rep. Coll., **7**, No. 1 (2004), 63–72.
- [19] F. QI AND B.-N. GUO, *Some logarithmically completely monotonic functions related to the gamma function*, J. Korean Math. Soc., **47**, No. 6 (2010), 1283–1297.
- [20] F. QI, B.-N. GUO AND C.-P. CHEN, *Some completely monotonic functions involving the gamma and plogamma functions*, RGMIA Res. Rep. Coll., **7**, No. 1 (2004), 31–36.
- [21] F. QI, B.-N. GUO AND C.-P. CHEN, *Some completely monotonic functions involving the gamma and plogamma functions*, J. Aust. Math. Soc., **80** (2006), 81–88.
- [22] F. QI, S.-L. GUO AND B.-N. GUO, *Complete monotonicity of some functions involving plogamma functions*, J. Comp. Appl. Math., **233** (2010), 2149–2160.
- [23] F. QI, W. -H. LI, S. -B. YU, et al. *A ratio of finitely many gamma functions and its properties with applications*, Rev. R. Acad. Cienc. Exactas Fis. Nat. Ser. A Math. RACSAM. **115**, No. 2, (2021), 14 pages.
- [24] M. E. H. ISMAIL, M. E. MULDOON AND L. LORCH, *Completely monotonic functions associated with the gamma function and its q -analogues*, J. Math. Anal. Appl., **116** (1986), 1–9.
- [25] L. YIN, *A monotonic properties for ratio of the generalized polygamma functions*, Octogon Math. Mag., **27**, No. 1, (2019), 92–100.
- [26] L. YIN AND W. -Y. CUI, *A generalization of Alzer inequality related to exponential function*, Proceeding Jangjeon Math. Sci., **18**, No. 3, (2016), 385–388.
- [27] L. YIN, L.-G. HUANG, ZH.-M. SONG AND X.-K. DOU, *Some monotonicity properties and inequalities for the generalized digamma and polygamma functions*, J. Inequal. Appl. (2018) 2018:249.