



A note on Turán type and mean inequalities for the Kummer function

Roger W. Barnard^a, Michael B. Gordy^{b,1}, Kendall C. Richards^{c,*}

^a Department of Mathematics, Texas Tech University, Lubbock, TX 79409, United States

^b Division of Research and Statistics, Federal Reserve Board, Washington, DC 20551, United States

^c Department of Mathematics, Southwestern University, Georgetown, TX 78627, United States

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ABSTRACT

Turán-type inequalities for combinations of Kummer functions involving $\Phi(a \pm v, c \pm v, x)$ and $\Psi(a, c \pm v, x)$ have been recently investigated in [Á. Baricz, Functional inequalities involving Bessel and modified Bessel functions of the first kind, Expo. Math. 26 (3) (2008) 279–293; M.E.H. Ismail, A. Laforgia, Monotonicity properties of determinants of special functions, Constr. Approx. 26 (2007) 1–9]. In the current paper, we resolve the corresponding Turán-type and closely related mean inequalities for the additional case involving $\Phi(a \pm v, c, x)$. The application to modeling credit risk is also summarized.

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1. Introduction

The Kummer confluent hypergeometric function is given by

$$\Phi(\alpha, \beta, x) = \sum_{n=0}^{\infty} \frac{(\alpha)_n x^n}{(\beta)_n n!},$$

where $(\alpha)_n$ is the Pochhammer symbol defined by $(\alpha)_n = \Gamma(\alpha + n)/\Gamma(\alpha) = \alpha(\alpha + 1) \cdots (\alpha + n - 1)$ for $n \in \mathbb{N}$, $(\alpha)_0 = 1$, $(\alpha + 1)_{-1} = \frac{1}{\alpha}$, and the Gamma function is $\Gamma(x) = \int_0^{\infty} t^{x-1} e^{-t} dt$, for $x > 0$.

Inequalities involving contiguous Kummer confluent hypergeometric functions of the form $\Phi(a \pm v, c \pm v, x)$ and $\Psi(a, c \pm v, x)$ were presented in Theorem 2 of [4] and Theorem 2.7 of [11]. These inequalities are of the Turán type [15] in the case that $v = 1$. In the present note, we resolve the remaining Turán-type case involving $\Phi(a \pm 1, c, x)$ and extend it to include $\Phi(a \pm v, c, x)$, $v \in \mathbb{N}$. We then establish a closely related mean inequality that provides simultaneous upper and lower bounds for $\Phi(a, c, x)$. Turán-type inequalities, which are of independent interest, also have important applications in Information Theory (as demonstrated by McEliece, Reznick, and Shearer in their paper [12]) and in modeling credit risk, as summarized below.

In particular, Carey and Gordy [9] model a lending relationship in which the bank has an option to foreclose upon the borrower at any time. Following the seminal models of Merton [13] and Black and Cox [6], it is assumed that the value of the firm's assets follows a geometric Brownian motion. It is shown that the bank's optimal foreclosure threshold solves a first order condition involving a ratio of contiguous Kummer functions, which implies that a Turán-type inequality for the Kummer function arises naturally in studying the comparative statics of the model. A proof of this key Turán-type

* Corresponding author.

E-mail addresses: roger.w.barnard@ttu.edu (R.W. Barnard), michael.gordy@frb.gov (M.B. Gordy), richards@southwestern.edu (K.C. Richards).

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