1.3 Overview of dissertation

In our literature review, the known extensions to the Dirichlet distribution (e.g., Connor and Mosimann, 1969; Dickey, 1983; Krzysztofowicz and Reese, 1993), and other known distributions on the positive orthant $\Re_{+}^{n}$ (such as Liouville distributions and their generalizations), will be given, as well as several measures of independence. These will be discussed in chapters 2 - 4. However, we do not have any comments about the distributions given by Grunwald, Raftery, and Guttorp (1993) and Gupta and Richards (1995), so they will not be discussed further. In these chapters, we will also propose some new forms of independence, and will explore the relations between the known simplex distributions, their covariance structures, and some newly discovered properties of these distributions.

Following the discussion in chapters 2-4, several different classes of new distributions will be proposed. These include:

1) Adaptive Dirichlet distributions with dependent ratios,

2) Liouville distributions with a non-Dirichlet base,

and

3) Other new simplex and positive orthant distributions created by partitioning.

In chapter 5, the need to develop adaptive Dirichlet distributions with dependent ratios (i.e., by relaxing the independent bifurcation assumption considered by Krzysztofowicz and Reese, 1993) will be demonstrated via examples. In addition, by considering the possible correlation sign structures, we will show that the adaptive Dirichlet distribution with dependent ratios is a more flexible modeling tool than the adaptive Dirichlet with independent ratios, and will discuss some feasible approaches for constructing specific distributions from this new class.

Chapter 6 delineates a conceptual framework for developing more new positive orthant distributions. In this chapter we discuss in detail extensions to the Liouville distribution with a multiple Dickey base. These new distributions will be shown to have significantly more general covariance and dependence structures than the Liouville and generalized Liouville distributions.

In chapter 7, we are interested in finding joint prior distributions for the system state probabilities in reliability systems so that the posterior system failure probability obtained by updating this prior with component-level data is the same as if we instead used system-level data. This property has been described as "perfect aggregation" (Bier, 1994 and Azaiez, 1993). We identify a number of distributions that have this property, including several existing unit simplex distributions as well as a new family of distributions developed in this chapter.

In chapter 8, we will discuss the application of the adaptive Dirichlet distribution to a snowmelt runoff problem, and note that Krzysztofowicz and Reese's original models were not entirely satisfactory. We then reanalyze this problem using adaptive Dirichlet distributions with dependent ratios, as developed in chapter 5.

Chapter 9 documents a simulation study comparing the performance of the adaptive Dirichlet distribution with and without dependent ratios in fitting data generated using a given correlation structure. The results of this simulation will help to determine whether the dependent ratios model we have developed in fact performs better than the independent ratios model developed by Krzysztofowicz and Reese when we know that the data were generated using dependence. Finally, our conclusions and suggestions for future research will be given in chapter 10.