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A COMBINED MLE AND EWMA CHART APPROACH TO ESTIMATE THE CHANGE POINT OF A GAMMA PROCESS WITH INDIVIDUAL OBSERVATIONS

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Abstract. *Statistical process control (SPC) charts are commonly used for detecting process disturbances. However, they do not provide enough information to identify the root causes of an out-of-control process. This difficulty can be overcome if we are able to promptly estimate the change point of a process, due to the fact that the change point usually reveals the most accurate information about root causes. As a consequence, this estimation becomes a very important research issue in SPC applications. Although recent studies have shown that the maximum likelihood estimation (MLE) estimator could be an effective estimate of the change point for a normal process, very little is known about the feasibility of using an MLE estimator for a gamma process with individual observations. In this study, our goal is to propose a fruitful approach to solving this problem. This study proposes the combination of MLE and the exponentially weighted moving average (EWMA) control charts to estimate the change point of a gamma process. We investigate various SPC modes and gamma process designs in this study, and the results show that an effective change point estimator could be achieved.*

Keywords: Exponentially weighted moving average, Gamma process, Individual observations, Change point, Maximum likelihood estimation

1. **Introduction.** Statistical process control (SPC) charts are commonly used for detecting the presence of disturbances in a process. The primary function of SPC charts is that an out-of-control signal will be triggered when the process disturbances have occurred in the process. It is believed that the quality characteristic of a product follows a certain type of probability distribution. The correspondence of the upper control limit (UCL) and lower control limit (LCL) can be calculated by specifying the type I error. A triggered signal implies that the root causes of the disturbances have intruded upon the process. At this point, the parameters of the probability distribution of a process are changed, and this is sometimes referred as the "change point" of a process.

It is worthwhile to distinguish the difference between the change point and the SPC signal. The change point is the starting time of a process disturbance, and the SPC signal indicates the time when the out-of-control state is detected by the SPC charts. As you can see, the change point time occurs first, and then the SPC signal is subsequently triggered. Although SPC charts are able to trigger a signal when disturbances have occurred in the process, it may still take a good while to determine the root causes. The primary reason for identifying the change point is to quickly and precisely determine the root causes of the disturbance. This identification is clearly able to enhance the process improvement.