ABSTRACT

In many areas it is important to detect the turning points in an on-going process. The main application in this thesis is detection of turns in business cycles. However, the methods presented here can also be used for other applications, one of which is natural family planning, where the detection of turns in body temperature and other indicators are important. The time of the detection is vital and this is considered in the theory of statistical surveillance. We study surveillance systems that are developed for cyclical processes in order to detect a turning point as soon as possible after it has occurred. A surveillance system is based on an alarm statistic and alarm limits. The main focus in the thesis is on a new approach, which is completely non-parametric regarding the shape of the turning point. The performance of this new method, where only monotonicity restrictions are use, is investigated with respect to different turning point times and different shapes of the turning point. Comparisons are made with other methods, which are in current use.

This thesis is based on four papers.

In Paper I a surveillance system for cyclical processes is presented and its basic properties are described. The aim is to detect a turning point as soon as possible after it has happened. The alarm statistic is based on the maximum likelihood ratio, with a non-parametric estimation procedure. Thus, no parametric function is assumed for the cyclical process, instead the likelihoods are maximized under monotonicity restriction.

In Paper II the properties of the non-parametric maximum likelihood ratio method for different shapes of the turning point are investigated. A theoretical investigation is made on the effect of the slope after the turning point, regardless of parametric function. A simulation study is made regarding the effect of the symmetry, sharpness and smoothness of the peak.

In Paper III the effect of methods for seasonal adjustment on the ability to detect a turning point is investigated. Since data on business cycles are often monthly or quarterly, seasonal adjustment is necessary.

In Paper IV a comparison is made between different ways to specify the monitoring system. The similarities and differences between the surveillance approach and the Hidden Markov Model approach are investigated. Comparisons are made with regard to i) the amount of information used about earlier states of the process, ii) the assumptions about the frequency of turns in the cyclical process and iii) the assumptions about the parametric form and values of parameters of the two states (expansion and recession). The effect of incorrectly specified parameters in a parametric approach is also investigated. The comparability with respect to false alarm properties is discussed. The pros and cons of evaluation by simulation studies or by using a real data set are discussed. The properties of the different methods are investigated by means of e.g. the expected delay of an alarm and the predictive value of an alarm.

Keywords: Business cycles; Turning point detection; Monitoring; Non-parametric regression; Statistical surveillance; Likelihood ratio; Bayes; Markov; Switching regime; Seasonal adjustment; Moving average.