



# Intelligent trading of seasonal effects: A decision support algorithm based on reinforcement learning



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## ABSTRACT

Seasonalities and empirical regularities on financial markets have been well documented in the literature for three decades. While one should suppose that documenting an arbitrage opportunity makes it vanish there are several regularities that have persisted over the years. These include, for example, upward biases at the turn-of-the-month, during exchange holidays and the pre-FOMC announcement drift. Trading regularities is already in and of itself an interesting strategy. However, unfiltered trading leads to potential large drawdowns. In the paper we present a decision support algorithm which uses the powerful ideas of reinforcement learning in order to improve the economic benefits of the basic seasonality strategy. We document the performance on two major stock indices.

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## 1. Introduction

Seasonalities and empirical regularities on financial markets are one of the most frequently studied phenomena in the scientific literature. This is due to simple but promising assumptions, which can easily be translated into a trading strategy. Hence, only investigating this phenomenon has lost its appeal. Therefore, it is our motivation, to not simply create a trading system based on seasonalities, but to verify the signals of this strategy with an intelligent filter in order to provide a robust decision support.

The procedure for filtering is the focus of our work. We use the promising approach of reinforcement learning (RL) to realize an effective filtering. This heuristic method is often used in unstructured and complex situations and provides very good results in the field of robotics, but also increasingly in economic decision-making. Our goal is to find a policy with RL in order to filter the output signals of the basic strategy to improve the reward to risk ratios.

A novel approach is used. To link the trading decision with a reward, we use an artificial neural network (ANN). The same ANN (a simple three

layer feedforward network) acts as decision support to determine the optimal parameters for future trades. We use a combination of three major research areas (RL, ANN, seasonalities). We only introduce the basics of each topic. For an in-depth insight many suggestions can be found in the corresponding section. This paper aims to demonstrate the strength of a combination of several economic and interdisciplinary methods.

Our paper is divided into the following parts. [Section 2](#) presents the ideas and methods. [Section 2.1](#) describes the results of a brief analysis on seasonalities. It shows the promising approach of this surprisingly simple strategy. We investigate two major indices (DAX and S&P 500) on detectable trading regularities like upward biases at the turn-of-the-month, exchange holidays and the pre-FOMC (Federal Open Market Committee) announcement drift. [Section 2.2](#) deals with RL and the detailed description of our modified version. [Section 2.3](#) offers a small introduction to the world of artificial neural networks. [Section 3](#) shows a merger of the mentioned disciplines in a fully automated and self-learning trading system. In [Section 4](#) the results are presented and discussed. [Section 5](#) discusses possible limitations of the strategy and provides an outlook for further research. [Appendix A](#) shows the complete algorithm in pseudocode.

## 2. Ideas and methods

In this section we present an overview of the methods and ideas. First, previous studies about seasonalities on financial markets are

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