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A parallel model for the foreign exchange market

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Abstract

A numerical model for the foreign exchange (FX) market is developed and its implementation on a distributed memory parallel computer is discussed. The model considers a description of the market at the level of the real agents, such as traders and market makers. These actors are represented by interacting computerized agents. Parallelism allows the study of systems with many actors and realistic trading rules. In order to analyse the generic dynamical properties of the market, simulations are considered. The results agree with several observed features of the real market, such as non-Gaussian distribution and negative short-term autocorrelation of price changes. © 2000 Elsevier Science B.V. All rights reserved.

Keywords: Simulation in economics; FX market; Parallelism; Performance analysis

1. Introduction

The need for new methods to investigate and better understand the behaviour of economical and financial markets has brought in the past few years a lot of attention to simulations of economical systems [1–3]. Microsimulations, which model on a computer the activity of most actors of a real system, are recognized as a very promising approach.

Among the attempts made so far, focus is given on the evolution (neural nets, genetic algorithms) of the market agents rather than on the emergence of a complex and global behaviour resulting from the interaction between many agents [4,5]. On the other hand, several toy models have been proposed to capture this global behaviour [6]. Unfortunately, the underlying hypotheses in these models seem too

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simplistic with respect to the mechanisms in effect in real markets. Most of these models deal with the stock market and, in addition, have been run sequentially. The foreign exchange (FX) market, which is yet the most active financial area in terms of money amounts, has been neglected so far. Global turnover in all traditional foreign exchange market segments, such as spot transactions, outright forwards and foreign exchange swaps, reached an estimated daily average of 1490 billion US dollars in April 1998 [7].

An artificial FX market which aims at capturing the essential "microscopic" rules of its real counterpart is proposed. The interest does not reside in the predictive capabilities of our model, but rather in its capacity to identify the key ingredients and their effect on generic properties of the market. The validation of the model will be considered in terms of its ability to reproduce the statistical properties of the real market – which have been well studied [8–11]. For this purpose the parallel software environment includes a windows-based interface (Tcl-Tk) which allows an easy control of the parameters and provides tools to display the market evolution and monitor the behaviour of each agent.

The paper is organized as follows. Section 2 presents the ingredients of the financial model under investigation. Simulation results are described in Section 3. The parallel implementation and numerical performance of the simulator are discussed in Section 4.

2. The FX market model

The market is considered as a multi-agent system in which each actor corresponds to a real individual on the market. These computerized agents interact according to the rules in effect in the real FX market. Although many different currencies are involved in the FX market, the two dominant ones, at the time of writing, are the US dollar (USD) and the German mark (DEM) [7]. For this reason, the model only considers transactions between these two currencies.

In the real market, one can identify two main types of agents: (i) The market makers (or large banks) who decide upon the transaction prices so as to favour large volumes of transactions in both ways (USD to DEM and DEM to USD). They make their profit on the difference between the bid and asked prices (i.e. on the difference between selling and buying price for a given currency). (ii) The traders who take advantage of the market evolution by performing transactions according to the market trends they forecast.

Each of the agents follows a non-evolving trading strategy which, of course, depends on whether the agent is a market maker or a trader. A strategy is determined by a set of randomly chosen parameters per agent (see below for a more detailed description). Once such a strategy is assigned, it remains constant throughout the whole simulation. We chose to implement only non-evolutionary strategies, since this case already displays interesting properties. Introducing evolution in the behaviour of the agents will not improve the model since, generally, a majority of traders do not learn from their mistakes.