Available online at www.sciencedirect.com
SCIENCE DIRECT®
Communications in Nonlinear Science and Numerical Simulation 10 (2005) 365–393
Communications in Nonlinear Science and Numerical Simulation
www.elsevier.com/locate/cnsns

# International finance, Lévy distributions, and the econophysics of exchange rates

Sergio Da Silva [a,*], Raul Matsushita [b], Iram Gleria [c], Annibal Figueiredo [d], Pushpa Rathie [b]

[a] *Department of Economics, Federal University of Rio Grande Do Sul, Rua Joao Pessoa 52, 90040-000 Porto Alegre RS, Brazil*
[b] *Department of Statistics, University of Brasilia, 70910-900 Brasilia DF, Brazil*
[c] *Department of Physics, Federal University of Alagoas, 57072-970 Maceio AL, Brazil*
[d] *Department of Physics, University of Brasilia, 70910-900 Brasilia DF, Brazil*

Received 24 September 2003; received in revised form 2 December 2003; accepted 3 December 2003
Available online 24 December 2003

**Abstract**

This paper surveys the developments in the field of international finance, in particular the research of economists on foreign exchange rates. That might be of interest to physicists working on the econophysics of exchange rates. We show how the econophysics agenda might follow naturally from the economists' research. We also present our own work on the econophysics of exchange rates.


*PACS:* 05.40.+j; 02.50.−r
*Keywords:* Econophysics; Lévy distributions; Foreign exchange rates

## 1. Introduction

Economists working on the field of international finance traditionally felt uneasy with the ideas in modern finance theory, in particular with its notion of efficient markets. Instead, foreign exchange markets are widely believed to behave like the unstable and irrational asset markets described by Keynes [1].

* Corresponding author. Tel.: +55-51-3316-4164; fax: +55-51-3316-3507.
*E-mail addresses:* sergiodasilva@angelfire.com, drsergiodasilva@hotmail.com (S. Da Silva).

1007-5704/$ - see front matter 
doi:10.1016/j.cnsns.2003.12.001

The efficient markets assumption stands against the role of mass psychology. But that has been challenged recently by studies in behavioral finance. Since real returns are nearly unpredictable, the real price of stocks is believed by efficient market theorists to be close to their intrinsic value. However, behaviorists think that such a case for efficiency represents "one of the most remarkable errors in the history of economic thought" [2].

International finance has thus been in practice *open economy* macroeconomics. As it happens, macroeconomics seems to have failed as well to satisfactorily address exchange rate behavior, as this paper will show briefly. That circumstance makes international finance economists more prone to welcome the new ideas coming from physics. In so-called econophysics, the behavior of exchange rates and other financial assets are seen as *complex*. In complex systems with many interacting units, everything depends on everything else.

Section 2 discusses the role of expectations in macroeconomics. Section 3 focuses on the failure of modeling attempts in the framework of open economy macroeconomics. Section 4 shortly presents the econophysics agenda. Sections 5 and 6 introduce the Lévy distributions and show some algebra behind them. Section 7 displays our previous results on the econophysics of exchange rates. Section 8 shows our work on exchange rate multiscaling. And Section 9 concludes.

## 2. Macroeconomics and expectations

Macroeconomics was practically single-handed launched by Keynes [3]. Keynes' basic insight was that a market economy is inherently unstable, and that the source of instability lies in the logic of financial markets. According to Keynes, market capitalism should be neither left alone nor abolished, but stabilized. After the developments that took place in macroeconomics after Keynes, what still arguably survives of Keynesian economics today is the above insight [4].

Keynes' book was greatly simplified in a paper by Hicks [5] which proposed the so-called IS-LM model. For tractability, the IS-LM model assumed stationary expectations, i.e. people forecast no change for future prices. Stationary expectations is a reasonable assumption in a stable zero-inflation environment, but that is not so when inflation departures from nil.

Adaptive expectations came up to take the possibility of a non-zero inflation into account. Here people forecast by looking at previous inflation. Adaptive expectations is a fair assumption if prices are growing up at a constant rate. However, it is not if prices speed up. Even if prices accelerate at a constant rate, people with adaptive expectations will make systematic forecast errors.

So rational expectations is the assumption that people also consider an accelerating inflation together with all past and current information, including that of government policy. But rational expectations assumes, too, that people behave as if they have the "true model" of the economy in their minds, and that is too demanding.

One must seriously accept that the models used by real world people ("popular models") are not the rational expectations one [6]. Economic modeling has thus no choice but collecting data on the popular models themselves. By doing so, Shiller [6] and colleagues found feedback systems with complicated dynamics, where one does not need to refer to a trigger to explain a crash.

That rational expectations is a quite restrictive borderline case can be illustrated with reference to the *El Farol* bar problem put forward by Arthur [7,8]. Suppose that one hundred people must