

Asymmetric Lévy Flight in Financial Ratios:
Proc. Natl. Acad. Sci. USA 108, 17883 (2011)

Boris Podobnik^{a,b,c}, Aljosa Valentincic^c, Davor Horvatic^d H. E.
Stanley^e

^aZagreb School of Economics and Management, 10000 Zagreb, Croatia

^bFaculty of Civil Engineering, University of Rijeka, 51000 Rijeka, Croatia

^cDepartment of Economics, University of Ljubljana, 1000 Ljubljana, Slovenia

^dDepartment of Physics, University of Zagreb, 10000 Zagreb, Croatia

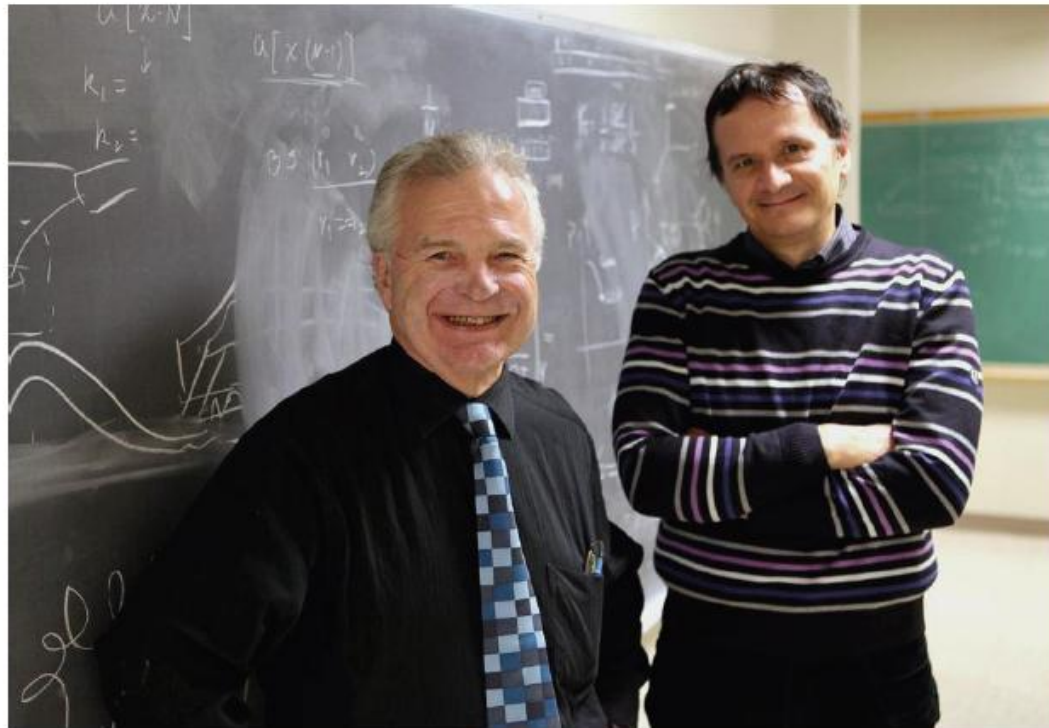
^eDepartment of Physics, Boston University, Boston, USA

December 13, 2012

Mixing physics, economics to gauge risk

Today's models called faulty for rare crises

By Carolyn Y. Johnson | GLOBE STAFF OCTOBER 31, 2011



WENDY MAEDA/GLOBE STAFF

BU physicist H. Eugene Stanley (left) and Boris Podobnik, a visiting scholar, proposed a new model to understand credit rating changes.

Introduction: FINITE OR INFINITE VARIANCE?

GAUSSIAN VERSUS POWER LAW—Mandelbrot, Fama
probability functional dependence of data determines:

- ▶ central limit theorem (CLT) or generalized CLT: POWER LAW versus GAUSSIAN

$$L_{\alpha,\gamma}(x) = (1/\pi) \int_0^\infty dq \exp(-\gamma q^\alpha) \cos(qx), \text{ where } \gamma > 0 \text{ and } 0 < \alpha < 2$$

$$\text{return}(\text{monthly}) = \sum_{i=1}^{30} \text{return}(\text{daily})_i$$

$$\text{RULE} : a_1 x^{1+\alpha_1} + a_2 x^{1+\alpha_2} + \dots + a_n x^{1+\alpha_n} \propto a_a x^{1+\alpha_a},$$

($\alpha_a = \text{minimum}(\alpha_1, \alpha_2, \dots, \alpha_n)$) dominates

METHODS

if probability distribution function (pdf) follows a power law

$$P(Z) \propto Z^{1+\alpha}$$

then Zipf plot (sorted Z from largest to smallest Z versus rank) also follows a power law with exponent

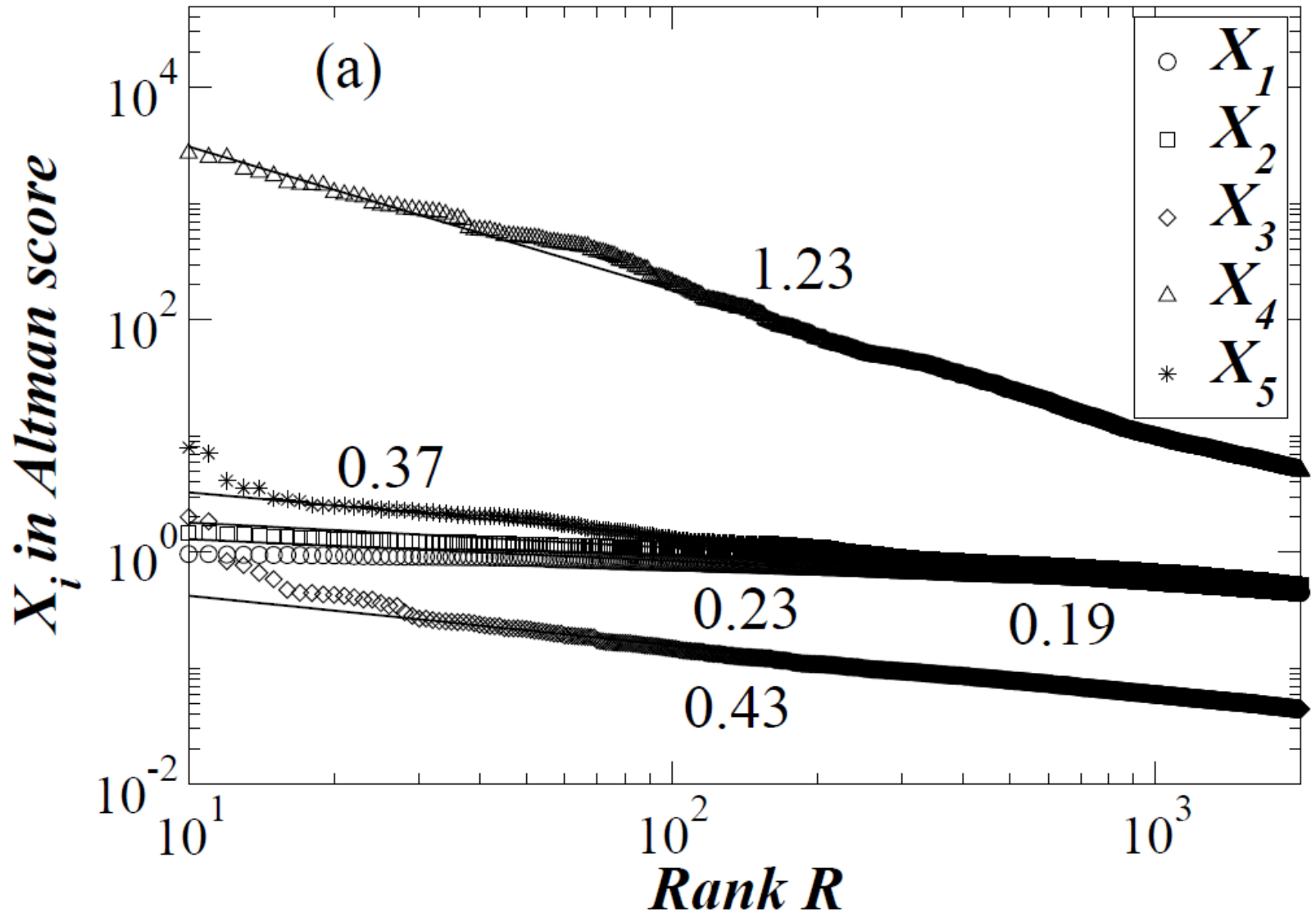
$$1/\alpha$$

The original Z-score

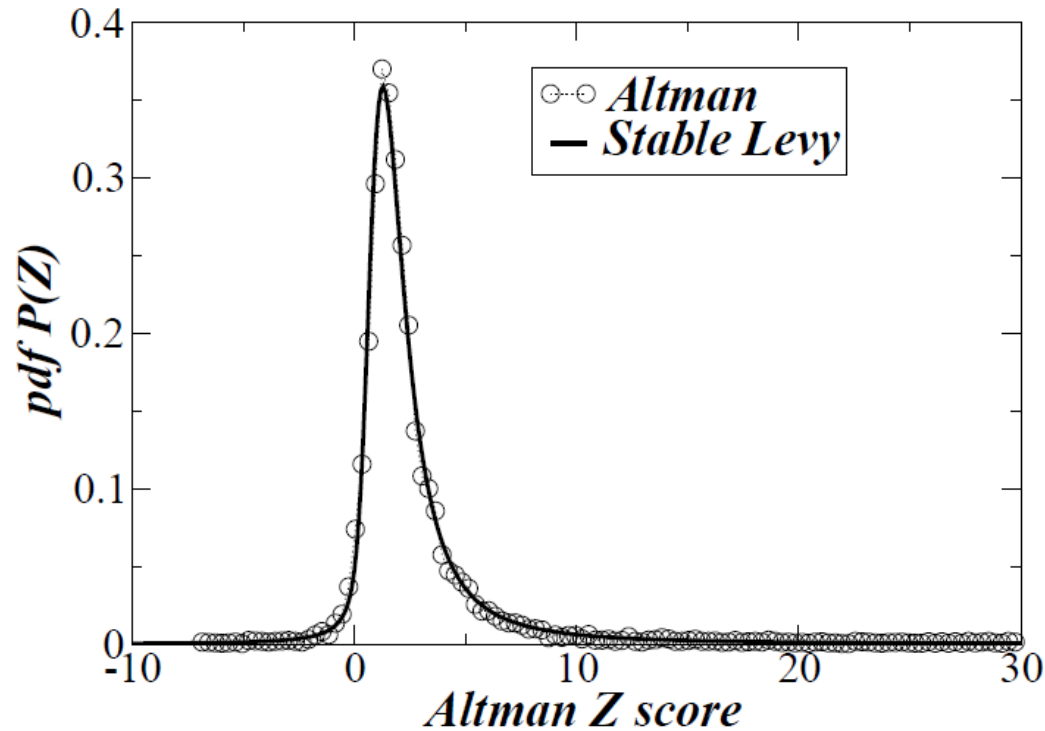
$$Z = 1.2T_1 + 1.4T_2 + 3.3T_3 + 0.6T_4 + 0.999T_5$$

- ▶ $T_1 = \text{Working capital} / \text{Total Assets}$
- ▶ $T_2 = \text{Retained Earnings} / \text{Total Assets}$
- ▶ $T_3 = \text{Earnings Before Interests and Taxes} / \text{Total Assets}$
- ▶ $T_4 = \text{Market Val. of Equity} / \text{B.V. of Tot. Liabilities}$
- ▶ $T_5 = \text{Sales} / \text{Total Assets}$

Far Tails of Financial Ratios: POWER LAW



Altman Z-score: POWER LAW in the far tails



ASYMMETRIC LEVY PDF

$$\varphi(t; \mu, c, \alpha, \beta) = \exp \left[it\mu - |ct|^\alpha \left(1 - i\beta \operatorname{sgn}(t) \tan(\pi\alpha/2) \right) \right]$$

$$\mathcal{L} = \frac{1}{2\pi} \int_{-\infty}^{\infty} \varphi(t) e^{-ixt} dt$$

Recent publications

- ▶ Z-Q. Jiang, W.-J. Xie, M.-X. Li, B. Podobnik, W-X. Zhou, H. E. Stanley, Calling Patterns in Human Communication Dynamics, PNAS, to be published
- ▶ Z. Zheng, B. Podobnik, L. Feng, and B. Li, Changes in Cross-Correlations as an Indicator for Systemic Risk, Nature Scientific Reports 2:888 srep00888
- ▶ B. Podobnik, D. Horvatic, D. Y. Kennet, and H. Eugene Stanley, The competitiveness versus the wealth of a country, Nature Scientific Reports 2, srep00678
- ▶ L. Feng, B. Li, B. Podobnik, T. Preis, and H. Eugene Stanley, Linking Agent-Based Models and Stochastic Models of Financial Markets, PNAS, 109 (22) 8388 (2012)
- ▶ B. Podobnik, D. Horvatic, A. M. Petersen, B. Urosevic, H. Eugene Stanley, Bankruptcy risk model and empirical tests, PNAS of the USA, 107 18325 (2010)
- ▶ B. Podobnik, D. Horvatic, A. M. Petersen, H. Eugene Stanley, Cross-Correlations between Volume Change and Price Change, PNAS of the USA. 106:22079 (2009) (105 citations)