

# M2 Research Internship: Long Only Portfolios and Spin Glasses

November 21, 2019

*Laboratory name:* CFM Chair of Econophysics & Complex Systems, LadHyX

*CNRS identification code:* UMR CNRS 7646

*Internship location:* Ecole polytechnique, Palaiseau, and Capital Fund Management, Paris.

*Thesis possibility after internship:* YES

*Funding:* YES

*Supervision:* Michael Benzaquen (Ecole polytechnique)

Stefano Ciliberti & Jean-Philippe Bouchaud (Capital Fund Management)

Email: michael.benzaquen@polytechnique.edu

## Subject

The problem of the minimal risk portfolio (Markowitz theory) is trivial in the absence of constraints: it suffices to invert the return covariance matrix of the eligible financial assets and to apply it to the unit vector. But in the general case, the corresponding weights are not all positive. If we want to restrict ourselves to portfolios without short sales (long only), we must impose that certain assets are absent from the final portfolio, until we find a self-consistent solution where all the remaining weights are positive. The problem is formally similar to some problems with spin glasses, or population dynamics *à la Lotka-Volterra*. In this project, we would like to explore this analogy in order to calculate, for example, the number of (quasi-) solutions to the Markowitz problem, and to characterise the resulting concentration of the portfolios obtained, within the limits of large portfolios where asymptotic calculations are likely feasible.

The internship will be held within the CFM Chair of Econophysics and Complex Systems at Ecole polytechnique (visit [www.econophysix.com](http://www.econophysix.com)) in close connection with Stefano Ciliberti and Jean-Philippe Bouchaud. A good background in Statistical Physics Machine Learning is advised.

## References

[1] Lehalle, C. A., & Simon, G. (2019). Portfolio Selection With Active Strategies: How Long Only Constraints Shape Convictions. Available at SSRN 3405228.

[2] Reigner, P. A., Nguyen, V., Ciliberti, S., Seager, P., & Bouchaud, J. P. (2019). The Case for Long-Only Agnostic Allocation Portfolios. arXiv preprint arXiv:1906.05187.