

# Investigating the Leverage Effect on the Polish Stock Market Using Principal Regression Analysis

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The impact of past directional changes — such as negative returns in a stock market — on dynamical features such as fluctuations and correlations is fundamental to risk modeling in complex systems. Among the well-studied phenomena in this context is the leverage effect — where declining asset prices are accompanied by increased fluctuations (also referred to as volatility). The contribution of time-varying correlations to this effect has been widely explored [1, 2], but their behaviour in smaller systems like the Polish stock market remains relatively unknown.

In this study, we analyse daily data for companies listed on the Polish stock exchange from 2010 to 2024. We construct a synthetic observable — an index — that reflects the collective state of the system at each point in time. We regress the system’s global volatility, average local volatilities, and mean pairwise correlations on delayed fluctuations in the global observable to investigate its predictive relationships across various time lags. Additionally, we apply principal regression analysis and model matrix correlations dependence on lagged index returns [1]:

$$\mathbf{C}(I) = \mathbf{C} + I\mathbf{D}.$$

Lastly, we examine the structure of response matrices  $\mathbf{D}$  through eigenvalue decomposition to better understand the dynamics of market movements. Preliminary observations suggest that the Polish market exhibits distinct behaviours compared to more established foreign markets, with lower in amplitude — but still influential — negative correlations. These insights help highlight differences in market dynamics and can inform Polish investors on how standard models perform for local conditions.

## References

- [1] P.-A. Reigner, R. Allez, and J.-P. Bouchaud, *Physica A* 390, 3026–3035 (2011).
- [2] A. Karami, R. Benichou, M. Benzaquen, and J.-P. Bouchaud, *Wilmott* 2021, 63–73 (2021).