Statistically similar portfolios and systemic risk

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We propose a similarity measure between portfolios with possibly very different numbers of assets and apply it to a historical database of institutional holdings ranging from 1999 to the end of 2013. The resulting portfolio similarity measure increased steadily before the 2008 financial crisis and reached a maximum when the crisis occurred. We argue that the nature of this measure implies that liquidation risk from fire sales was maximal at that time. After a sharp drop in 2008, portfolio similarity resumed its growth in 2009, with a notable acceleration in 2013, reaching levels not seen since 2007.

I. INTRODUCTION

The 2007 − 2008 financial crisis has drawn the attention of both academics and regulators to the complex interconnections between financial institutions, and called for a better understanding of financial markets especially from the viewpoint of systemic risk [1–3]. In this respect, much effort has been devoted to the study of counter-party and roll-over risks caused by loans between institutions [1, 4, 5] while the ownership structure of financial assets has received relatively less attention, primarily because of lack of data and of powerful analysis techniques. Yet, while in traditional asset pricing theory the ownership structure of financial assets does not play any role, there is increasing evidence that it is a potential source of non-fundamental risk, and, as such, can be used for instance to forecast stock price fluctuations unrelated to fundamentals [6, 7]. More worryingly, if institutional portfolios are too similar (as measured by the fraction of common asset holdings, or portfolio overlap), this may trigger fire sales, which is an important channel for financial risk contagion and therefore contributes to systemic risk [3, 8–10]: in the presence of fire sales, losses by financial institutions with overlapping holdings become self-reinforcing and trigger further simultaneous sell orders, leading to downward spirals for asset prices. The point is that fire sale risk builds up gradually, but reveals itself rapidly.

This contribution proposes a new measure of portfolio overlap based on null statistical network models. Whereas the data only contains links (investments) between institutions and assets, the problem consists in establishing links between institutions based on the assets they own, or between assets based on their investors. In order to simplify the present discussion, let us focus on institutions for the time being. In a naive view, two institutions are linked as soon as their portfolios contain at least one common asset; this adds too many links. Another simple way is to compute the fraction of common holdings between two institutions, which defines a weighted network with as many links as the previous method. Here, we propose to find which institutions have strikingly similar holdings, i.e., to build a non-weighted network of institutions based on the probability that the similarity between two portfolios is not due entirely to chance alone.

Determining this probability requires to solve a technical problem caused by the heterogeneity of both institution sizes and asset capitalizations. For example, it is hard *a priori* to compare a portfolio with very few assets and one with very many assets. However, as we shall see, bipartite configuration models provide suitable null network models that obey certain constraints, allowing us easily to build a proper statistical test and to find significant portfolio overlaps.

When applied to a historical database of SEC 13-F filings, our method yields networks of statistically overlapping portfolios whose properties turn out to be related to the occurrence of the 2008 financial crisis. In particular, we propose to regard the average number of links between institutions (i.e., the number of statistically similar portfolio overlaps) as a simple measure of fire sale risk. This measure gradually built up in 2004-2008, and quickly decreased in 2008. Because there is only one large crisis in our dataset, we refrain from making strong claims about the systematic coincidence of highly connected validated networks and the occurrence of financial crises. At any rate, our measure of portfolio similarity has been increasing since 2009 and reached at the end of 2013 a value not previously seen since 2007.

The reminder of the paper is organized as follows: Sec. II introduces the dataset. In Sec. III we explain the method used to build the network of similar portfolios. In Sec. IV we present and discuss the main results, while Sec. V is the