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FINANCIAL NETWORKS AS DIRECTED CYCLIC GRAPHS – DRAFT

The study of financial networks is not new and neither the awareness of its importance. In late 2009 the European Central Bank (ECB) hosted a workshop called "Recent advances in modelling systemic risk using network analysis" (see ECB (2010)) which gathered practitioners and academics from around the world to share and discuss advances in network theory. At that time the organization of such discussion can be seen a little bit as post factum given that the contagion started by a few defaulted SIFIs had already spread. The importance of the discussion was not to acknowledge that the world is vastly interconnected – this is a well-known fact – but rather to attract the attention around the need of more systematic investigative approach to the properties and sources of instabilities that such interconnectedness can entail.

Directed Cyclic Graphs (DCG) are a subset of the more general toolkit of Probabilistic Graphical Models which has already found applications in Finance, Engineering, Computer Science and Medicine. Unlike Bayesian Networks (BN) and Markov Random Fields (MRF), they allow both directed and undirected edges in the graph as well as cycles. This provides a natural representation of a network of debt relations where an institution can have debt with a chain of other institutions and some of them can be in turn indebted with it, something that cannot be represented by acyclic graphs. Neither a structure which allows cycles but with fully undirected edges (like MRF) can be satisfactory since it precludes to account for interventions and manipulations in the network.

The model we are going to introduce here is a simple static one period model which will provide us with the distribution of defaults, let's say, over 1 year horizon, given the mutual debt structure in the network. We thus ignore the complication of a dynamic multi-period model which can complicate the entire apparatus by introducing difficult to calibrate, difficult to manage parameters (e. g. volatility of the assets, reconfiguration of the debt in each period). We believe that important messages can be distilled in the simple setting here and that can be obscured by introducing additional parameters.

Financial networks' study and understanding has become extremely important since the global financial meltdown in 2007–2009 when the interconnectedness of institutions has surfaced as one of the major culprits for the magnitude of the distress. This paper aims at providing a new approach, based on a concept already in use in other domains such as physics and computer science, to describe and better

understand the net-works of institutions and their global properties. We draw some parallels and contrasts with other approaches to this field.

We introduced the theory of Directed Cyclical Graphs to the study of Financial Networks. We believe that such tool provides a good model of such networks as it is takes into account the directionality of influence and the existence of cycles in real world cases. The framework presented here allows for normative queries about how manipulating exogenously the network will propagate through it. Moreover, the contagion effects of one or more entities in default are easily inspectable in terms of joint probability tables. The results are transparent (no black boxes!) and can be easily examined through visual tools and graphs of probability distributions.