PURE AND APPLIED MATHEMATICS

Systemic Risk of Socio-Economic Networks

Funded By	Dipartimento DISMA FONDAZIONE CRT CASSA DI RISPARMIO DI TORINO [P.iva/CF:06655250014]
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Context of the research activity	The main goal of this project aims to develop and analyze network models of large-scale socio-economic and financial systems and study their systemic risk and resilience in response to exogenous shocks and disruptions. This will allow us to identify causal effects and study how certain policies can help to mitigate the risk.
Objectives	It is widely recognized that interdependencies between the economic sector and the society are based on complex connections that must be taken into account in a theory that wants to be reliable and effective in supporting the decision-makers. Our approach follows the one described in large research initiatives in world-leading academic institutions such as https://idss.mit.edu at MIT or https://yrise.yale.edu/spillover-network-and-equilibrium-effects/ at Yale University. The key idea is that economic sectors are interlinked (Acemoglu et al.-2012) and that this topology is at the origin of the propagation of both positive and negative shocks. The baseline model is based on the so-called Cobb-Douglas preferences and technologies. It leads to analytic solutions that allow one to explicitly determine, in terms of the input-output linkage matrix, the impact that idiosyncratic shocks in the productivity of the different firms have on the macro economy. The notion of Bonacich centrality, originally proposed to analyze social networks and to rank webpages by search engines, is then proved to play a key role also in production networks. Specifically, [Acemoglu et al:2012] show that the effect of a productivity shock on aggregate fluctuations of the economy is proportional to its Bonacich centrality in the production network itself. Therefore, heterogeneous production networks containing “hub nodes” with high Bonacich centrality tend to be more fragile as small idiosyncratic shocks, even if originally independent, can spill over and generate sizable macroeconomic fluctuations. Our project aims to enhance the research in various directions:

	1. Analyze more complex models encompassing the Cobb-Douglas case, and allowing for more general production systems (substitutability of goods, capital, imperfect competition, and misallocations). This will allow considering more general shock phenomena (e.g. destruction of facilities). 2. Study the effect of a shock on single nodes of the network in contrast with the available analysis that is prevalently done at an aggregate level. This should allow understanding the 'fragility' of a single node and introduce a concept of 'distance to failure'. 3. Make the production network into a probabilistic graphical model (inserting the statistics of primal shocks) and use powerful distributed learning algorithms to compute the risk, namely the probability of default events. 4. Analyze the production network in interconnection with the financial system to understand both how financial shocks can hit the real world, as well how disruptions in the productive systems can alter the financial world. D. Acemoglu, V. Carvalho, A. Ozdaglar, A. Tahbaz-Salehi. The network origins of aggregate fluctuations. Econometrica, 80 (2012), 1977–2016.

Skills and competencies for the development of the activity	The candidate student should have a good knowledge of undergraduate math and a fundamental interest in interdisciplinary research among applied mathematics, engineering, and economics. It is however not necessary to have a background in economics or finance.