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Incentivizing resilience in financial networks☆

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ABSTRACT

When banks extend loans to each other, they generate a negative externality in the form of systemic risk. They create a network of interbank exposures by which they expose other banks to potential insolvency cascades. In this paper, we show how a regulator can use information about the financial network to devise a transaction-specific tax based on a network centrality measure that captures systemic importance. Since different transactions have different impact on creating systemic risk, they are taxed differently. We call this tax a systemic risk tax (SRT). We use an equilibrium concept inspired by the matching markets literature to show analytically that this SRT induces a unique equilibrium matching of lenders and borrowers that is systemic-risk efficient, i.e. it minimizes systemic risk given a certain transaction volume. On the other hand, we show that without this SRT multiple equilibrium matchings exist, which are generally inefficient. This allows the regulator to effectively stimulate a 'rewiring' of the equilibrium interbank network so as to make it more resilient to insolvency cascades, without sacrificing transaction volume. Moreover, we show that a standard financial transaction tax (e.g. a Tobin-like tax) has no impact on reshaping the equilibrium financial network because it taxes all transactions indiscriminately. A Tobin-like tax is indeed shown to have a limited effect on reducing systemic risk while it decreases transaction volume.

1. Introduction

Systemic risk is a property of interconnected systems, by which the failure of an initially small set of entities can lead to the failure of a significant part of the system. Mechanisms by which such failures can spread have been studied in financial and economic networks, where different institutions (e.g. banks, funds, insurance companies, etc.) are exposed to each other through a network of assets and liabilities (e.g. Amini et al., 2013; Boss et al., 2004; Eisenberg and Noe, 2001; Gai and Kapadia, 2010). The insolvency of a particular institution can then precipitate other institutions into insolvency, thus generating an insolvency cascade threatening the whole system. It is now understood that systemic risk is a network property and thus different network topologies exhibit different levels of resilience to insolvency cascades. For example, Acemoglu et al. (2013), Elliott et al. (2015) or Glasserman and Young (2015) study how the level of interconnectedness, in conjunction with exogenous shocks, affects the resilience of financial or economic networks.

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Since systemic risk is closely related to network structure, managing systemic risk can be understood as attempting to optimally shape the architecture of the financial network. While some work has studied the formation of financial networks (e.g. Anufriev et al., 2016; Babus, 2016; Farboodi, 2014; Zawadowski, 2013), less work has been devoted to controlling the incentives that institutions (e.g. banks) may have to form a resilient network. Moreover, the main policies and regulations currently employed or under consideration do not emphasize network structure. In financial systems, one such policy consists of setting capital buffers or reserve requirements, especially for systemically important institution.[1] Such strategies largely fail to address the essence of the problem since they neglect the financial networks aspect altogether (Poledna et al., 2017). Taxes imposed on banks in the form of contributions to a rescue fund have also been implemented.[2] Finally, financial transaction taxes (FTT) have also been proposed.[3] Such FTT's however fail to capture the idea that transactions between different counter-parties may have drastically different impacts on the resilience of the whole financial system, as this depends critically on their respective positions (and thus their centrality) in the network of assets and liabilities (Poledna et al., 2017). For instance, a borrowing bank that borrows from a systemically important lending bank may inherit its systemic importance. Indeed if the former becomes insolvent, then it may cause the insolvency of the latter, which can then initiate a large insolvency cascade. On the other hand, if the borrowing bank borrows from a lending bank with low systemic importance, then the insolvency of the former will have little impact of the system, even if it causes the insolvency of the latter (Thurner and Poledna, 2013, Poledna and Thurner, 2016). More and more now, information about the topology of financial or interbank networks is available to regulators (e.g. Central Banks). This allows them to measure the impact of different transactions on the resilience of the whole system.

In this paper, we show how a regulator can use such information about the topology of the interbank system to design incentives that help create a more resilient system. Using this information, the regulator can design a *transaction-specific* tax that discriminates among the possible transactions between different lending and borrowing banks. By taxing transactions between different counter-parties differently, a regulator can effectively control the architecture of the financial system. A regulator can use this *systemic risk tax (SRT)* to select an optimal equilibrium set of transactions that effectively 'rewire' the interbank network so as to make it more resilient to insolvency cascades. This tax was previously introduced and simulated using an agent-based model in Poledna and Thurner (2016). We will prove analytically that this can be done *without* reducing the total credit (transaction) volume and thus without making the system less efficient. This leads to the notion of a *systemic risk-efficient equilibrium*. The intuition behind this result is that under the SRT, any given transaction volume is exchanged under a different network configuration, which creates less systemic risk. Under this desired configuration, transactions remains untaxed, whereas under other configurations, transactions are taxed according to how much they increase systemic risk. The systemic risk tax in Poledna and Thurner (2016) is based on a notion of network centrality (e.g. Battiston et al., 2012) and can be easily implemented using information about the topology of the interbank networks and the banks' capitalization.

To illustrate those facts, we study a stylized economy in which institutions (e.g. banks) are hit by liquidity shocks from their clients and then trade that liquidity with other banks. We derive a strategic equilibrium in which borrowing banks prefer to borrow from banks offering the best terms (lowest borrowing rates) while lending banks, on the other hand, manage their risk by setting a risk premium according to the probability of default of the borrowing bank. This results in the creation of an interbank network of financial exposures (loans), which carry default risk. Our equilibrium concept is inspired by the literature on matching markets (e.g. Gale and Shapley, 1962; Roth and Sotomayor, 1992).[4] Borrowing banks are thus matched to lending banks in a way that reflects their preferences for one another. We make no assumptions on the topology of the interbank system, instead allowing it to emerge endogenously from the banks' rational decisions.

We start by showing that under a standard bilateral contracting mechanism, in which the lending rate is set according to the borrower's default risk, multiple network configurations can arise in equilibrium, and most of them may present 'high' systemic risk. We then show that the proposed SRT allows a regulator to select a *unique* equilibrium network that is efficient in the sense that it presents the lowest systemic risk given a certain transaction volume. We also show that a standard financial transaction tax (FTT), such as a Tobin tax, does not eliminate the multiplicity of equilibria and reduces transaction volume, while having only a minimal effect on decreasing systemic risk. Indeed, a standard FTT has no effect on controlling the topology of the financial system since it taxes all transactions indiscriminately. In this sense, a SRT can be understood as a generalization of a standard FTT, where each particular transaction can be taxed differently, thus allowing a regulator to select distinct equilibrium configurations.

We provide some additional results, such as that a risk management strategy by which lending banks favor the least risky borrowers leads to a unique equilibrium network that is generally inefficient, i.e. it presents higher systemic risk than can be achieved with the SRT.

[1] The Basel III framework acknowledges systemically important financial institutions (SIFI) and argues for increasing their capital requirements. See for example Georg (2011).

[2] For example, the International Monetary Fund has proposed such a tax, the 'financial stability contribution' (FSC). This means a contribution made by financial institutions to reserves for eventual crises. Such taxes have also been proposed in many countries.

[3] Unlike a bank tax, a financial transactions tax (FTT) is a tax placed on certain types of financial transactions. Such FTTs are being considered in various countries. A goal of such taxes is to curtail financial market volatility (see, for example, Summers and Summers, 1989; Tobin, 1978). Related empirical research generally remains ambiguous about Granger causality between FTTs and market volatility (e.g. Matheson, 2012; McCulloch and Pacillo, 2011).

[4] It also bears similarities to equilibrium concepts found the literature on network formation games (e.g. Jackson and Wolinsky, 1996).