Social and Economic Networks in Corporate Culture

David Easley[+] and Maureen O'Hara*

+*Department of Economics and Department of Information Science, Cornell University,*

**Johnson College of Business, Cornell University*

February, 2025

Abstract

We use psychological game theory, cognitive dissonance, and network analysis to investigate how economic connections within firms and social connections outside of firms play a role in determining corporate culture. We demonstrate how employees' social interactions and work interactions create networks in which their behavior can influence the behavior of others. Agents can play cooperatively or non-cooperatively in social and work networks, with equilibrium behavior in each network influenced by the behavior of others in the network. We show how non-cooperative behavior in psychological games played in social networks can be contagious, with otherwise cooperative players shifting to playing non-cooperatively. Because these players are also part of employee networks, contagion of "bad" behavior in social networks can spread to employee networks within firms and across firms. The main lesson of our analysis is that a firm's culture does not exist in isolation from the culture of the society in which the firm is embedded. Contagion of non-cooperative behavior can begin far away from the network of the firm's employees and eventually invade the firm. This invasion is less likely, the culture of the firm is more resilient, if the social density of its set of workers is large or if the critical value for invasion is low. If this gap is large, the firm's culture can withstand shocks to either the social density of its workers or to the payoffs to cooperative behavior; but if it is small, even a slight perturbation in the network can cause a collapse in the firm's culture.

Keywords: corporate culture, social networks, contagion, psychological game theory

We thank Sanjeev Goyal, Marcos Lopez de Prado and seminar participants at NYU Abu Dhabi and the Abu Dhabi Investment Authority for helpful comments and suggestions.

Social and Economic Networks in Corporate Culture

1. Introduction

Recently, Citicorp suspended a senior executive of its high-yield bond trading unit for stealing sandwiches from the staff canteen. Mizuho Bank dismissed a London banker for stealing a bicycle part. Blackstone sacked a senior executive caught "fare jumping" in his daily commute.[1] While these behaviors are certainly boorish (and puzzling – why would someone making a top banker's salary engage in such petty theft?), equally perplexing is why would these banks react so strenuously to trivial offenses that have little to do with the bankers' actual jobs? And why would the Financial Conduct Authority deem the fare-jumper's misdeeds so serious as to ban him for life from any future roles in the UK finance sector? The answer must be more than just signaling types of people, but instead the impact that these behaviors can have on others in the bank and in the overall market, but how or even why would this be the case?

In this paper we use psychological game theory, cognitive dissonance and network analysis to investigate how economic connections within the firm and social connections outside of the firm play a role in determining corporate culture. Of particular interest, we demonstrate how employees' social interactions and work interactions create networks in which their behavior can influence the behavior of others. Agents can play cooperatively or non-cooperatively in social and work networks, with equilibrium behavior in each network influenced by the behavior of others in the network. We show how "bad" behavior in the psychological games played in social networks can be contagious, with otherwise cooperative players shifting to playing non-cooperatively. Because these players are also part of employee

---

[1] See "Citi suspends senior bond trader over alleged theft from canteen," Financial Times, February 5, 2020; "Banker Sacked for Stealing 5 [pound] bike chain loses unfair dismissal claim", The Telegraph, April 5 2019.; and "Fund Manager in London Who Dodged Train Fares is Barred from Financial Jobs", NY Times, December 15, 2014. Citi also fired another employee for claiming expense reimbursement on a work trip for two sandwiches when one was for his companion see "Citi wins case after sacking banker for two sandwich lunch claim," BBC News, October 16, 2023.

networks, linkages across the networks arising from the potential for cognitive dissonance set the stage for contagion of "bad" behavior in social networks to spread to employee networks within firms and across firms. Contagion effects can also flow in the opposite direction, meaning that "bad" culture at firms can translate in to "bad" culture more broadly in society.

The idea that culture could matter for corporate behavior has a long history in economics and related literatures (see Cremer 1993; Glazer, Sacerdote and Scheinkman (1996); Guiso, Sapienza, and Zingales 2006; Grullon, Kanatas, and Weston 2008; Liu 2016; Lo 2016; and Mokyr 2016). An excellent survey is Gorton, Grennnan, and Zentefis (2022)). Recent work by Graham, Grennan, Harvey, and Ragapol (2022) underscores this importance by finding that 92% of North American executives in their survey sample believe that improving corporate culture can improve firm value, yet just 16% of executives felt their company's culture was where it needed to be. Nonetheless, as Zingales (2015) points out, even defining corporate culture, let alone knowing how to improve it, is a daunting task.[2] Much of the literature devoted to this improvement task has focused on factors internal to the firm such as compensation schemes (Holmstrom (1982)), corporate governance structures (Kandel and Lazear (1999), Guiso, Sapienza and Zingales (2006)), company norms (Kreps (1986)), employee training and the like.

While agreeing that these internal features are very important to culture, we believe there is more to the story. The contribution of our research is showing why in equilibrium linkages arising from social networks can denigrate firm culture via the contagion of bad behavior. Thus, factors external to the firm are not irrelevant for culture. Indeed, one intriguing result of our network analysis is that there can be a "culture cliff" within a firm in which even one defection to non-cooperative play near a critical social density can create a cascade, effectively destroying a firm's culture.

Equally important, our analysis demonstrates how firms can combat such degradation through changes to the density and structure of the networks in which their employees participate. We show why some social and economic network structures are more resilient than others to bad behavior. We also demonstrate why firms are more likely to have a good culture or bad culture, but not one that is somewhere in between. We show why it is easy to destroy a good

[2] For example, he cites Steinmetz (1999) who argues there at least 160 definitions of culture, rendering this concept so diffuse as to be unworkable.

culture, and hard to rebuild one. Our analysis also suggests, for example, why firms should punish or fire people who behave badly in social settings and replace them with those who behave cooperatively in the social settings, and why firms should pay attention to social signals in vetting new hires.

One issue we wish to make clear at the outset is our notion of "culture". The myriad definitions of "culture" in the literature defy easy characterization or, more to the point, implementation. We follow the advice of Gorton et al (2022) to recognize that "different constructs of culture serve different purposes". Our focus here is on culture as captured by playing cooperatively or playing non-cooperatively. In our model, cooperative play results in greater firm value, which we believe is consistent with the notion that a "good" culture is value-enhancing. We believe our reduced-form version of culture is broadly consistent other views of culture such as those related to ethical behavior.

Our analysis of culture is built on multiple games played on a network describing both social interactions and interactions within firms. Individuals play multiple two-person, psychological games on their social networks. Psychological games differ from standard games in that players payoffs directly depend on others' beliefs about their play. Players experience endogenously determined guilt in these social games if they behave non-cooperatively when they think that the other player expected them to play cooperatively. They are also employees of firms and play a team game within the firm in which they can behave cooperatively and make everyone better off or non-cooperatively and exploit the cooperative behavior of other workers. The social and economic worlds are tied together through the potential for cognitive dissonance. An individual who behaves cooperatively in one setting makes cooperative behavior salient and would suffer from cognitive dissonance if they behave non-cooperatively in the other setting. We use this structure to examine the potential for contagion of behavior through both the social and economic worlds.

Our analysis relies on psychological game theory and so is related to research by Huck, Kubler and Weibull (2012) and Dufwenberger and Patel (2017).[3] Closely related to our research

[3] Another relevant body of work examines contagion in financial networks (see Benoit et al 2017 and Glasserman and Young 2016 for recent surveys). Most papers consider the effect of more or less densely connected, but exogenously-given networks (see for example, Allen and Gale 2000; Eisenberg and Noe 2001; Freixas et al 2000; Allen and Babus 2008; Gai et al 2011; Acemoglu et al 2015; and Elliot et al 2014), while a few (Blume et al 2013; Erol and Vohra 2014; and Babus 2016) consider endogenously-determined networks. Our agents are playing a

is our earlier paper Easley and O'Hara (2023) which looks at contagion of unethical behavior in a financial market. The analysis here differs both in orientation and approach as we consider the evolution of play across multiple networks. We believe we are the first to apply psychological game theory to understand the interaction between social and work networks.

Finally, our work is related to Young (1996), and the literature on conventions discussed there, as well as to the more recent work by Morris (2000) and Jackson and Storms (2019). This literature, discussing multiple conventions in population games, stability of clusters of behavior on a network and communities of agents in networks who always behave the same way, studies groups of agents who play the same or who adopt the same behavior. We, too, ask about groups playing similarly, but our use of psychological games allows us to describe and analyze the evolution of cooperative and noncooperative play in business and social networks.

2. Culture, Games, and Networks

In this section, we describe the interaction between individuals in firms and the social interaction between these individuals. Inside a firm, individuals choose to play cooperatively and benefit everyone in the firm or non-cooperatively and not provide external benefits. In their social interactions, these individuals also decide whether to play cooperatively or non-cooperatively with their neighbors. We define "culture" as the result of these decisions, with a "good" culture in either setting arising from cooperative play and a "bad' culture from non-cooperative play. Neighbor relationships and employment relationships are represented by two differing networks. Play in these two networks is tied together through psychological forces of the potential for guilt in the social world and cognitive dissonance in the business world.

2.1. The Games

Our individuals participate in both economic and social networks. In their economic networks players work for firms, and inside each firm there is a completely connected network between the firm's workers.[4] In this network, each worker can play Cooperatively (CE) or Non-

psychological game on two exogenous networks, and we are interested in contagion of behavior, rather than contagion of defaults leading to systemic risk.

[4] Completely connected means that every worker in a firm interacts with every other worker in that firm. That is, they play a team game. We use this simple structure between workers to isolate the effects of contagion between the social and economic worlds.

Cooperatively (NE). Payments to workers depend on the revenue their firm receives and this revenue depends on the play of the workers. In their social networks, agents play two-player games with each of their social neighbors. In these social games they also can play Cooperatively (CS) or Non-Cooperatively (NS). Although agents will play these games many times, we assume that they do not view their interaction as part of a repeated game. Instead, they play in each period a one-period game.

There are I players indexed by $i \in \mathcal{I} = \{1,...,I\}$ and N firms indexed by $n \in \mathcal{N} = \{1, \ldots, N\}$. Firms in our model employ workers who are paid some fixed share of the revenues generated by the firm. The firm is the residual claimant of the remaining revenue. In our setting, culture arises from the behavior of the workers so the firm is not a player in our game. We begin with a description of the payoffs to workers. The total revenue the firm makes depends on its total number of workers and on the number of its workers who play cooperatively; and, of course on its capital, but we hold capital fixed. Revenue is weakly increasing in the total number and strictly increasing in the number who play cooperatively. The amount of revenue paid to workers in firm n in total is given by the function $R(\overline{d}_n, d_n)$ where $\overline{d}_n$ is the number of workers in firm n and d_n is the number of these workers who play cooperatively. In this setting, the value of the firms is also increasing in the number of workers who play cooperatively, consistent with the idea that good culture is value-enhancing for the firm.

The play of individual workers is not observable to other workers or to the firm. We assume that each worker in a firm receives an equal share of total payment to workers.[5] Playing cooperatively is costlier for a worker than playing non-cooperatively; it takes more effort which we measure in money terms with x. So, the payoff to worker i in firm n, where n is the firm employing worker i (we abuse notation slightly by not indicating explicitly that n is i's employer) is

[5] Complete unobservability is not necessary for our analysis. It's sufficient to have the compensation paid to a worker depend on both the worker's own choice about cooperative behavior and on the choices made by others in the firm about their play. We use unobservability to keep the presentation simple. There is an extensive literature on contracting within firms, see Holmstrom (1982) and the many papers that cite it.

$$\begin{bmatrix} \dfrac{R(\overline{d}_n, \widehat{d}_n^i + 1)}{\overline{d}_n} - x & \text{if} \quad s_E^i = CE \\ \dfrac{R(\overline{d}_n, \widehat{d}_n^i)}{\overline{d}_n} & \text{if} \quad s_E^i = NE \end{bmatrix}$$

where $\widehat{d}_n^i$ is the number of workers in firm n, other than i, who play cooperatively. Player i's payoff depends on the number of workers in his firm, the number of them who play cooperatively and on i's own play. A strategy for player i in firm n in the economic game (considered in isolation) is $s_E^i(\overline{d}_n, \widehat{d}_n^i) \in \{CE, NE\}$.

The difference in i's payout from the firm if i plays cooperatively or not will be important for determining i's play. Denote this difference by

$$\Delta_n^i(\overline{d}_n, \widehat{d}_n^i) = \frac{R(\overline{d}_n, \widehat{d}_n^i + 1)}{\overline{d}_n} - \frac{R(\overline{d}_n, \widehat{d}_n^i)}{\overline{d}_n}.$$

For the economic game in isolation i's best response is obviously

$$s_E^i(\overline{d}_n, \hat{d}_n^i) = \begin{bmatrix} CE & \text{if} & \mathrm{x} \le \Delta_n^i(\overline{d}_n, \hat{d}_n^i) \\ NE & \text{if} & \mathrm{x} > \Delta_n^i(\overline{d}_n, \hat{d}_n^i) \end{bmatrix}$$

We assume that the gain a worker receives from playing cooperatively is increasing in the number of other workers who play cooperatively. However, as we want to focus on an environment in which guilt and cognitive dissonance are necessary to induce cooperative we also assume that even if everyone else plays cooperatively the marginal benefit of playing cooperatively is still too small to offset the cost of cooperative play. In this case, if the economic game is considered in isolation no worker will play cooperatively.[6] A simple example is $R(\overline{d}_n, d_n) = \alpha d_n$ and $x > \alpha / \overline{d}_n$. In this example, only cooperative workers produce output and payment to workers is linear in the number of these workers.

[6] We consider this worst-case scenario to focus on the power of social connections. It is possible to extend this to have some level of cooperative play occur without these external forces, but that extension complicates the analysis without adding any new insights.

Assumption 1: For all i and n

1. Cooperative play is a strategic complement, i.e. $\Delta_n^i(\overline{d}_n, \hat{d}_n^i)$ is weakly increasing in $\hat{d}_n^i$.
2. $x - \Delta_n^i(\overline{d}_n, \overline{d}_n - 1) > 0$.

Each agent is also embedded in a social network in which they have a choice in each period between two types of behavior: cooperative (CS) and non-cooperative (NS). If there is an edge between two agents they play a two-person game with each other and they each receive payoffs from their joint play. We follow the literature (see Morris (2000)) in assuming that each agent must choose one strategy to use in all of its social interactions, and one strategy to use in its economic interactions, but we allow these two strategies to differ.

The social game played by each pair of linked agents is described by the following payoff matrix. The player index (i) is dropped here for clarity. Note that in the social game guilt plays an important role, unlike in the within firm in which players participate in a standard game without guilt.[7]

	Player 2	CS	NS
Player 1	CS	a,a	$0, c - g\hat{\beta}$
	NS	$c - g\hat{\alpha}, 0$	$b - g\hat{\alpha}, b - g\hat{\beta}$

In this social game, if both players chose cooperative social behavior (CS), then they each receive a payoff of $a > 0$. If one player behaves non-cooperatively (NS) and the other behaves cooperatively, then the cooperative player receives a payoff of 0. The non-cooperative player has a material payoff c, but may experience payoff reducing guilt. This payoff reduction is the guilt parameter $g > 0$ times the player's expectation of the other player's expectation of the probability that they will play cooperatively.[8]

---

[7] Including guilt for unexpected non-cooperative play within a firm is possible. We do not present results for this case here as they do not yield additional insights into our investigation of the influence of social connections on play within the firm.

[8] Note that if g=0 (for both players), c>a and b>0, then non-cooperative behavior is a strictly dominant strategy and the only Nash equilibrium in the social game is (NS, NS). In this uninteresting case, every agent in the social network plays non-cooperatively regardless of the network structure. In the setting in which non-cooperative play

Let α be player 1's probability of playing cooperatively and β be player 2's probability of playing cooperatively. Then, player 1's expectation of player 2's beliefs about 1's play is $\hat{\alpha} = E_1[E_2[\alpha]]$ where subscripts on the expectation operators indicate to which player's expectation we are referring. Similarly, 2's expectation of 1's beliefs about 2's play is $\hat{\beta} = E_2[E_1[\beta]]$. The payoff matrix encapsulates the idea that payoffs in the social game directly depend on expectations about behavior, hence the term "psychological game".

Our players experience guilt, and thus a payoff reduction, from behaving non-cooperatively in a social interaction if they believe that the other player expected them to play cooperatively. This endogeneity of guilt makes play, and the eventual stable configuration of play, history dependent and sensitive to the structure of the network.

We first analyze this social game in isolation before considering it in a network.[9] If both players in the social game chose non-cooperative behavior (NS) then they receive payoffs of $b - g\hat{\alpha}$ and $b - g\hat{\beta}$, where we assume that $b > g$ so that NS is the best response to NS for all beliefs. We also assume strategic complementarity so that CS is a best response to CS if the player expects the other player to expect play of CS; otherwise, NS would be a dominant strategy for any beliefs and the only possible play would be (NS, NS). Finally, we assume that c>a so that without guilt non-cooperative play is dominant. These parameter assumptions are summarized below.

Assumption 2: The parameters of the social game satisfy the restrictions:

1. Cooperative play is a strategic complement, i.e. $a + b - c > 0$.
2. $b > g > 0$ and $c > a$.

A **psychological Nash equilibrium** in this two-player game considered in isolation consists of a pair of strategies, one for each player, beliefs for each player about the other

---

is dominant in terms of material payoffs, cooperative play in the social network is possible only because of guilt. It's guilt that induces our rational agents to pass up the opportunity to exploit the other player by playing non-cooperatively.

[9] This game also appears in Easley and O'Hara (2023).

player's strategy and beliefs for each player about the other player's beliefs $(\hat{\alpha}, \hat{\beta})$ such that each player best responds to the strategy of the other player and each player's beliefs are correct.[10]

Suppose that each player expects the other player to play cooperatively and each player's beliefs about the other player's beliefs are correct ($\hat{\alpha} = \hat{\beta} = 1$). For these beliefs to be part of a psychological Nash equilibrium CS must be a best response to CS given these beliefs. This follows from our base model assumption that $a > c - g$. So (CS, CS) is a psychological Nash equilibrium in the two-player social game. Similarly, suppose each player expects the other player to play non-cooperatively and each player's beliefs about the other player's beliefs are correct ($\hat{\alpha} = \hat{\beta} = 0$). For these beliefs to be part of a Nash equilibrium NS must be a best response to NS given these beliefs. This follows immediately from $b > 0$. So (NS, NS) is also a psychological Nash equilibrium in the two-player social game. Note also that asymmetric play, (CS, NS) or (NS, CS), is not possible in equilibrium.[11]

2.2 Network

In the network we consider there are two types of nodes: individual player nodes and firm nodes. An edge exists between two player nodes who interact in the social game i.e. play the game specified above. We assume that every player plays the social game with someone and possibly with many others. An edge exists between a player node and a firm node if the individual works for the firm. There are no firm to firm edges and each individual shares an edge with at most one firm.

Figure 1 depicts a piece of a network indicating that individuals i and j play the social game with each other, both play with individual k, and both play with other distinct nodes. Individuals i, k and l all work at firm 1, while individuals j and m work at firm 2.

Each individual node has some number of incident edges to other individual nodes, with this number ranging from 1 if the node has only one social neighbor to I-1 if the node is connected to every other individual. Denote the **social degree of node i** by D^i . In Figure 1, the social degree of nodes i and j is 4 while the social degree of node k is 2. Note that edges to firms are not counted in the social degree calculation.

---

[10] We focus on pure strategy Nash equilibria.

[11] Calculation shows that there is also a symmetric mixed strategy equilibrium in which $\alpha = \hat{\alpha} = \beta = \hat{\beta} = b/(a - c + b + g)$.

Before considering the role of firms in the network, it's useful to consider the social network in isolation. A player/node's payoff from participation in the social network depends on its play, the play of each of its social neighbors and on what those neighbors expect it to do. A node plays the same strategy, CS or NS, in its interaction with each of its social neighbors so its payoff from either strategy can be written as a function of the number of its social neighbors playing either strategy and the expectations those nodes have about its play. In an equilibrium, expectations about the play of others must be correct, but during the adjustment process we suppose that each player assumes that a node will play now as it did in the previous period and that each player knows this fact.[12]

Suppose that fraction p of node i's D^i social neighbors play CS. Then the node's payoff to cooperative social play is $pD^i a$ and its payoff to non-cooperative social play is $pD^i c + (1-p)D^i b - D^i g\hat{\alpha}$. So, the node will choose cooperative social play if

$$pD^i a \geq pD^i c + (1-p)D^i b - D^i g\hat{\alpha} \qquad (1)$$

The ranking of these payoffs does not depend on the number of neighbors. So, the inequality above reduces to

$$pa \geq pc + (1-p)b - g\hat{\alpha} \qquad (2)$$

Thus, there is a critical value of the fraction of social neighbors playing cooperatively such that the node will play cooperatively if and only if at least this fraction of its neighbors play cooperatively. This critical value determines a tipping point; if the fraction of neighbors playing cooperatively falls below this value the node switches to non-cooperative play which may then spread to others. This critical value is

$$p^* = \frac{b - g\hat{\alpha}}{a + b - c} \qquad (3)$$

Note that $0 < p^* < 1$ follows from Assumption 2.[13]

Our model of the social network induces a threshold rule, as in Easley and O'Hara (2023). A node's play is determined by the fraction of its neighbors playing cooperatively; the number of social neighbors does not matter (for play of the social game in isolation) and payoffs

[12] Of course, we are also implicitly assuming that every player knows how each of its neighbors played last period.

[13] The critical value can be interpreted using strategic complementary. Increasing the fraction of a node's neighbors playing CS makes playing CS more attractive. So, for fractions above the critical value the node plays CS and for ones below it the node plays NS.

affect play only through their effect on p*. However, our threshold depends on expectations of play. Multiple correct expectations are possible in the underlying game which naturally raises the question of where player's expectations come from. In our network model the interaction between players is local; each player needs only local knowledge of the network and his social neighbors play. Given his local information, in each period, no player has a reason to expect anyone to change their play from last period as it was a best response to the players own play last period.[14] Of course, his neighbors may change their behavior either through an exogenous shock or in response to changes in the behavior of others, and if they do the player may change his behavior in subsequent periods.

In our standard use of the threshold rule (see Morris 2000 for the development of the theory or Easley and Kleinberg 2010 for an exposition of it), players believe that the fraction of their neighbors who currently play a strategy will be the fraction who played it last period. Their expectations are correct in a steady state, but may be wrong while play is evolving in the network.

If a node played cooperatively last period, then $\hat{\alpha}=1$ and the node will play cooperatively this period if and only if enough of its social neighbors are expected to play cooperatively this period, i.e. if $p \geq p^{**}=\dfrac{b-g}{a+b-c}$, where p^{**} is p^{*} evaluated at $\hat{\alpha}=1$. Alternatively, if a node played non- cooperatively y last period, then $\hat{\alpha}=0$ and the node plays non- cooperatively this period if $p<\hat{p}=\dfrac{b}{a+b-c}$, where $\hat{p}$ is p^{*} evaluated at $\hat{\alpha}=0$. From our assumption of c>a we have $\hat{p}>1$ so in the social game in isolation play of NS is an absorbing state.

2.3 Interaction Between the Economic and Social Networks

Play in the social and economic networks is tied together through a psychological cost of playing differently in the two networks. The theory of cognitive dissonance asserts that when an individual's beliefs or values are inconsistent with the individual's actions they suffer a psychological cost. In our setting, playing cooperatively in one network makes cooperation

[14] If a player knew the entire network and was aware of how each node plays then the players could simulate the propagation of behavior through the network and if play converges they would find a steady state in which all expectations are correct. Then there would be no dynamics. A shock to the system would just be a device to compute steady states.

salient and as a result the cognitive dissonance that would result from non-cooperative play in the other network is costly.[15] This is a crucial assumption for our analysis; without it there is no link in behavior in the two types of networks and no reason for firms to care about the social behavior of their workers. We assume that play of (CS, NE) or (CE, NS) induces a cost of $t > 0$ for each interaction in which play is non-cooperative. For this psychological cost to play any role in our analysis it must be large enough to offset the gain to playing NE rather than CE.

Assumption 3: The psychological cost of simultaneously playing CS and NE is such that

$$t(\overline{d}_n - 1) > x - \Delta_n^i(\overline{d}_n, \overline{d}_n - 1)$$

With this psychological cost tying play together across the two types of networks we need to analyze play in the social and economic networks jointly. We say that a configuration of play, $\{\boldsymbol{a}_i\}_{i \in \mathcal{J}}$ where each $a_i \in \{(CE,CS),(NE,NS),(CE,NS),(NE,CS)\}$, is a **Network Equilibrium** if: (i) each player is playing a best response to the play of others in the both the economic and social games, and, (ii) all player's beliefs (both first and second order) about the play of their neighbors in the social games are correct.[16]

Our interest is in the evolution of play and, in particular, in the potential for contagion of non-cooperative play arising in the social network and moving into the firm. These dynamics induced by this evolution also select between multiple Network Equilibria. But before discussing dynamics it's useful to describe in more detail equilibrium configurations of play in which all agents behave symmetrically. These will be natural starting points for an exploration of the evolution of play.

First, note that, regardless of the network structure and beliefs, playing (CE, NS) is strictly dominated by play of (NE, NS). This follows immediately from noting that if NS is played there is no psychological cost to playing NE and within the economic game alone Assumption 1 implies that NE strictly dominates CE. Second, it's useful to note that a Network Equilibrium trivially exists as all agents playing non-cooperatively in both their social and economic interactions, and all agents expecting non-cooperative play, is an equilibrium. Third, it's also

[15] See Festinger (1957) for the first development of this standard theory.

[16] Formally, an equilibrium consists of both play and beliefs but as correct beliefs are determined by play we focus on equilibrium configurations of play.

easy to show that the asymmetric configuration of play $\{\boldsymbol{a}_i\} = \{(\text{NE}, \text{CS})\}_{i \in \mathcal{I}}$ is not a Network Equilibrium.

Finally, all agents playing cooperatively in both their social and economic interactions, and all agents expecting cooperative play, is an equilibrium if guilt in the social game is large enough to offset the gains of deviating to non-cooperative play in the economic game. If this is not the case, then cooperative play cannot be sustained and only non-cooperative play in both social and economic settings will be observed. So, we assume[17]

Assumption 4:
For any individual i, the benefit of playing CS, when others expect CS, is greater than the gain from switching from CE to NE, i.e.

$$D^i(g - c + a) > x - \Delta(\bar{d}_n^i, \bar{d}_n^i - 1).$$

With Assumption 4 we have the existence of a second Network Equilibrium, $\{\boldsymbol{a}_i\} = \{(\text{CE}, \text{CS})\}_{i \in \mathcal{I}}$. There may, of course, be many equilibrium configurations of play, but the existence of at least two such equilibria is necessary to make our analysis of contagion interesting.

Thus far, we have established conditions under which a culture of behavior can exist in a network and how a "bad" culture and a "good" culture can be equilibrium outcomes. What is of more interest is how these cultures change over time and, particularly, whether a "bad" culture from one part of the social network can invade and cause a good culture in the firm to falter, or more succinctly, can culture be contagious? To address this question, we use contagion dynamics on the networks to analyze the stability of these symmetric equilibria and to provide criteria for the existence and stability of configurations in which individuals do not all play the same way.

3. Contagion and Culture

The analytical question we begin with is: starting from a network in which everyone plays cooperatively or everyone plays non-cooperatively, can a small number of nodes

[17] Note that we do not assume that the inequality in Assumption 4 holds for all configurations of play; only that it holds for each individual if everyone else is playing cooperatively.

exogenously flipping to the other type of behavior cause that new behavior to spread through the network possibly flipping everyone to the new behavior?[18] This group of initial switchers may simply be trying out a new behavior to see what happens. This new behavior isn't a best response to what others are currently doing so it is initially payoff reducing. But perhaps they are interested in observing how others respond to their new behavior. Alternatively, they could simply be trembling---mistakenly choosing a new strategy. In either case we ask whether this new behavior diffuses throughout the network or whether it stops before becoming widespread.

Obviously, widespread diffusion of cooperative play cannot occur if every node begins with non-cooperative play, as given past non-cooperative play, playing non-cooperatively is dominant. So, a network of non-cooperative play is stable. Alternatively, if every node initially plays cooperatively, and a small number of nodes flip to non-cooperative play, the eventual outcome depends on the parameters of the game and the structure of the network. Most importantly, whether these flipped nodes cause other nodes to flip depends on what fraction of their neighbors are playing non-cooperatively and on the parameters of the economic and social games.

The dynamic process induced by these flipped nodes evolves as follows:

1. Initially each node is labeled with the same play: all (NE,NS) or all (CE,CS).
2. Next the labels for some set of nodes are exogenously switched from Cooperative play to Non-cooperative play if all were initially labeled Cooperative, or from Non-cooperative play to Cooperative play if all were initially labeled Non-Cooperative.[19]
3. Then each node expecting its neighbors to play as labeled and knowing that its neighbors expect it to play as labeled selects a best response.
4. The nodes are then labeled with these best responses and step (3) is repeated.
5. The process is declared to have stopped if in two successive labelings no labels are modified.

We imagine a network in which exogenous shocks are rare and first ask if the dynamic process stops. In our framework any node that exogenously switches to non-cooperative

---

[18] In actual markets, this flip or mutation could occur if employees playing cooperatively (or non-cooperatively) are replaced by ones who turn out to be the other type (for evidence of this see Liu (2016)).

[19] We only consider flips to playing cooperatively or non-cooperatively in both types of networks as asymmetric play isn't sustainable.

continues to play non-cooperatively and any node that is induced to play non-cooperatively because of the play of its neighbors won't switch back to cooperative play. There are a finite number of nodes so the process stops in finite time either with all nodes playing (NS,NE) or some playing (NS,NE) and the remaining nodes playing (CS,CE). This guarantees that following an exogenous shock with some nodes switching their behavior the process of behavioral adjustment converges in finite time.

Theorem 1: The dynamic process stops in finite time and once it is stopped the configuration of play is a Network equilibrium.

The evolution of play that Theorem 1 addresses has important implications for firm culture. Because of the network linkages between individuals work networks and social networks, "bad" behavior in the social network can affect the culture of the work network. This behavior comes in through the social networks of individual workers, and through them potentially to the workers in their firm network. Thus, culture can be degraded. Whether this degradation spreads to the entire firm network, thereby "destroying" firm culture, is the focus of our analysis.

To address this question, we first need a few definitions. A **social cluster of density p** is a set of individual nodes such that each node in the set has at least fraction p of its social neighbors in the set.[20] A socially dense cluster is a set of individual nodes for which most of their social interaction with other individual nodes occurs within the set rather than with individual nodes outside of the set. Social density plays a critical role in how, or even whether, contagion occurs.

How contagion proceeds through a network depends on the structure of the network and on the payoffs in the social and economic games. Network structure determines the social density of clusters of individuals. We show that if the social density of a cluster is large enough then contagion of non-cooperative play cannot invade the cluster. How large this density needs to be to stop contagion depends on both the social and economic games.

[20] We use the same notation for density, p, as was used for the fraction of neighbors playing ethically in the social game. This slight abuse of notation is intentional as a cluster of cooperatively playing nodes persists if it is dense enough.

We first consider an arbitrary cluster, K, of individual nodes. Suppose that initially all of these individuals play cooperatively in all of their interactions, (CE, CS). Our primary interest is in whether a contagion of non-cooperative play arising from outside of K can invade K. Whether this invasion is possible depends on the density of the cluster of K. If invasion is to occur there must be some individual in the cluster K who first deviates from (CE, CS). It's easy to show that this deviation cannot be to (CE , NS) as this is a dominated strategy, and it follows from Assumption 3 that it cannot be to (NE, CS). So, the first switcher must switch to (NE, NS). This will not occur if the cluster is sufficiently dense. The required density is the social density term p** plus a term determined by the gain in economic payoffs from playing non-cooperatively scaled by the benefit of playing CS when others expect CS.

This **critical density** for the cluster K is

$$\widehat{p}_K = p^{**} + Max_{i\in K}\left(\frac{x-\Delta(\overline{d}^{i}_{n(i)}, K_{n(i)}-1)}{D^{i}(a-c+b)}\right)$$

where $K_{n(i)}$ is the number of nodes in cluster K with edges to firm n(i), the firm where individual i works (if i does not work at any firm then the term in brackets above is 0). Note that this critical social density is determined by the network structure and payoffs in the games. For any cluster it can be computed without reference to how individuals actually play.

Consider a network in which every node initially plays (CE, CS). We say that a set of nodes, B, changing their behavior to (NE,NS) causes a **complete cascade** if when the nodes in B change to (NE, NS) eventually every other node in the network plays (NE, NS). Morris (2000) shows that, for the structure he analyzes, whether complete cascades occur or not is determined entirely by whether sufficiently dense clusters exist or not. His analysis, modified to accommodate our psychological game and our two types of networks, applies to our setting.

Theorem 2: Suppose the parameters of the game satisfy Assumptions 1-4. Consider a network in which every node initially plays (CS, CE). Suppose that a set B of individual nodes switch to behavior (NS, NE).

(i) If the remaining network, consisting of nodes in $\mathcal{J} - B$, the social edges between them, the firms they work for and the edges between them and these firms, contains a social cluster K of density at least $\hat{p}_K$ then a complete cascade does not occur.

(ii) If a complete cascade does not occur, then the remaining social network , consisting of nodes in $\mathcal{J} - B$, the social edges between them, the firms they work for and the edges between them and these firms, must contain a social cluster K of density at least $\hat{p}_K$.

All proofs are provided in Appendix A. This theorem is a modification of the argument in Easley and O'Hara (2023) to our setting. Essentially this result says that clusters stop contagion of non-cooperative play and contagion can only be stopped by clusters. In our culture setting, this means that while bad behavior can spread through the social network, and potentially into the firm, this outcome is not guaranteed. What determines whether this occurs is the structure of the social network and payoffs in the social and economic games.

Figure 2 illustrates the evolution of non-cooperative behavior. In the first panel of the figure there are four workers in firm 1: represented by nodes j, l, m and n. Nodes j and l, and nodes m and n, have a social connection, and nodes j and l have a social connection to node k who does work at firm 1. In the second panel node k exogenously switches to non-cooperative behavior. Then in period 2 (the third panel) j and l connected to this first mover have one-half of their social neighbors playing non-cooperatively so they switch to non-cooperative play in period 2 (regardless of the behavior within firm 1). Thus, non-cooperative behavior has invaded firm 1. Next nodes n and m do not switch to non-cooperative behavior as they each have all of their social neighbors (each other) playing cooperatively.

Figure 3 illustrates how sufficiently dense social clusters can stop cascades. In this figure the social network from Figure 2 is enriched (with the blue edges) to a completely connected social network between the employees of firm 1. Again, node k exogenously switches to non-cooperative behavior. But now nodes j and l have only one-fourth of their social neighbors playing non-cooperatively. Whether they switch depends on the second term in $\widehat{p}_K$ for the cluster K={j, l, m, n}. This cluster has social density 0.75. So, if this second term in $\widehat{p}_K$ is less than 0.2, then $\widehat{p}_K$ is less than 0.75 and non-cooperative behavior cannot invade the firm.

The intuition for part (i) of Theorem 1 is straightforward. Suppose that the contagion of non-cooperative play could invade a cluster K of nodes all playing (CS,CE) of density at least $\widehat{p}_K$. Then there must be some first node in this cluster who flips to (NS,NE), but at the time of the flip at least fraction $\widehat{p}_K$ of its social neighbors are playing (CS,CE). Therefore, this node will not flip and thus no node in the cluster flips. The intuition for part (ii) is similar. If a complete cascade does not occur then some nodes remain playing (CS,CE). Unless those nodes are a cluster K of nodes, all playing (CS,CE), of density at least $\widehat{p}_K$, then at least one of them wants to switch to (NS,NE). But then the cascade has not stopped.

4. Building and sustaining culture

In this section we discuss the implications of contagion on networks of workers for any individual firm's culture. We first consider the stability of cooperative play in the firm in response to non-cooperative play originating outside of the cluster of the firm's workers. Theorem 2 implies that cooperative play is stable if the social density, p, of the cluster of the firm's workers, F_n, is greater than $\hat{p}_{F_n}$. Anything that increases the (positive) gap between p and $\hat{p}_{F_n}$ increases regions of stability of cooperative play by the individuals in F_n.

4.1 How the social network affects the firm's culture

We can apply the logic of Theorem 2 to the invasion of non-cooperative play in a firm. Consider a firm n and its set of workers F_n where initially all of these workers play cooperatively, (CS, CE). Can a contagion of non-cooperative play arising from outside of F_n invade F_n through the social network of its workers and cause the firm's workers to switch to non-cooperative play in the firm? If invasion is to occur there must be some individual in the set

F_n who first deviates from (CS, CE). The first switcher must switch to (NS, NE). This will not occur if the social density of the cluster of the firm's workers is sufficiently large. The required density is the same as in Theorem 2.

Theorem 3: Consider a network in which every node initially plays (CE, CS). Consider a firm n with set of workers F_n. A set of nodes, B, with $B \cap F_n = \phi$ changing their behavior to (NE,NS) cannot create non-cooperative behavior within firm n if the social density of its set of workers is at least

$$\widehat{p}_{F_n} = p^{**} + MAX_{i \in F_n}\left(\frac{x - \Delta(\overline{d}_n, \overline{d}_n - 1)}{D^i(a - c + b)}\right)$$

If the social density of firm n's workers is large enough, at least $\widehat{p}_{F_n}$ then contagion cannot occur. We call the gap between the actual social density of n's workers and $\widehat{p}_{F_n}$ the **region of cluster stability** for the firm. The larger this gap the more resilient is behavior in the firm to changes in the social network of its workers. Alternatively, a firm with social density of its workers near $\widehat{p}_n$ is near a **contagion cliff**; a small change in the social network of workers can push the actual social density below $\widehat{p}_{F_n}$ and allow contagion to occur. Note also that once contagion occurs it cannot be reversed; a worker who switches to non-cooperative play will not switch back to cooperative play. So, if a good culture among the firm's workers begins to decay it may stop or it may spread to all of the firm's workers, but it will not be reversed.

This potential is illustrated in Figure 4. If some of a firm's workers switch to non-cooperative play this makes cooperative play within the firm less attractive for the remaining workers. This can cause them to switch and potentially create a cascade of non-cooperative play that arises primarily from incentive effects within the firm.

In Theorem 3 the firm initially has only cooperative workers. Alternatively, it could begin with a mix of cooperative and non-cooperative workers. The presence of these non-cooperative workers reduces the payoff that cooperative workers receive from cooperation. This makes invasion of non-cooperative behavior easier and thus the initial configuration of behavior in the firm is less robust; the region of cluster stability shrinks. These non-cooperative workers increase the required social density of the cooperative workers in firm n, $\hat{p}_{F_n}$, needed to prevent invasion of non-cooperative play. Thus, a configuration of mixed play inside the firm tends to be less stable than one in which all workers are either cooperative or non-cooperative. From a culture perspective, this has the important implication that firms are more likely to have good cultures or bad cultures, but not one in between

Our analysis of contagion takes place on a fixed network, but we can ask how the network structure affects both dynamics and network equilibria. For example, adding an edge between a firm and a worker changes the local network of the firm and has implications for the play by the firm's workers and potentially for others as well. If a firm adds an edge to a worker who currently plays cooperatively in social interactions, and who finds that cooperative play in the firm is a best response, then this increases the payoff to existing workers from playing cooperatively. This reduces $\hat{p}_{F_n}$ and thus makes cooperative play within the firm and increases the regions of stability for the firm. If this new worker also has social ties to existing workers then this increases the social density, p, of the firm's workers which again makes contagion of non-cooperative behavior more difficult. This impact can be large if the firm is near a contagion cliff, i.e. the social density of its existing workers, p, is near the critical value $\hat{p}_{F_n}$.

Alternatively, deleting an edge between a firm and worker who plays non-cooperatively in their social interactions makes cooperative play for other workers in the firm more attractive and contagion of non-cooperative play less likely. This, too, can have a large impact if the firm is near a contagion cliff. The other workers, and the firm, cannot observe individual play within the firm, but an individual's social neighbors do know how the individual behaves in social interactions, and someone who behaves non-cooperatively in social interactions also behaves non-cooperatively in economic interactions.[21] This provides a rationale for firing (deleting an edge to) workers who behave badly in their social interactions.

A consistent theme emerges from our analysis: social factors external to the firm are not irrelevant for a firm's culture. We believe our findings can help explain actions that may seem counter-intuitive given standard views of culture and provide new explanations for some empirical findings in the literature. Equally important, we believe our results delineate actions

[21] This follows from our assumption about the cost of cognitive dissonance. A less extreme assumption might make identifying play in economic interactions from play in social interactions more difficult.

for firms wishing to improve their corporate culture. In this sub-section, we discuss three aspects of our results in more detail.

One of our main results is that an individual's behavior in social networks is predictive of their behavior in work networks. Returning to the examples in the beginning of this paper, fare-jumping, or stealing sandwiches, or nicking bicycle parts is not in and of itself important, but it becomes important because of the linkages of non-cooperative social behavior to non-cooperative work behavior. As we have shown, such non-cooperative behavior can degrade corporate culture, and if in combination with a contagion cliff, even result in a total collapse of corporate culture. Removing such individuals from the firm is not just advisable, but necessary given these potential wider impacts.

A similar issue arises with respect to changes to a firm's work network arising from corporate actions such as hiring decisions and mergers and acquisitions. Adding a node to the firm's network brings with it the individual's social network as well. Carefully vetting the social behavior of any potential hires is thus crucial to avoid introducing noncooperative behavior into the firm. Dimmock et al (2018) show that fraud by financial advisors is more likely if new co-workers have a history of fraud. Liu (2016) finds a similar effect when insiders move from companies with a low corruption index to a high corruption index. Egan, Matvos, and Seru (2019) show that one-third of advisors with misconduct are repeat offenders and that firms that hire such advisors are those with higher rates of misconduct.

Not surprisingly, there is also an extensive literature documenting the important role that culture plays in determining the success (or failure) of merger activity (see, for example, Weber and Camerer (2003); Bereskin, Byun, Officer, and Oh (2017); Graham et al (2022)). Mergers bring multiple networks into play, and as we have shown a sufficiently large jump in the fraction of nodes playing noncooperatively can undermine the stability of a good culture. Indeed, an intriguing prediction of our model is that bad cultures are more stable than good cultures, adding yet more urgency to evaluating the "cultural fit" of any proposed combination.

A second main result is that contagion of bad behavior can spread between social and work networks. Unfortunately, examples abound of just such behavior in the financial markets. Both the LIBOR rate setting scandal and the foreign exchange price fixing manipulation involved illegal behavior arising from traders' chat room linkages across banks.[22] The FX scandal, involving behavior dating back over 10 years, eventually led to $10 billion in fines across 6 major banks and new prohibitions by banks on chat room participation. A more technologically advanced but eerily similar scandal surfaced in 2022 when the SEC charged 15 broker-dealer firms with failing to police employees who used What's Ap and other text messaging services on their personal cell phones to communicate on work-related matters.[23] As discussed in Stellmach (2022), these platforms use an encryption technology that precludes third party monitoring and can allow messages to immediately "self destruct". The SEC settlements now explicitly prohibit such communications and require firms to implement new approaches to record retention.

What then can firms do to strengthen their culture? Our research highlights the important role that external social linkages play in forming a firm's culture. Hence, one avenue to build a better firm culture is to encourage stronger social linkages among its workers. To see why, recall that the risks of contagion to the firm depend upon the social density of its workers. This is because as Theorem 3 showed, it is more difficult for bad behavior to invade a socially dense cluster of individuals. Thus, one way a firm can make its culture more resilient is to foster these social linkages. Internal employee interest groups may be one avenue to do so, but perhaps counter intuitively, an even more potent approach can be to foster social linkages more broadly. For example, volunteering for community or charitable activities can expand these social linkages – and thus help the firm as well as society. Yet, for at least some companies, this dual benefit seems to be unrecognized. For example, Citigroup's 43-page Code of Conduct only mentions such community activities on page 39 and asks that "you do so on your own time and your own expense".[24] Our analysis suggests that a less penurious approach could help a firm improve its culture.

[22] For more discussion see "The Global FX rigging scandal", Reuters, January 11, 2017, and "Trading scandals: The final nail in chat rooms coffins?" available at https://www. cnbc.com/2013/11/11/trading-scandals-the-final-nail-in chatrrooms-coffins.html. See also O'Hara (2016) for examples of corporate misbehavior.

[23] [23] See "Texting on Private Aps Costs Wall Street Firms $1.8 Billion in Fines," New York Times, Sept. 27, 2022. The firms in question were charged with violating record keeping provision. As discussed in Stellmach, the SEC uses records on communications to bring enforcement charges and such off-channel inaccessible messages would greatly interfere with this process.

[24] See https://www.citigroup.com/rcs/citigpa/storage/public/codeconduct_en_2023.pdf

5. Conclusion

The main lesson of our analysis is that a firm's culture does not exist in isolation from the culture of the society in which the firm is embedded. Contagion of non-cooperative behavior can begin far away from the network of the firm's employees and eventually invade the firm. This invasion is less likely, the culture of the firm is more resilient, if the social density of its set of workers is large or if the critical value for invasion is low. If this gap is large, the firm's culture can withstand shocks to either the social density of its workers or to the payoffs to cooperative behavior; but if it is small, even a slight perturbation in the network can cause a collapse in the firm's culture.

It's useful to note that the individuals we consider here are not inherently cooperative or non-cooperative---everyone is willing to cooperate and enhance others payoffs and a firm's profits if it's in their best interests. They are all rational economic agents reacting to the environment in which they interact. It's this endogeneity of behavior that makes corporate culture fragile. If others behave badly this reduces the payoff to behaving cooperatively and can cause a cascade of non-cooperative behavior.

FIGURES:

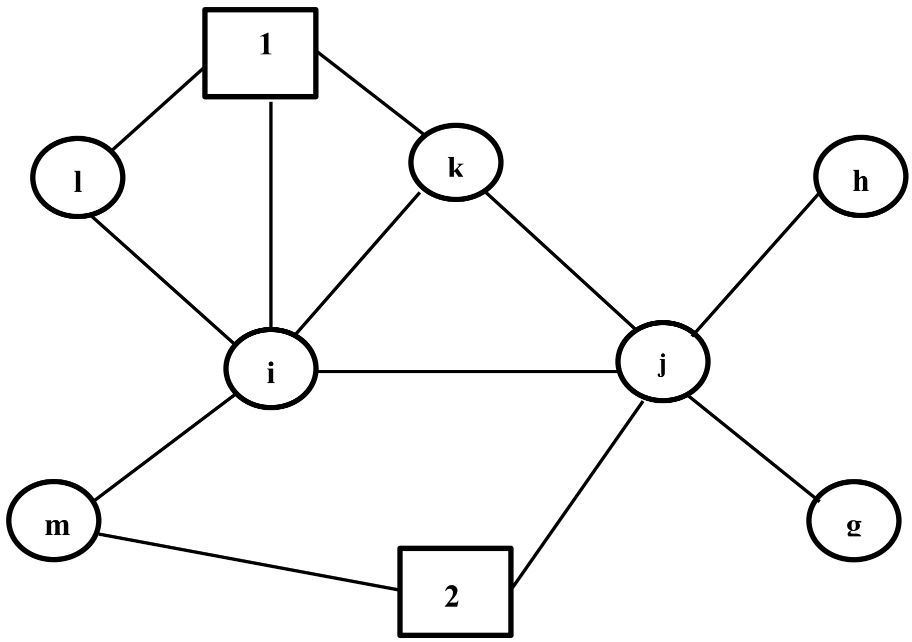
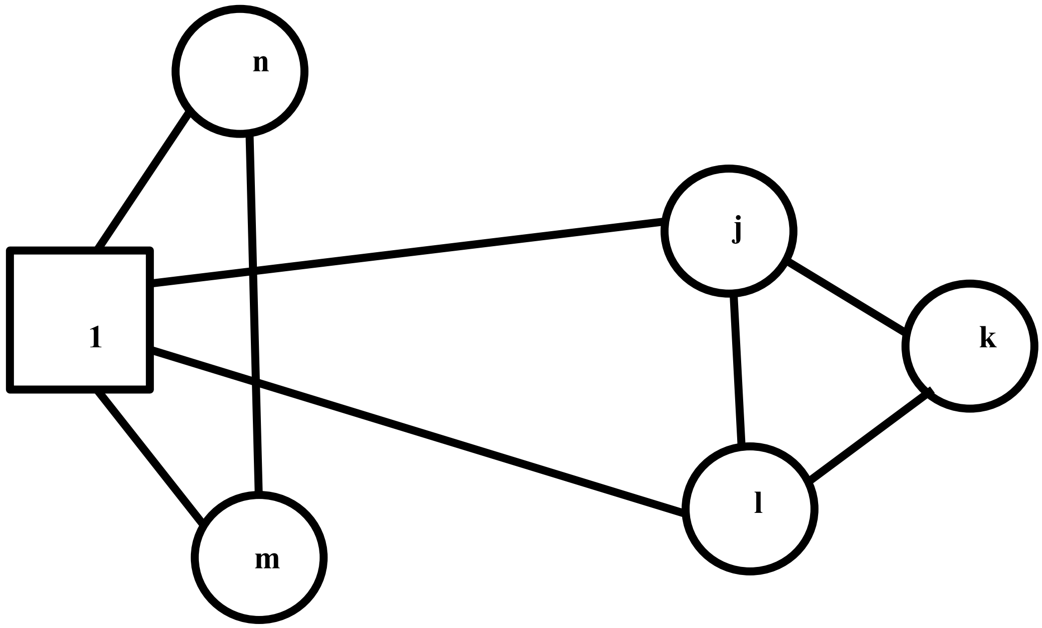
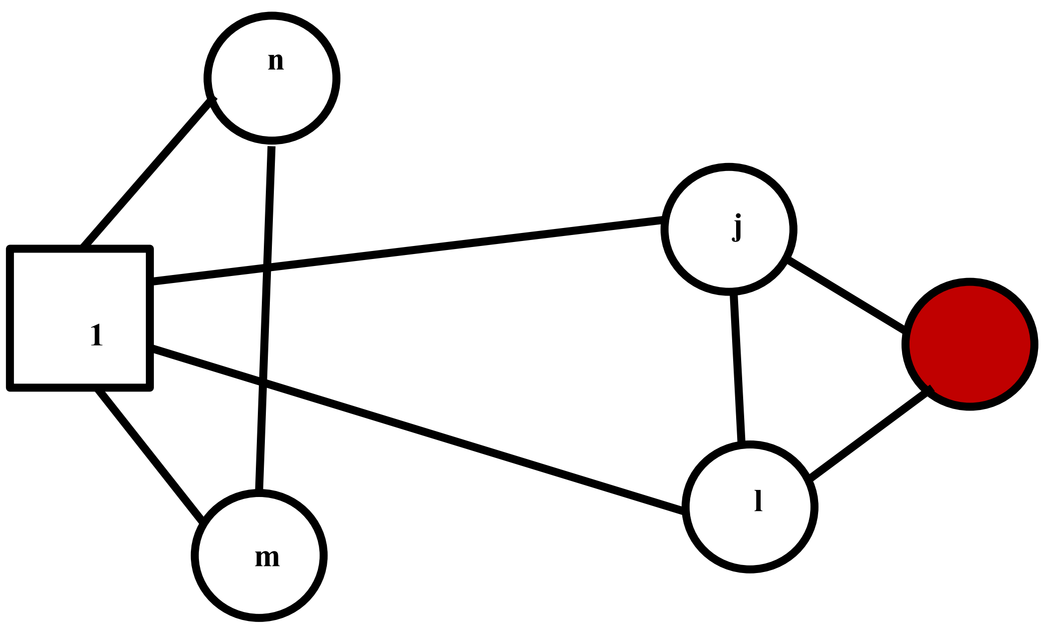


Figure 1: Nodes representing individual are depicted as circles and nodes representing firms are depicted as squares. This figure displays a piece of the network containing individual nodes i and j and their neighbors. Nodes i and j play the game with each other and both play it with individual k. In addition, each of i and j play the game with two other individuals. Individuals i, k and l all work at firm 1 while individuals j and m work at firm 2.


n
j
1
k
l
m


n
j
1
l
m

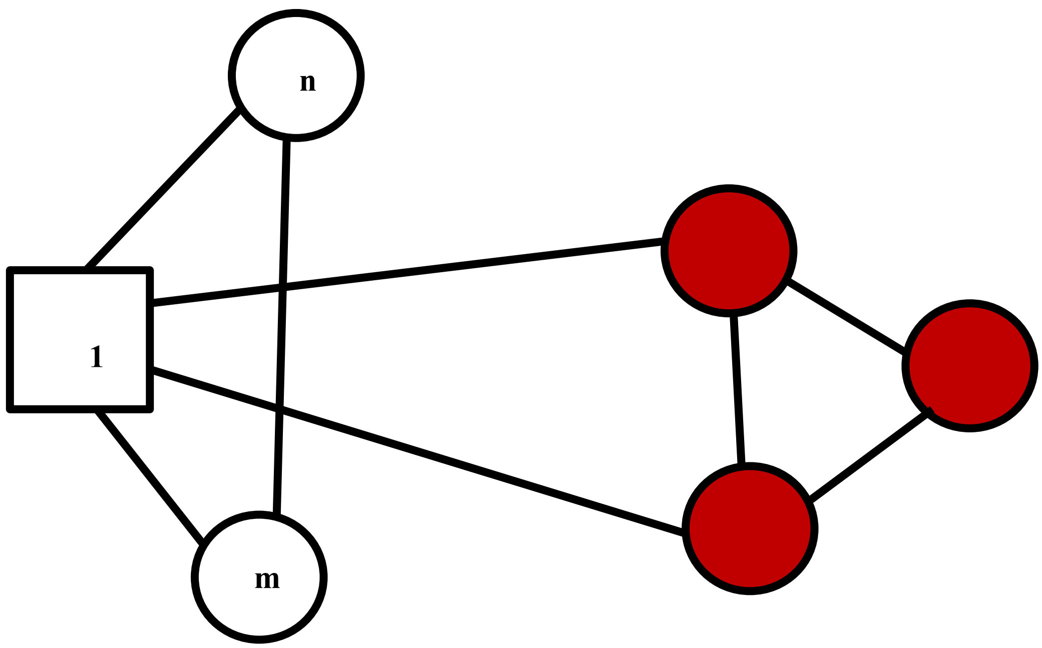


Figure 2: These graphs show the spread of non-cooperative behavior represented as red filled nodes in a network in which each node initially plays cooperatively in all of its interactions and the parameters of the social game are such that p** is 0.55. In the first figure there are four workers in firm 1: represented by nodes j, l, m and n. Nodes j and l, and nodes m and n, have a social connection, and nodes j and l have a social connection to node k who does work at firm 1. In the second figure node k exogenously switches to non-cooperative behavior. Then in period 2 (the third figure) j and l connected to this first mover have $0.5 < 0.55 = p^{**} \leq \hat{p}_K$, for all clusters K, of their social neighbors playing non-cooperatively so they switch to non-cooperative play in period 2 (regardless of the behavior within firm 1). Thus, non-cooperative behavior has invaded firm 1. Next (not represented in the figure) depending on the benefits of playing non-cooperatively in firm 1 when 2 of the 4 employees play non-cooperatively nodes n and m may also switch to non-cooperative behavior.

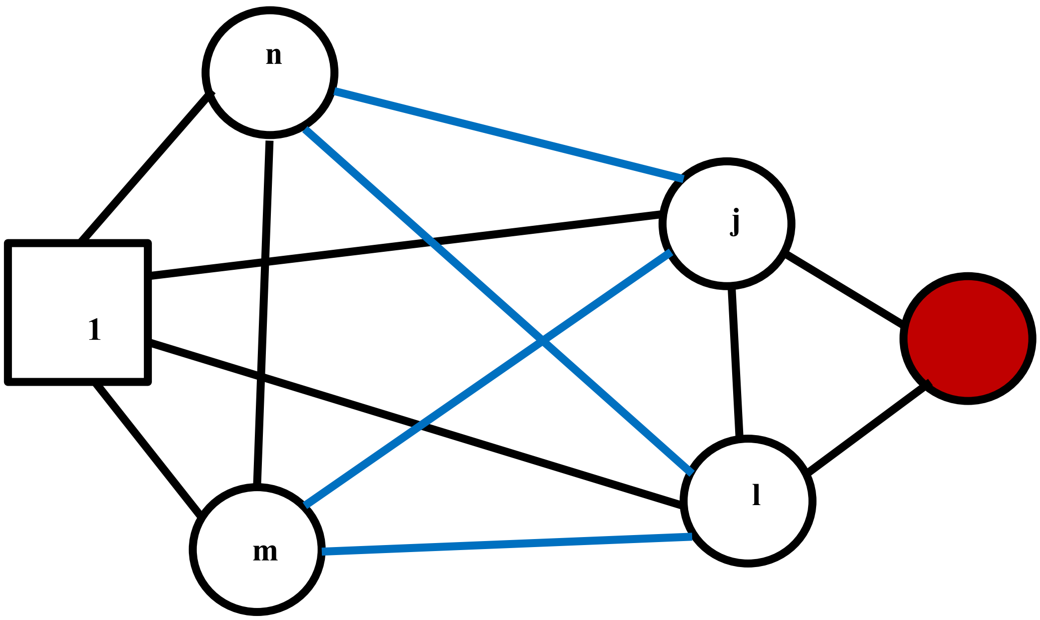


Figure 3: In the figure above the social network from Figure 2 is enriched (with the blue edges) to a completely connected social network between the employees of firm 1. Again, node k exogenously switches to non-cooperative behavior. But now nodes j and l have only one-fourth of their social neighbors playing non-cooperatively. Whether they switch depends on the second term in $\widehat{p}_K$ for the cluster K={j, l, m, n}. This cluster has social density 0.75. If this second term in $\widehat{p}_K$ is less than 0.2 then $\widehat{p}_K$ is less than 0.75 and non-cooperative behavior cannot invade the firm.

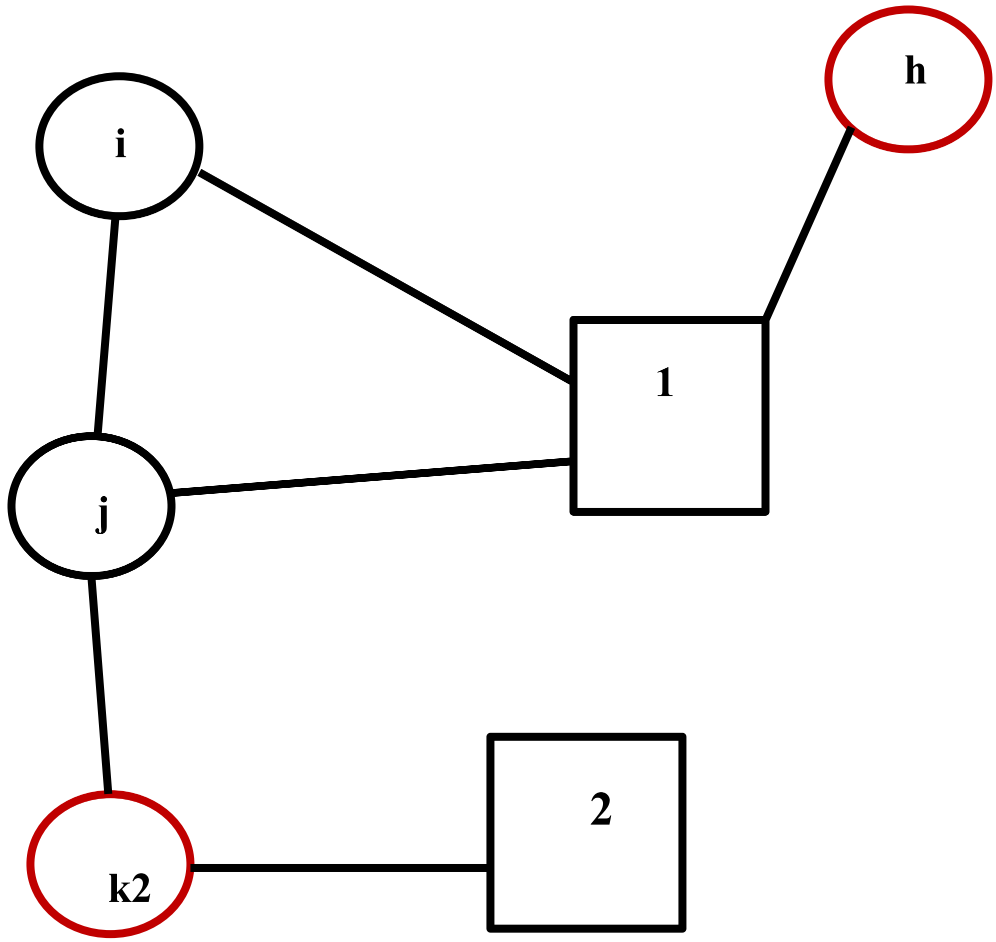


Figure 4: Nodes h, i, and j work at firm 1. Nodes k works for firm 2. Node Nodes i and j, and nodes j and k have social connections. Suppose that initially all nodes play (CE, CS). Then nodes h and k exogenously switch to play of (NE, NS). Node k switching to non-cooperative play need not be enough to cause node j to switch. But as node H also switches the number of cooperative workers, other than node j, in firm 1 falls from 2 to 1. This along with k playing non-cooperatively can cause node j to switch to non-cooperative play in the next period. Then node I also switches and a complete cascade occurs.

Appendix A: Proofs

Proof of Theorem 1:

Given in the text above the statement of Theorem 1.

Proof of Theorem 2:

(i) A complete cascade requires all of the nodes in the cluster of density $\hat{p}_K$ to switch from (CE, CS) to (NE, NS). For a complete cascade to occur there must be some first node in the cluster to switch to (NE, NS). At the time t at which this node switches to (NE, NS) it and all of the other nodes in the cluster had played (CE, CS) at time t-1. By Assumption 1.2 each of the nodes in the cluster thus has at least fraction $\hat{p}_K$ of its neighbors who are expected to play (CE, CS) at time t. However, with at least fraction $\hat{p}_K$ of its neighbors expected to play (CE, CS) this first node does not switch to (NE, NS). Thus, no node in the cluster switches to (NE, NS) and a complete cascade does not occur.

(ii) If a complete cascade does not occur then there is some remaining set of nodes, K, playing (CE, CS) with all others playing (NE, NS). We will show that K is a cluster with density at least $\hat{p}_K$. Consider any node $i \in K$. This node choses to play (CE, CS) so it must have at least fraction $\hat{p}_K$ of its neighbors who are expected to play (CE, CS), that is, who played (CE, CS) in the previous step and because the cascade has stopped who will play (CE, CS) again. The only nodes left playing (CE, CS) are the nodes in the set K. So, the fraction of i's neighbors who are in K must be at least $\hat{p}_K$. This holds for all $i \in K$ so K is a cluster of nodes playing (CE, CS) with density at least $\hat{p}_K$.

Proof of Theorem 3:

For noncooperative play to invade F_n there must be some first node $i \in F_n$ to switch to (NE, NS). At the time t when this node switches to (NE, NS) all other nodes in F_n are playing (CE, CS), all of these nodes played (CE, CS) at time t-1 and all expected to play (CE, CS) at time

t. So at least fraction $\hat{p}_n$ of i's neighbors expected to play (CE, CS) and this first node does not switch to (NE, NS). Thus, no node in the cluster F_n switches to (NE, NS).

References

Acemoglu, D., and M. O. Jackson, 2015, History, expectations, and leadership in the evolution of social norms, *Review of Economic Studies*, 82, 1–34.

Acemoglu, D., A. Oxdaglar, and A. Tahbaz-Salehi, 2015, Systemic risk and stability in financial networks, *American Economic Review*, 105(2), 564-608.

Allen, F. and A. Babus, 2009, Networks in finance, in The Network Challenge: Strategy, Profit and Risk in an Interconnected World, edited by P. Kleindorfer, Y. Wind, and R. Gunther, (Prentice Hall)

Allen, F. and D. Gale, 2000, Financial contagion, *Journal of Political Economy*, 108(1), 1-33.

Babus, A., 2016, The formation of financial networks, *RAND Journal of Economics*, 47, 239–272.

Benoit, S., J. Colliard, C. Hurlin, and C. Perignon, 2017, Where the risks lie: A survey on systemic risk," *Review of Finance*, 21, 109–152.

Bereskin, Frederick L. and Byun, Seong K. and Officer, Micah S. and Oh, Jong-Min, 2018,The Effect of Cultural Similarity on Mergers and Acquisitions: Evidence from Corporate Social Responsibility, *Journal of Financial and Quantitative Analysis*, 53, (5) 1995-2039,

Blume, L., D. Easley, J. Kleinberg, R. Kleinberg, and E. Tardos, 2013, Network formation in the presence of contagious risk, *ACM Transactions on Economics and Computation*, 1,2, 1-20.

Cremer, J., 1993, Corporate culture and shared knowledge, *Industrial and Social Change*, 2, 351-386.

Davidson, R., A. Dey, and A. Smith, 2015, Executive "off the job" behavior, corporate culture, and financial reporting risks, Journal of Financial Economics, 117, 5-28.

Dimmock, S. G., W. C. Gerken, and N. P. Graham, 2018, Is fraud contagious? Co-worker influence on misconduct by financial advisors, *Journal of Finance*, 73, 1417– 1450.

Dufwenberg, M. and A. Patel, 2017, Reciprocity networks and the participation problem, *Games and Economic Behavior*, 101, 260-272.

Easley, D. and J. Kleinberg, 2010, Networks, Crowds, and Markets. (Cambridge University Press: Cambridge, UK).

Easley, D. and M. O'Hara, 2023, Financial Market Ethics, Review of Financial Studies,

Eisenberg, L. and T. H. Noe, 2001, Systemic risk in financial systems, *Management Science*, 47, 2, 236–49.

Egan, M., G. Matvos, and A. Seru, 2019, The market for financial advisor misconduct, *Journal of Political Economy*, 127(1), 233-295.

Erol, S. and R. Vohra, 2014, Network formation and systemic risk, working paper, University of Pennsylvania.

Festinger, L., 1957, *A Theory of Cognitive Dissonance.* Stanford University Press.

Freixas, X., B. Parigi, and J.-C. Rochet, 2000, Systemic risk, interbank relations, and liquidity provision by the central bank, *Journal of Monetary Economics*, 32(3), 611-638.

Gai, P., A. Haldane, and S. Kapadia, 2011, Complexity, concentration and contagion, *Journal of Monetary Economics,* 58(5), 453–70.

Glasserman, P. and H. P. Young, 2016, Contagion in financial networks, *Journal of Economic Literature*, 54(3), 779-831.

Gorton, G., J. Grennan, and A. Zentefis, 2022, Corporate Culture, Annual Review of Financial Economics, 14, 535-561.

Gorton, G. and A. Zentefis, 2024, Corporate Culture as a Theory of the Firm, Economica, 91(364) 1391-1423

Graham, J., J. Grennan, C. Harvey, and S. Rajopal, 2022, Corporate Culture: Evidence from the Field, Journal of Financial Economics, 146, 552-593

Guiso, L. P. Sapienza, and L. Zingales, 2006, Does culture affect economic outcomes? *Journal of Economic Perspectives*, 20(2), 23-48.

Holmstrom, B.,1982. Moral Hazard in Teams. *The Bell Journal of Economics*, *13*(2), 324–340.

Huck,S., D. Kubler, and J. Weibull, 2012, Social norms and incentives in firms, *Journal of Economic Behavior and Organizations*, 83, 173-185.

Jackson, M. O. and E. C. Storms, 2019, Behavioral communities and the atomic structure of networks, working paper, Stanford University.

Liu, X., 2016, Corruption culture and corporate misconduct, *Journal of Financial Economics*, 122(2), 307–327

Lo, A. W., 2016, The Gordon Gekko Effect: The role of culture in the financial industry, *Economic Policy Review*, Aug, 17-42.

Mokyr, J., 2016, A Culture of Growth, (Princeton University Press; Princeton NJ).

Morris, S. 2000, Contagion, *Review of Economic Studies*, 67, 57-78.

O'Hara, M., 2016, Something for Nothing: Arbitrage and Ethics on Wall Street, (W.W. Norton: NY)

Stellmach, W., 2022, The SEC and Messaging Aps, *Harvard Law School Forum on Corporate Governance*, June 15, 2022.

Young, H. P., 1996, The economics of conventions, *Journal of Economic Perspectives*, 10(2), 105-122.

Young, H. P., 2015, The evolution of social norms, *Annual Review of Economics*, 7(1), 359-387.