The Geographic and Social Distance in Finance

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The Geographic and Social Distance in Finance
The Geographic and Social Distance in Finance

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Business Administration

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ABSTRACT

Our research interests lie in studying the economic behavior, choices, and actions of individuals given their geographical and social proximity to others, and analyze the consequences of such decisions to the financial health and survival of households, firms, and the macro economy. Network analysis and spatial econometrics take account of information spillovers and constraints of behaviors as consequence of the geographical and social distance between and among individuals. In this research, we apply those techniques to analyze aspects of corporate governance and explanations for the recent housing crisis.

The literature on principle-agent problems has devoted most of its attention to aligning the CEO’s incentives with public shareholders. The problems resulting from directors’ excessive loyalty to CEOs are largely ignored. In the first essay of the dissertation, we apply social network analysis to study the effectiveness of independent directors in directing the firm. We define powerful independent directors to be those with high social network centrality, and thus high social influence over their peers. We show that boards dominated by powerful independent directors are less likely to demonstrate excessive loyalty to CEOs. They carry out the duties of monitoring and advising more effectively, resulting in superior financial performance and higher firm value.

In the second and third essays of the dissertation, we study how financial risks are spread by proximity and contagion. Given advancing technology and globalization, financial markets are ever-more linked. We examine Rajan’s (2010) “credit for income” hypothesis as a root cause of U.S. mortgage defaults during the financial crisis of 2008. Over the past several decades, as U.S. household income became more unequal, those with stagnant incomes took on high leverage to boost their consumption to keep up with their wealthier neighbors. We provide
empirical support for the credit for income hypothesis using household-level data showing that default is highest for middle-income, low-educated borrowers — precisely the ones with stagnating income.

We also apply spatial models to identify the “hot spots” of defaults. We use Spatial Statistics (Anselin, 1988, 1990) to analyze data of residential foreclosures at county level to account for the unusual concentration of foreclosures observed in the south Pacific, east North Central, and south Atlantic regions. We find that spatial correlation plays an important role in explaining the large number of mortgage foreclosures that are clustered strongly in those regions. Moreover, default contagions are more severe at counties with younger households and largely usage of variable loans.
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DEDICATION

To my Dad and Mom
# TABLE OF CONTENTS

I. Introduction 1

II. Essay 1: Powerful Independent Directors 3
   A. Introduction 3
   B. A Behavioral Theory of Corporate Governance 7
      1. Disobedience to Authority and Corporate Governance 7
      2. Corporate Governance Reforms 16
      3. Degree of Separation and Corporate Governance 22
   C. Data and Variables 24
      1. Social Network Centrality as a Measure of Power 24
      2. Variables of Interest 29
      3. Firm Governance and Financial Variables 32
   D. Empirical Results and Discussion 33
      1. Power and Shareholder Value 33
      2. The Direction of Causality 35
      3. How Independent Directors Matter 39
         a. Merger and Acquisition 39
         b. Free Cash Flow 41
         c. CEO Turnover 42
         d. CEO Compensation 43
         e. Earnings Management 43
      4. Robustness Check 44
   E. Conclusions 46
   F. References 49
   G. Tables 54

III. Essay 2: Income Inequality, Leverage, and the Mortgage Crisis 116
   A. Introduction 116
   B. Household Data Sources 120
   C. Household and Regional Influence on Mortgage Foreclosure 121
      1. Households Attributes and Property Characteristics: Profiles of Mortgage Default 123
      2. County Influences on Mortgage Default 125
      3. Contagion in Household Defaults 128
   D. Income Inequality, Leverage, and Mortgage Default 130
      1. Income and Education Interactions 131
      2. Detailed Household Interactions 137
   E. Conclusion 139
   F. References 141
   G. Appendix 142
   H. Tables 143

IV. Essay 3: Geographic Concentration of Residential Foreclosures: Household Demographics and Spatial Contagion 166
   A. Introduction 166
   B. Residential Default Models 168
      1. Frictionless Default Model 168
      2. Spatial Default Model 170
I. Introduction

The literature on principle-agent problems has devoted most of its attention to aligning the CEO’s incentives with public shareholders. In economics, an agency problem (Jensen and Meckling (1976)) arises where a CEO advances her private interests, instead of serving as a faithful agent of the uncomprehending shareholders, the firm’s owners or principals. The board of directors hypothetically limits agency problems by representing the shareholders’ interests in major decisions (Weisbach (1988)). However, there are limited empirical evidence that directors actually play such a role in directing a firm effectively (Adams, Hermalin and Weisbach (2010)).

In the first essay, we apply Milgram’s (1974) famous agentic shift theory to examine the agency problem in a new perspective. Agency in social psychology entails individuals discarding rational decision-making to reflexively obey an authority figure. Economics thus finds problems with insufficiently loyal agents, while social psychology finds problems with agents’ sometimes excessively loyalty. For example, an Enron executive describes an atmosphere of intimidation in which many could see problems looming, but no-one dared confront the CEO (Cohan (2002)). Plausibly, the problem was not director’s self-interest eclipsing the shareholders, but an agentic shift disengaging their rational self-interest and rendering them pliant agents of the CEO.

We use social network analysis to construct centrality measures as proxies for a person’s authority, influence, or social power (Proctor and Loomis (1951), Sabidussi (1966), Bonacich (1972), Freeman (1977, 1979), Watts and Strogatz (1998), Hanneman and Riddle (2005), Jackson (2008)). These power centrality measures gauge the number and importance of the person’s direct and indirect connections to others in the network. More or more important connections provide more access to information, more resources to fall back on, more ability to
influence events, and thus more power. In this study, we find that powerful independent boards are associated with high firm performance and firm value. We also show the linages of value enhancing through board of directors’ monitoring and advising functions.

A recent growing body of literature documents the importance of geographic and social proximity on investor behavior, corporate governance, and financial policies. Households with similar social, economic, and demographic attributes will cluster together. Research shows that a foreclosure within 250 feet adversely affects housing price by about $1,666, after accounting for the spatial dependence of housing prices and in the errors of models and other known factors impacting sale price of a home (Leonard and Murdoch (2009)). Similarly, Harding, Rosenblatt and Yao (2009) show that contagion from nearby foreclosure amounts to about 1% decline in local housing price per foreclosed property and diminish quickly with the increased distance to the distressed property. Both papers focus on the effects of foreclosure on housing price changes, but not on the determinants of foreclosure itself.

In the second and third essays of this dissertation, we study how financial risks are spread by geographic proximity and contagion. We examine the default decision of US households using a unique dataset with full information of household characteristics, property characteristics, and some loan information. We examine Rajan’s (2010) “credit for income” hypothesis as a root cause of U.S. mortgage defaults during the financial crisis of 2008. We provide empirical support for the credit for income hypothesis showing that default is highest for middle-income, low-educated borrowers — precisely the ones with stagnating income. The spatial correlations also play a role in explanation of the clustering pattern of residential mortgage defaults.
II. Powerful Independent Directors

Abstract: In social psychology agentic behavior connotes excessive obedience to a proximate authority, and is mitigated by a rival authority or peer voicing dissent. Corporate governance reformers advocate non-CEO chairs and independent directors, respectively, as potential rival authorities and dissenting peers – plausibly to mitigate excessive director loyalty to errant CEOs. Measuring director power by social network power centrality, elevated market valuation is linked to powerful independent directors’ constituting a majority of independent directors and, less robustly, to a powerful director serving as the non-CEO chair. Sudden deaths of powerful independent directors significantly reduce shareholder value, consistent with independent director power “causing” shareholder value. Further empirical tests associate powerful independent directors with fewer value-destroying M&A bids, more high-powered CEO compensation and accountability for poor performance, and less earnings manipulation. These results suggest that independent directors and non-CEO chairs can be effective if they have sufficient power to challenge the CEO.

A. Introduction

Recent reforms in corporate governance stress independent directors, mandating their minimal number, proportion, and exclusive writ over key decisions; all while restricting the CEO’s power to chair the board, nominate directors, and even be present as certain decisions are made. If the goal of corporate governance reforms is to constrain agency problems by empowering public shareholders, such reforms seem oblique. But if the goal is checking errant CEOs, they are more on point.
Ideally, CEOs are uniquely talented individuals to whom savers entrust capital. Because such a CEO necessarily has abilities and information public shareholders do not have, shareholders must trust her with broad discretionary powers to “get things done” so as to advance their interests. But because public shareholders do not understand precisely how the CEO is to do this, issues of accountability can arise. In economics, an agency problem (Jensen and Meckling (1976)) arises where a CEO advances her private interests, instead of serving as a faithful agent of the uncomprehending shareholders, the firm’s owners or principals. The board of directors hypothetically limits agency problems by representing the shareholders’ interests in major decisions (Weisbach (1988)). Empirically, evidence that directors actually play such a role is absent, problematic, or severely limited in scope (Adams, Hermalin and Weisbach (2010)).

This may be because economists have a somewhat one-sided approach to agency problems, and thus misapprehend the way in which directors constrain CEOs’ decisions and the situations in which their role is most pronounced. Agency in social psychology entails individuals discarding rational decision-making to reflexively obey an authority figure: Milgram’s (1974) famous agentic shift\(^1\). Economics thus finds problems with insufficiently loyal agents, while social psychology finds problems with agents’ sometimes excessively loyalty.

U.S. law leaves directors personally liable for shareholder wealth destruction due to CEOs’ imprudence, aligning directors’ self-interest with shareholders’ wealth. Mired in multimillion dollar lawsuits and suddenly aware of the limitations of their liability insurance, the directors of AIG, Enron, Lehman Brothers, and other corporate governance shipwrecks hardly

\(^{1}\) The social psychology version of agency can also be thought of as an information cascade problem (Banerjee (1992), Bikhchandani et al. (1992)), in which directors accept the CEO’s decisions because gathering and processing information necessary make their own rational decisions is costly.
maximized their personal wealth. *Post mortem* accounts allege corporate cultures that equated honest dissent to disloyalty to the CEO. For example, an Enron executive describes an atmosphere of intimidation in which many could see problems looming, but no-one dared confront the CEO (Cohan (2002)). A lone dissenter might be fired, but a majority of directors could fire the CEO and avoid the lawsuits. Plausibly, the problem was not director’s self-interest eclipsing the shareholders, but an agentic shift disengaging their rational self-interest and rendering them pliant agents of the CEO.

The reform agenda above makes more sense if its objective is to prevent directors from abrogating rational decision-making under the sway of an authoritative CEO. Variants of Milgram’s study show the agentic shift weakened by the physical absence of the authority figure, further weakened by dissenting peers, and interrupted entirely by a rival authority figure openly disagreeing. Excluding the CEO from meetings of the board’s audit, compensation, and nominating committees render the CEO physically absent from key decisions delegated to those committees. Independent directors might be potential dissenting peers, able to disturb inside directors’ agentic shift and bestir their rational decision-making faculties. A chair other than the CEO might become a rival authority, able to interrupt their agentic shift entirely. The efficacy of such measures depends on the authority directors or non-CEO chair can muster against the CEO.

Proxies for a person’s authority, influence, or social power are constructed from graphs of the social networks in which they function (Proctor and Loomis (1951), Sabidussi (1966), Bonacich (1972), Freeman (1977, 1979), Watts and Strogatz (1998), Hanneman and Riddle

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2 Lone “whistle blowers” are often punished with ruined careers, even if proven right (Alford (2000)).
(2005), Jackson (2008)).\textsuperscript{3} These \textit{power centrality measures} gauge the number and importance of the person’s direct and indirect connections to others in the network. More or more important connections provide more access to information, more resources to fall back on, more ability to influence events, and thus more power. Applying these measures to networks of connections reflecting past \textit{curriculum vitae} commonalities, we construct four measures of the \textit{power centrality} for every CEO and director. We say a person is \textit{powerful} if and only if she scores in the top quintiles in three of four tests of power centrality.\textsuperscript{4} CEOs, non-CEO chairs, and independent directors who are also powerful are designated \textit{powerful CEOs} (PCEOs), \textit{powerful independent directors} (PID s), and \textit{powerful non-CEO chairs} (PNCs), respectively. We say a firm has a \textit{powerful independent board} (PIB) if a majority of its independent directors are PIDs.

Consistent with power centrality capturing directors’ and non-CEO chairs’ authority and willingness to challenge CEO power, firms with PIBs exhibit significantly higher shareholder valuations, as measured by \textit{Tobin’s average Q ratios}. Moreover, these effects are largely independent of each other. In contrast, legally independent directors and generic non-CEO chairs are uncorrelated with Q ratios. Further regressions link PIBs and PNCs to less aggressive earnings manipulation, fewer value-destroying takeovers, and fewer free cash flow agency problems in general (Jensen (1986)). PIBs and PNCs are likely to fire CEOs for poor performance and to hire new CEOs from outside; but also pay CEOs more generously. Finally,

\textsuperscript{3} A second line of Milgram’s (1967) work helped develop the notion of a social network. Milgram mailed randomly selected people in Omaha, Nebraska packages, each with a note asking the recipient to forward the package (and note) to the “first name basis” acquaintance most likely able to forward it to a specified addressee in Boston. The packages passed through an average of 5.2 acquaintances of acquaintances. If individuals are nodes in a network, with lines between nodes denoting acquainted individuals, this exercise reveals about six mutual acquaintance pairs – “6º of separation” – linking a random Omahan to a Bostonian.

\textsuperscript{4} This approach reflects the Pareto or power law distributions power centrality measures typically obey, whereby e.g. 20% of the individuals have 80% of the power.
an event study of PID sudden deaths reveals that PIDs cause changes in shareholder value, rather than the converse.

The remainder of the paper is organized as follows. Section 2 links relevant social psychology work to a behavioral theory of corporate governance. Section 3 describes the data and variables. Section 4 presents the results and robustness checks. Section 5 concludes.

B. A Behavioral Theory of Corporate Governance

Behavioral finance constructively applies a set of findings from social psychology – prospect theory, salience, etc. – to augment rational agent models of financial markets (Shleifer (2000)). A different set of social psychology results, primarily due to the work of Stanley Milgram (1967, 1974), suggests a behavioral basis for corporate governance.

1. Disobedience to Authority and Corporate Governance

Milgram (1974) sought to understand Nazi concentration camp guards, who met charges of mass murder by explaining “I was only obeying orders”. To see if Germans were more obedient to authority than Americans, he conducted an experiment. Milgram asked the “real subject” of the experiment to “assist” by acting as a “teacher”, and introduced her to a second participant, the “learner”, actually a professional actor. The purpose the experiment, Milgram falsely explained to the “teacher”, was to measure how being punished for errors would affect the “learner’s” ability to concentrate. Milgram explained that he would ask a series of questions,

5 This subsection and the next both draw heavily on material presented in more detail, and with more complete references to the psychology literature, in Morck (2009), and recast as teaching material in Morck (2010). To avoid clutter, a pervasive reference to these sources is extended across the subsequent pages.
and each time “learner” answered incorrectly, he would gesture to the “teacher”, seated in front of a panel of switches marked with voltages increasing to potentially lethal levels, to give the “learner” a larger electric shock. The “learner” was scripted to feign worse electric shocks as the “teacher” increased the voltage.

The real purpose of the experiment was to see if subjects would electrocute a total stranger merely because they were so instructed. Milgram planned to run the experiment in Connecticut and then in Germany to test for differences. In fact, he was so appalled by ordinary Americans obediently putting potentially deadly currents of electricity through screaming “learners” that he never repeated the experiments in Germany. One hundred percent of “teachers” obediently administered shocks up to 150 volts, whereupon the “learner” screamed in agony. Some eighty percent obediently continued administering shocks up to 300 volts, after which the “learner” demanded to be released and refused to answer more questions. About 63% of Milgram’s “teachers” continued administering shocks all the way up to 450 volts, the final few switches being marked “XXX”.

Milgram’s findings are robust. Yale students and middle class Connecticut residents, males and females, blue and white collar workers, educated and uneducated subjects all exhibit similar obedience patterns. Others replicate his general findings across a wide range of experimental settings and subject groups (Merritt and Helmreich (1996), Blass (1998, 2000, 2004), Tarnow (2000), Burger (2009)), including Germans (Miller (1986)). To ensure that subjects did not see through the actors’ pretense of pain, Sheridan and King (1972) replicate the experiment using real shocks to a puppy.

These experiments were widely condemned for eliciting sadism. This seriously
misapprehends their actual findings. Milgram (1974, 188) despairs that the

“virtues of loyalty, discipline, & self-sacrifice that we value so highly in the individual are the very properties that create destructive engines of war & bind men to malevolent systems of authority.”

That is, he concludes that humans have a ‘loyalty reflex’, not a sadistic bent. Martin et al. (1976) affirm this interpretation by replicating Milgram’s approximate results in a variant of the experiment in which “teachers” punish “learners” by activating a noise maker at levels marked as “50% risk of permanent hearing damage”. Although the “teachers”, seated only feet away from the “learner”, obviously risked damaging their own hearing too, similar obedience ensued.

Many of Milgram’s subjects were visibly shaken, and clearly did not enjoy inflicting pain but did so anyway (Blass (2000, 2004)). In exit interviews, after the experiment was explained, Milgram (1974) found that “People … asked to render a moral judgment on what constitutes appropriate behavior … unfailingly see disobedience as proper.” Asked why they behaved inappropriately, the subjects advanced excuses such as politeness, the importance of keeping a promise, the awkwardness of disagreement, absorption in technical details of the experiment, or a belief that a greater good, such as the advancement science, must justify the learner’s pain. But the most universal response was a sense of loyalty to the experimenter.

6 This debate led to university ethics review committees, which prevent complete replications of the Milgram’s experiment at present (Blass (1991, 1996, 2000)).
7 For further elaboration of the adverse social consequences of humans deriving utility from obeying authority, see Kelman and Hamilton (1989) and Zimbardo (2007).
8 Consistent with this, Cheetham et al. (2009), recreating the Milgram experiment in a virtual setting with the subject in an fMRI scanner, report activation in areas of the brain associated with personal emotional distress, but not in areas associated with the representation of others’ emotional state.
Thus, Milgram (1974, p. 7-8) concludes

“The typical subject did not lose his moral sense; instead, it acquires a radically different focus. He does not respond with a moral sentiment to the actions he performs, Rather, his moral concern now shifts to a consideration of how well he is living up to the expectations that the authority has of him.”

He summarizes the exit interview results by noting that virtually every subject indicated disobedience as morally right choice, yet few disobeyed. Asked why they obeyed, subjects stressed loyalty (I agreed to obey instructions); duty (my role in the experiment); honor (I made a promise to the experimenter); trust (I presumed experimenter acting for the greater good); and fitting in (I felt discomfort about creating a scene).

Based on these interviews, Milgram (1974, p. 8) proposes that the subjects experienced an agentic shift, which he defines thus:

"the essence of obedience consists in the fact that a person comes to view themselves as the instrument for carrying out another person's wishes, and they therefore no longer see themselves as responsible for their actions. Once this critical shift of viewpoint has occurred in the person, all of the essential features of obedience follow"

Milgram’s agentic shift is obverse to Jensen and Meckling’s (1976) agency theory, long a workhorse model in corporate governance research. Jensen and Meckling correctly observe that problems can arise if agents, the CEOs who run widely held corporations, act in their own interests, rather than as faithful advocates of the interests of the corporation’s principals, its shareholders. Milgram’s agentic shift, equally correctly, sees problems arising from excessively obedient agents, such as dutiful concentration camp guards.

The thesis that humans reflexively obey authority is not foreign to classical economics. Hobbes (1651) argues that people submit to the police power of the state, however capricious or
tyrannical, because the anarchy is worse. Darwin (1871) argues that evolution thus favors a propensity to, among other things, loyalty and obedience:

“a tribe including many members who, from possessing in a high degree the spirit of patriotism, fidelity, obedience, courage, and sympathy, were always ready to give aid to each other and to sacrifice themselves for the common good, would be victorious over other tribes; and this would be natural selection.”

Recent advances in mathematical biology demonstrate that natural selection can occur rapidly at the group level if in-group self-sacrifice is juxtaposed against continual deadly between-group warfare, now the standard model of hunter-gatherer societies in anthropology (Wilson (2012)). The depth of emotion that the concepts of loyalty, duty, and honor arouse – comparably profound in many to emotions associated with sexual reproduction and care for young – are consistent with Darwin’s hypothesis of an instinctive basis. For brevity, we refer to this as reflexive obedience, though a broader behavioral range encompassing patriotism, fidelity, and other related concepts is intended to be implicit throughout.

Reflexive obedience appears to be an example of what Kahneman (2011) calls “fast” thinking. After an exhaustive overview of behavioral economics, Kahneman concludes that far more human behavior is, in one form or another, reflexive than was previously thought; but that humans nonetheless possess a capacity for rational decision-making – “slow” thinking – that can overrule reflexive behavior. Because slow thinking is apparently metabolically costly, though in ways not yet well understood, humans rely on what “fast” thinking by default. This entails unconscious or only marginally conscious “rules of thumb” that arise from instinct, either directly or from innate, and quite likely instinctive, learning-response mechanisms. This dichotomous model of human behavior differs from simple stimulus-response models in that, when “fast” thinking fails to converge on a decision rapidly, “slow” thinking activates. This
model, though far from universally accepted, finds increasingly solid support in both neuroimaging and experimental data (reviewed in Kahneman (2011)).

Kahneman’s dichotomy may explain instances in which Milgram’s (1976) “teachers” decided to disobey his instructions to electrocute the “learner”, as well as a very few variants of the experiment that failed to replicate the baseline results described above. “Teachers” who decided to disobey appear to have switched from “fast” thinking, in which reflexive obedience induced an agentic shift, to “slow” thinking, in which the disobedient “teachers” rationally reflected on what they were doing – perhaps weighing the legal, ethical, and financial consequences of seriously harming the “learner”. This cognitive cost expended, the “teacher’s” rational decision making system took charge and overruled reflexive obedience.

Those variants of the experiment that failed to replicate the baseline pattern of obedience also fit this pattern (Milgram (1965), Packer (2008)). In the baseline experiments, Milgram instructed the “teacher” while standing a few feet away. Disobedience increased if he instead stood outside the room, or instructed the “teacher” by phone. A second set of experiments, motivated by Asch’s (1951) finding that dissenting peers reduce conformity, introduced additional confederates who posed as “other teachers”. The “real subject” was asked to operate the electrocution switches while the “other teachers” watched. The “other teachers” were scripted to voice dissent by criticizing the propriety of the experiment once a pre-specified voltage was reached. This induced substantial disobedience. A third variant, in which a “second psychologist”, of similar heights and bearing to Milgram, and also wearing a white lab coat, entered the room partway through and criticized the experiment, induced every “teacher” to
switch entirely to disobeying Milgram – 100% disobedience. Each intervention was timed to correspond with the first drop in obedience evident in the baseline studies at 150 volts, when the “learner” first voiced objections, and thus can be interpreted as magnifying that effect.

In each variant, Milgram posits that changes in the setting weaken reflexive obedience. However, equally consistent with the data, these situations might strengthen rational “slow” thinking. If the authority figure is not proximate, his authority becomes less salient, but obedience is also less rational because the authority figure may not have all the information the subject has. Dissenting peers might weaken the subject’s innate tendency to fall into line with what he perceives to be the behavior expected of him, but could also disrupt “fast” thinking and allow “slow thinking” to be activated. Conflicting rival authority figures likewise plausibly keep “fast” thinking due to the obedience reflex from converging, forcing the subject to snap out of her agentic shift and expend the effort necessary to make a rational decision.

Institutions – legal, economic, and social – plausibly evolve at the group-level to reinforce or damp individual behavior that is socially beneficial or harmful, respectively. For example, American soldiers in the War of 1812, allowed to elect their officers, tended to put in pacifists just before key battles (Taylor (2011)). Institutional constraints that protect reflexive obedience from rational decision-making arguably make for a more competitive army. Likewise, a communist economy demands obedient implementation of a central plan (Shleifer and Vishny (1992)), and all communist states equated rational profit-making decisions by state officials to treason. Hierarchical religions, government bureaucracies, and any number of other large

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10 Burger (2009) fails to replicate this disobedience. However, because these subjects may administer shocks up to 150 volts only, not greatly above household AC current in the United States and below the 220 volt standard elsewhere, disobedience may have less obvious justification to them.
organizations rely heavily on obedience to overrule the self-interested behavior of individuals. Sometimes, this is accomplished by paying the individuals for obedience – the convergence of interests Jensen and Meckling (1976) stress. However, stirring individuals’ passions of patriotism, duty, loyalty, and so on may well stimulate reflexive obedience more effectively and more reliably than money (Wilson (2011)), which necessarily acts by triggering the undesirable process of rationally self-interested decision-making in the first place.

Competition between economies, or even economic systems, arguably selects for institutions that allow reflexive obedience to play out in situations where obedience is generally socially beneficial, but that trigger rational decision-making in situations where society benefits from individuals thinking for themselves. Hobbes (1651), presaging Nash’s (1950) concept of a low-level equilibrium in arguing that life in nature is “every man against every other man” and inevitably leads to live that are “solitary, nasty, brutish, and short”, posits that people prefer universal obedience to an absolute monarch because this leads to less awful outcomes. Thus, Hobbes’ Leviathan – the monster that is the State’s monopoly on the legal use of deadly force, and perhaps the most fundamental of institutions (North, Wallis and Weingast (2009)), arguably arises from economy-level competition of this sort.

Institutions that activate rational decision-making likewise persist where they augment group survival odds. An important achievement of the 1688 Glorious Revolution was the creation of position of Leader of His Majesty’s Loyal Opposition – a leader-in-waiting duty-bound to criticize the decisions of the Prime Minister and government. In other words, the leader of the opposition demonstrates loyalty to the country by playing the role of an outspoken rival authority figure, often even in situations where a government he led would do no different.
Some variant of this Westminster system, with at least two parties and institutionalized rival authority figures, is now considered an integral part of every democracy. Perhaps the sight of rival authority figures, volubly criticizing each other in Parliaments and Congresses throughout the developed world, induces “slow thinking” in elected representatives and thus elicits better quality legislation. Perhaps the sole authority figures who dominate the governments of authoritarian states, however well-intentioned and competent, elicit reflexive obedience that lets errors go uncorrected and lowers the quality of government. Official harmony might then be a sign of bad government, and argument a sign of broader rational decision-making. To the extent that democracy has gained ground against authoritarianism, dissent-induced rational decision-making in governments is arguably a group survival trait.

A major difference between Common Law and Napoleonic Code legal systems is procedural: In Common Law courts, rival lawyers attack each-others’ arguments as a disinterested judge and jury, both explicitly neutral, watch. In Napoleonic Code courts, in contrast, a judge magistrate directs the police, calls and grills witnesses, consults experts, and decides the case as the interested parties’ lawyers, who occasionally interject respectfully, remain largely passive. The large empirical literature correlating superior economic outcomes with Common Law legal systems may have less to do with the laws per se than with these procedural differences: Common Law courts feature rival authority figures, whose discord can activate rational decision-making in the judge and jury; Civil Code courts feature a single authority, the judge magistrate, conducive to reflexive obedience.

Academic journals and conferences draft referees and discussants, respectively, whose duty is to serve as rival authorities. The effect is presumably to activate “slow” thinking, rational
decision making, in editors and conference attendees. These practices arose recently, in the mid-
20th century in most disciplines, and science advanced at unprecedented rates in subsequent
decades. Argument from authority, once a crucial means of persuasion, is now risible in research
universities.

All of these institutional innovations create an official “devil’s advocate”, duty-bound to
criticize the authority at hand. In each case, this criticism arguably leads to better decision
making by those watching on – backbenchers in Parliament, Common Law judges and juries,
journal editors, or academic researchers. Indeed, the term derives from the Holy Office of the
Devil’s Advocate (Advocatus Diaboli), a Vatican position established in the Counterreformation
by Pope Sixtus V to rebuild respect for the Roman Catholic Church by exposing sham sainthood
nominees. For centuries, the Devil’s Advocate was a top Canon Law expert duty-bound to
contest the character and miracles of prospective saints. The office was abolished by John Paul
XXIII, who created more saints that all previous 20th century pontiffs combined.

2. Corporate Governance Reforms

Corporate governance reforms, from a behavioral perspective, can then be viewed as
ttempts to inject a Devil’s Advocate into key forums of corporate decision-making: boardrooms
and annual general shareholders meetings. Corporate CEOs are, of necessity, powerful authority
figures because business corporations are hierarchies, in which decisions at the top must be
carried out below (Coase (1937)). This validates the view of many corporate executives that
loyalty is an essential virtue in middle managers and employees. As Milgram (1974, p. 145-6)
explains,
“The most far-reaching consequence of the agentic shift is that a man feels responsibility to the authority directing him, but feels no responsibility for the content of the actions that the authority prescribes.”

Neither an army nor a business corporate could function if every decision had to be justified economically and ethically to every employee before any action could ensue. The information and coordination costs would be immense and the speed of implementation glacial, if not sessile. The corporation is a command and control mechanism because obedience to an authority is less inefficient than information gathering, cost benefit analysis, and rational decision making throughout (Williamson (1979)).

But like absolute monarchs, judge magistrates, and prominent academics, CEOs can err. Various corporate governance mechanisms appear designed to interrupt reflexive obedience in specific ways. For example, some recent reforms seek to distance the CEO from key decision makers by, for example, excluding her from key board subcommittee meetings. Recall that obedience decreased if Milgram stepped outside the room, or issued instructions by phone. Efforts to increase the number and powers of independent or outside directors can be seen as efforts to encourage dissent among directors’ peers. Recall that Milgram’s experimental variants featuring dissenting peers reduced obedience. Designating a Lead Independent Director, like mandating that an independent director chair the board, arguably creates a Leader of His Majesty’s Loyal Opposition in the boardroom. Recall that rival authority figures entirely eliminated obedience in those variants of Milgram’s experiments.

Empowered institutional investors might similarly serve as vocal dissenting peers at annual general meetings or shareholder, which otherwise can resemble one-position-one-candidate elections in Soviet Socialist Republics. Dissident slates of candidates in proxy battles
can be thought of as rival authorities.

In each case, these corporate governance reforms track results from Milgram’s experiments and subsequent related studies that expose situations likely to interrupt a subject’s agentic shift and restore individual responsibility and economic rationality. They deter Kahneman’s (2011) reflexive “fast” thinking, decision making via reflexive obedience, and promote his “slow” thinking, costly and time consuming decision-making requiring the gathering and processing of information and the calculation of a rational decision to stop the CEO before directors’ lives are destroyed by lawsuits and criminal charges, before middle managers’ and employees’ jobs are lost in corporate bankruptcies, and before shareholders’ wealth is demolished.

This behavioral perspective on corporate governance thus views excessive or misplaced loyalty to the CEO as a potential problem for self-interested directors, officers, middle managers, employees, and shareholders. This perspective in no way eclipses Jensen and Meckling’s (1976) theory that top managers’ insufficient loyalty to shareholders also causes problems. Rather, good corporate governance would appear to require attention to both. Thus, Jensen and Meckling (1976) argue that social welfare maximization requires that CEOs be loyal to shareholders, but ensuring this loyalty may require institutions that promote disloyalty to CEOs. Fama (1980), building on Jensen and Meckling (1976), argues that directors increase their pay by building reputations “as effective monitors”, but behavioral considerations suggest a reputation for “loyalty” might be more valuable if CEOs select directors, and that Fama’s argument might therefore be contingent on CEOs’ absence in nominating committees.

Empirical studies present, at best, mixed evidence as to the efficacy of independent
directors or non-executive chairs in affecting corporate governance (Hermalin and Weisbach (2003), Adams, Hermalin, and Weisbach (2010)). Weisbach (1988) finds that boards containing predominantly independent directors are more apt to replace the CEO after prolonged sub-par financial performance. However, the ultimate test of independent directors’ contribution to governance would be a clear causal link to superior share valuations (Rosenstein and Wyatt (1990), Shleifer and Vishny (1997), Rhoades et al. (2000), Perry and Shivdasani (2005), Jackling and Johl (2009)). However, the preponderance of empirical studies find no correlation between board independence and firm performance (Daily and Dalton (1992), Yermack (1996), Dalton et al. (1998), Heracleous (2001), Bhagat and Black (2002), Shivdasani and Zenner (2002), Dulewicz and Herbert (2004), Erickson et al. (2005), Weir and Laing (2001), Hsu (2010)). Bhagat and Black (1999) even report a negative correlation. The conclusion of Hermalin and Weisbach (2003) that the extant empirical literature forces the conclusion that “there does not appear to be an empirical relationship between board composition and firm performance” remains essentially unchallenged, though Duchin et al. (2010) find evidence of an effect in inverse proportion to information costs.

Fama and Jensen (1983), Jensen (1993) and others similarly argue that separating the roles of CEO and board chair improves governance, and thus ought to elevate share valuations. Morck, Shleifer and Vishny (1989), Finkelstein and D'Aveni (1994), and others link CEOs chairing their own boards to low shareholder value. However, Anderson and Anthony (1986), Stoebel and Sherony (1985), Faley (2007), and Coles et al. (2010) reported positive effects, whereas Brickley, Coles, and Jarrell (1997), Rechner and Dalton (1991), Baliga, Moyer, and Rao (1996), Dalton et al. (1998), and Dahya (2004) dispute these findings.
One explanation of this paucity of evidence, suggested by Higgs (2003, p. 39) in a report on British corporate governance, is that most independent directors and non-executive chairs are not, in fact, very independent. Rather, Higgs explains that

“Almost half of the non-executive [independent] directors surveyed for the Review were recruited to their role through personal contacts or friendships. Only four per cent had had a formal interview, and one per cent had obtained their job through answering an advertisement. This situation was widely criticised in responses to consultation, and I accept that it can lead to an overly familiar atmosphere in the boardroom.”

In the United States, an independent director has “no relationship with the company, except the directorship and inconsequential shareholdings, that could compromise independent and objective judgment” (Securities and Exchange Commission (1972)). This definition was adopted in response to a study by Mace (1971), who found that U.S. directors “do not establish objectives, strategies, and policies” and refrain from “asking discerning questions - inside and outside the board meetings”. The current reincarnation of these rules for NYSE listed firms is as follows:

An Independent Director must not, within the past three years, have been any of the following:

- An employee (exception: Employment as an interim Chairman or CEO does not count) of this company.
- The recipient of over $100,000 in direct compensation, excluding director fees, from this company.
- Affiliated with this company’s internal or external auditor.
- An executive director of another company, whose compensation committee
included any present executives of this company (exception: directorships of charities do not count).

- An executive officer of a supplier or customer of this company (exceptions: business amounting to less than $1M or less than 2% of the other firm’s sales does not count, nor do executive positions with charities)
- The immediate relative of someone who would be disqualified as an independent director on any of the above grounds.

Higgs (2003) suggests that CEOs simply comb through lists of their friends until they find ones who satisfy such a checklist of independence requirements. Consistent with this, Hwang and Kim (2009) find informal ties – a common alma mater, hometown, military service, and the like – pervasive between CEOs and legally independent directors. They further find that such ties correlate with higher CEO pay, lower CEO turnover, and lower firm operating performance. Such problems with the legal definition of director independence also loom large in recent litigation. For example, in a case against the independent directors of DHB Industries for knowingly selling the US military defective body armour, the SEC alleges the independent directors “were [the CEO] Brooks' long-time friends and neighbors, with personal relationships with Brooks that spanned decades. Chasin lived close to Brooks, and he and his family went out to dinner with Brooks and the Brooks family two or three times a month. Nadelman and his family had a social relationship with Brooks and the Brooks family, and regularly attended Brooks' family social functions. Krantz had a relationship with Brooks starting in 1998 or 1999, and was Brooks' insurance agent before Brooks asked him to join DHB's board.”

3. Degrees of Separation and Corporate Governance

Milgram’s finding that reflexive obedience is interrupted by distance, dissenting peers, and rival authorities suggests that more credibly authoritative and genuinely independent directors and board chairs might promote better corporate decision-making. But what makes one a credible rival authority figure to the CEO? Intelligence, prestigious degrees, breeding, height, a baritone voice, hair, and power all come to mind.

Oddly, power is arguably among the more readily measurable of these traits. Decades of work in graph theory and social network theory (Milgram (1967), Proctor and Loomis (1951), Sabidussi (1966), Bonacich (1972), Freeman (1977, 1979), Watts and Strogatz (1998)) provides a set of network centrality measures, which in different ways measure a person’s power. These measures, computed from ties between thousands of individuals, are intuitively plausible and empirically validated in diverse contexts (Padgett and Ansell (1993), Banerjee et al. (2012)).

A social network, representing individual as nodes, social connections as lines between nodes, and the quickest routes for one individual to reach another as geodesic distances (shortest paths) between nodes, allows the calculation of each individual’s centrality, and thus her social power. Four measures of power centrality arguably apply in the present context.

The simplest of these is an individual’s degree centrality (D), the number of direct connections that individual has with other people. Thus, D is an integer between 0 and N-1. Intuitively, a director with more connections may have more direct sources of information and more friends to fall back onto.

A second measure, called betweenness centrality (B) is the number of shortest paths
between the \((N-1)\times(N-2)/2\) possible pairs of other people that pass through the individual in question. Intuitively, a director with a higher B has more power to connect people with each other and more power to provide information about people to each other. Padgett and Ansell (1993) use high betweenness to explain the Medici family dominance in 15th century Florence: other elite families generally connected to each other only through the Medicis, who had direct times to most elite families.

A third measure, closeness centrality (C) averages the degrees of separation – that is, the number of links in the shortest paths – between the individual in question and every one of the other \(N – 1\) individual in the network. Closeness centrality is defined as \(N – 1\) divided by the sum of these degrees of separation. Intuitively, having closer connections to more people makes an individual transmit information to others faster, and thus having greater influence on others’.

A fourth measure, eigenvector centrality (E) is recursively calculated. Intuitively, eigenvector centrality is a weighted average of the importance of the individual’s direct contacts, with weights determined by the importance of their direct connections, with weights … and so on.

Taken together, these centrality measures can readily be interpreted as meaningfully measuring the individual’s power (Hanneman and Riddle (2005, Chapter 10)). High centrality individuals are more able to receive information, and to pass information along or not strategically. More connections and more central network positions mean more resources, more friends to fall back on, and more powerful friends, all of which lessen the downside of acting as a “Devil’s advocate”, enhancing a director’s credibility as a rival authority in the board room.
C. Data and Variables

This section describes the social connection data and the mathematics we use to calculate these centrality measures. We then define a powerful independent director (PID) as an individual with at least three of these four centrality measures falling in their top quintiles of the distributions of the centrality measures of all officers and directors of listed firms included in Boardex.

1. Social Network Centrality as A Measure of Power

We use relational data reported in BoardEx from 1996 through 2010 to approximate the social network of executives and directors of over 8,000 U.S. public and private firms. These data include background information that let us estimate both current business relationships and common backgrounds potentially indicating relationships going back many decades. Each individual in the network is a node, and each connection (past and current) is a link. These connections are all professional: through overlaps in graduate and professional education, prior or current common work experience in listed and unlisted firms, and shared board membership in non-profit organizations. Obviously, a director’s network would ideally also include links from her social life – connections through family, neighbors, and friends – but these data cannot be collected systematically without self-reporting and self-selection biases. In contrast, information on professionally formed connections is from proxy statements and annual reports, and thus is likely to be more objective, comparable across individuals, and free of self-selection bias. In total, our data include roughly 12 million pairs of connections formed through positions at listed firms, and another 9 million pairs formed through education and positions at unlisted
firms and non-profit organizations. This includes all reported individuals in BoardEx with at least one connection to the rest of the network. Table 1 reports the number of nodes in each year’s network.

For each year, using an IBM iDataPlex supercomputer, we calculate four measures of network centrality to capture the importance of each individual connected in the network. As detailed below, some measures of centrality are based on the shortest social distances between pairs of individuals. Not including individuals from unlisted firms and firms outside the list of S&P 1500 could miss prominent individuals, such as bankers and hedge fund managers, who serve as bridges to shorten one’s social distance to many parts of the network. The four measures are degree centrality, betweenness centrality, closeness centrality, and eigenvector centrality (Proctor and Loomis (1951), Sabidussi (1966), Freeman (1977), and Bonacich (1972)).

For each individual, degree centrality is simply the number of unique and direct connections; that is

$$D_i = \sum_{j \neq i} x_{ij}$$

where $x_{ij} = 1$ if individuals $i$ and $j$ has a connection, and zero otherwise.

The first step for calculating both closeness and betweenness centralities is to identify the shortest social distance (or geodesic distance, $g$) between any pair of individuals in the network. If $i$ does not know $j$ directly, but knows $k$ who knows $j$, then the shortest social path from $i$ to $j$ is

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12 We lack information on the quality of these 21 million pairs of connections. For example, we do not know whether the individuals at each end of the link are friendly or hostile, close friends or just acquaintances, talk daily or every ten years or never. We assume that, once one person knows another, the connection lasts until one dies.
i – k – j, and thus i and j have a shortest distance of 2.

Closeness centrality is the inverse of the sum of the shortest distances between one individual and every other individual in the network:

$$\text{Closeness}_i = \frac{n-1}{\sum_{j \in N} d_{ij}}$$

This definition assumes that the entire network is connected: that is, there exists at least one path between any two nodes. However, our data on business professionals contain a number of small sub-networks not connected to the rest of the nodes. Setting the shortest distance between two unconnected nodes to $d_{ij} = \infty$ in such a case is untenable because one infinite value in the denominator reduces all closeness measures to zero. Excluding infinite $d_{ij}$ from the calculation is also problematic. Individual A in a small network might have a much higher Closeness than individual B in a large network, but A might have much less power than B, whose influence extends across many more people. As an extreme case, consider a sub-network with two connected individuals. Dropping all unconnected nodes leaves each has the highest possible Closeness value, one; yet they have negligible social influence because they are unconnected to the remaining 300,000+ business professionals.

To account for these data issues, we modify closeness centrality to

$$C_i = \frac{n-1}{\sum_{j \in N} d_{ij}} \times \frac{n}{N}$$

where $n$ is the size of the sub-network (or component) individual i belongs to, and $N$ is the total number of individuals in the entire network. Such definition scales the original
closeness measures with the size of the component one belongs to in order to more accurately reflect one’s overall social power. It follows that individuals in a larger network usually has a higher closeness value than those in smaller networks.

Betweenness is the incidence of an individual lying on the shortest path between pairs of other members of the network. For every possible triplet of individuals i, j and k, we define the indicator variable

$$m_{ij}(k) = \begin{cases} 1 & \text{if } k \text{ is a node on a geodesic linking } i \text{ and } j \\ 0 & \text{otherwise} \end{cases}$$

The betweenness centrality of k is then

$$B_i = \sum_{i<j \neq k \in N} \frac{m_{ij}(k)/m_{ij}}{(n-1)(n-2)/2}$$

where $$m_{ij}$$ is the number of geodesics linking i and j. This adjustment is necessary because, while the length of the shortest path between two individuals is unique, they may be linked by more than one shortest path.

Eigenvector centrality is recursively calculated. Individual i’s eigenvector centrality is his importance, weighed by the similarly calculated importance of all his direct contacts, each weighted by the importance of their direct connections, and so on. More formally, assume the existence of this measure for person i, and denote it Ei. In matrix notation, with E = [E1, … Ei, … EN], the recursions collapse into the condition that $$\lambda E = E \ 'AE$$. Thus, E is an eigenvector of the matrix of connections A, and $$\lambda$$ is its associated eigenvalue. To ensure that $$E_i \geq 0$$ for all individuals, the modified Perron-Frobenius theorem is invoked and the eigenvector centrality
values of the individuals in the network are taken as the elements of the eigenvector \( E^* \) associated with \( A \)’s principal eigenvalue, \( \lambda^* \).

To make the centrality measures comparable with each other and over time, we rank the raw values of each centrality of all individual for each year and assign a percentile value, with 1 the lowest and 100 the highest, to each individual’s centrality measures for that year. In other words, regardless of the size of the network, a person with a higher valued centrality percentile is more centrally positioned in the network than a person with lower value. We denote these rank-transformations of \( D_i, B_i, C_i, \) and \( E_i \) as \( d_i, b_i, c_i, \) and \( e_i \) respectively.

Table 2 presents summary statistics for the power centrality measures. Panel A presents the raw figures. The mean CEO betweenness of 0.00455% indicates that the mean CEO in our sample lies on just under 0.005% of the shortest paths between all pairs of individuals in the network. Note that the mean exceeds the 75th percentile and the maximum is 0.362%. Loosely speaking, the great majority of the connectedness power in the network is in the hands of the most connected individuals. The typical director’s mean closeness is 25.3%, indicating that the typical director is about four \( (1 / 0.253 = 3.94) \) degrees of separation from any other randomly chosen individual. The median degree centrality of 78 for CEOs indicates that the median CEO has direct ties with 78 other individuals in the network. The raw eigenvector centrality measures are not readily amenable to intuitive explanation.

The four centrality measures are highly correlated, with correlation coefficients averaging 79%, and statistical significance under 0.001. For example, Jeffrey Garten, served at BlackStone and Lehman Brothers, as Dean of Yale’s School of Management, and in the Nixon, Ford, Carter, and Clinton administrations, exhibits high centrality by all four measures: his mean \( d_i \) over the
sample period is at the 94th percentile, his bi is at the 98th, his ci, at the 93rd, and his is also ei at the 93rd percentile. The correlations are imperfect, largely because some individuals are connected directly to only a handful of others (low degree centrality), but these connect to highly powerful people (high betweenness or eigenvector centrality). Thus, Ray Wilkins Jr., a director of H&R Block in 2000, ranks only in the 66th percentile in degree centrality, but the importance of some of those connections push his betweenness, centrality up to the 93th percentile.

Hereafter, we focus in on officers and directors of S&P 1500 firms, as provided by Risk Metrics. That is, we merge the percentile centrality measure data described in Panel B of Table 2 with BoardEx date on the names of the CEOs and directors of listed firms, matching by individual’s first, middle, last names; company names, and years. This generates a final panel containing 132,020 individual-years from 1999-2010. The mean percentile centrality within this group is 78, the maximum is 100, the minimum is 1, and the standard deviation is 22.6.

2. Variables of Interest

We define Powerful Independent Directors (PIDs) as legally independent directors with at least three centrality measures falling above the 80th percentiles of their full distributions across all CEOs and directors (not just those in S&P1500 firms). Directors are defined as

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13 The tables below define a powerful independent director (PID) as one with at least three of the four centrality measures lying in the top quintiles of distributions based on the centrality measures of all officers and directors of listed firms covered by BoardEx. Qualitatively similar results ensue, by which we mean identical patterns of signs, significance, and rough coefficient magnitudes to those in the tables, if use top quintiles of distributions based on all officers and directors of listed and unlisted firms. Using the top 15% or 25%, rather than top quintiles, of the distributions also generates qualitatively similar results. Also, in constructing the power centrality measures, we assume that, once one person knows another, the connection persists until one of them dies. As robustness checks, we construct alternative versions of the network, and recalculate the power centrality measures assuming
independent if so-designated by the firm. To identify independent directors who are also powerful, we define four dummy variables, one for each percentile centrality measure, set to one if that measure falls in the top quintile of its distribution across all the executives and directors included in Tables 1 and 2, and to zero otherwise. Thus, we denote whether or not individual $i$ is powerful in terms of her degree centrality using

$$\delta(d_i \geq 80) = \begin{cases} 1 & \text{if } d_i \geq 80 \\ 0 & \text{otherwise} \end{cases}$$

and define $\delta(b_i \geq 80)$, $\delta(c_i \geq 80)$, and $\delta(e_i \geq 80)$ analogously. We then say independent director $i$ is powerful, setting her value of PID to one, if three or more of her power centrality measures fall into the top quintiles of their distributions. That is,

$$\text{PID}_i = \begin{cases} 1 & \text{if } \delta(d_i \geq 80) + \delta(b_i \geq 80) + \delta(c_i \geq 80) + \delta(e_i \geq 80) \geq 3 \\ 0 & \text{otherwise} \end{cases}$$

We aggregate individual data to the firm-level, and set the indicator variable powerful independent board (PIB) to one if a majority of firm $h$’s independent directors are PIDs, and to zero otherwise.

$$\text{PIB}_h = \begin{cases} 1 & \text{if a majority of firm } j's \text{ independent directors are PIDs} \\ 0 & \text{otherwise} \end{cases}$$

For comparison, we define firm $h$ as having an independent board by setting IB$h$ to one if a majority of its directors are designated independent in its financial statements and to zero.

connections form only after three years of overlap, and assuming connections break after five years of non-overlap, and both. Qualitatively similar results to those in the tables ensue in each case.
Also for comparison, we say a firm has a non-CEO chair of the board and NCCh to be one if firm h’s CEO is does not also chair its board of directors, but set NCCh to zero otherwise. We then designate firm h as having a powerful non-CEO chair if NCCh = 1 and the person serving as chair is powerful, in that at least three of her four centrality measures fall into the top quintiles of their distributions. That is, we say firm h has a powerful non-CEO chair as

\[
PNC_h = \begin{cases} 
1 & \text{if h’s board is chaired by individual i who is not its CEO & has} \\
0 & \text{otherwise}
\end{cases} 
\]

\[
\delta(d_i \geq 80) + \delta(b_i \geq 80) + \delta(c_i \geq 80) + \delta(e_i \geq 80) \geq 3
\]

Finally, we analogously identify a firm as having a powerful CEO (PCEO) if at least three of its CEO’s four centrality measures in the top quintiles of their distributions. Thus, we say firm h has a powerful CEO as

\[
PCEO_h = \begin{cases} 
1 & \text{if h’s CEO is individual i and has} \\
0 & \text{otherwise}
\end{cases} 
\]

\[
\delta(d_i \geq 80) + \delta(b_i \geq 80) + \delta(c_i \geq 80) + \delta(e_i \geq 80) \geq 3
\]

The average CEO centrality is the 74th percentile, and the median is the 80th percentile, indicating that half of S&P 1500 CEOs are powerful CEOs.

We require all firms to have a minimum of three years in the sample. Our final sample includes 15,889 firm-years for 1956 unique firms. Table 3 lists the names and definitions of the variables that used in the tables to follow.

Table 4 tallies the percentages of boards with a majority of independent directors and powerful independent directors, the percentages of firms that separate the CEO and chair jobs
and that appoint a powerful director as the non-CEO chair. Over our sample period of 1999 to 2009, boards with independent directors increase monotonically, as do boards with a majority of PIDs. Likewise, an increasing fraction of firms separate the CEO and board chair jobs and name a powerful director as the non-CEO chair. The importance of powerful independent directors on key board committees also rises steadily through time.

3. Firm Governance and Financial Variables

We obtain financial accounting data from Compustat and stock return data from CRSP for our sample of S&P 1500 firms from 1999 to 2009. CEO compensation data are taken from ExecuComp and additional information on each director of the S&P 1500 boards are obtained from Risk Metrics. This includes a director’s age, and her assignments to the audit, nominating, and compensation committees.

We measure shareholder valuation by a firm’s Tobin’s Q, the sum of book value of total assets and market equity of common shares, minus book value of equity and deferred taxes, all divided by total book assets.14

We also include control variables known to affect Tobin’s Q. The control variables include various firm characteristics: size, the logarithm of total assets; leverage, defined as total debt over total assets; profitability, net operating cash flow plus depreciation and amortization; growth, net capital expenditure scaled by previous year’s net property, plant and equipment

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14 Using Compustat variable names, $Q = \frac{at + (precc_f \times csho) - ceq - txdb}{at}$. As a robustness check, we also calculate the numerator as the sum of market value of common shares, book value of short-term and long-term debts, liquidating value of preferred shares, and deferred taxes and investment tax credit, while using the same denominator of total book assets. Qualitatively similar results ensue.
(Yermack (1996)); and intangibles, advertising and R&D expenditure, each scaled by total assets and set to zero if not reported (Morck et al. (1988)). We also control for key corporate governance variables shown elsewhere to affect Q ratios. These include CEO age (Morck et al. (1988)) and board size (Yermack (1996)), in logarithm form, and the e-index of Bebchuk, Cohen and Farrell (2009) — a composite index reflecting the absence or presence of economically important management entrenchment devices: supermajority requirements on amending corporate charters, similar requirements for mergers, limits on amending bylaws, staggered boards, poison pills, and golden parachutes.

Table 5 Panel A presents summary statistics. In our sample, the average Tobin’s Q is 1.58, with a standard deviation of 1.55. The average board has nine members. Over the entire sample period, independent directors constitute 80% of the typical board, and 57% are PIDs. The mean independent director centrality is at the 81th percentile. The summary statistics of the other variables accord with those in other studies using these data.

D. Empirical Results and Discussion

We hypothesize that the presence of powerful CEOs, powerful non-CEO chairs, and a predominance of powerful independent directors might affect shareholder value. In particular, we posit that powerful non-CEO chairs and powerful independent directors do so more reliably than generic non-CEO chairs and independent directors.

1. Power and Shareholder Value

As a first pass test of this, firm valuation is measured by Tobin’s Q, the market value of a firm over the replacement costs of its assets, or empirically defined using Compustat data as the
book value of total assets minus the book value of equity plus the market value of equity minus deferred tax obligations, divided by total book assets. Table 5 Panel B contrasts the Q ratios of firms with versus without PCEOs, PIBs and PNCs, inferring significance from t-tests adjusted for firm-level clustering.

Table 5 Panel B shows firms with PIBs and PNCs exhibiting significantly higher Tobin’s Q’s. In contrast, the table shows that merely having someone other than the CEO chair the board and merely having a majority of legally independent appear unrelated to Q. Indeed, firms with a majority of independent directors who are not PIDs actually exhibit depressed Qs, as do firms that separate the roles of chair and CEO, but have a non-powerful individual as chair.

Average Q is known to be affected by other factors. Table 6 therefore re-estimates these comparisons using OLS regressions of Q ratios on industry and year dummies and a standard set of control variables, again adjusting significance for firm-level clustering. The control variables attract their typical coefficients and significance levels. Larger firms, larger boards, more levered firms, and firms with more entrenched managers (indicated by a higher e-index) all have significantly lower shareholder valuations. Firms with more capital investment, higher R&D spending, and higher profitability are tend to have higher Tobin’s Q ratios.

Regression 6.1 shows that shareholders no longer attach a valuation premium to firms with a powerful CEO after the various controls are included. Regressions 6.2 and 6.3 reveal that shareholders do not value a generic non-CEO chair, but add a statistically and economically significant 5.1% (0.08 over 1.58) to a firm’s value for a powerful non-CEO chair. Likewise, 6.5 and 6.6 show shareholders attaching no value to a predominance of independent directors, but adding about 1.9% (0.03 over 1.58) to the market value of a firm if the average rank of
independent directors’ centrality increases by 10%. In panel B, we run the same regressions of firm value on a powerful independent board and the controls, but a powerful board is defined by each centrality respectively. A high firm value is attached for powerfully independent boards when the directors have higher rank of direct connections, linkage, and friends’ power.

Table 7 investigates whether the effects in Table 6 are independent or not. All the controls and fixed effects using in table 6 are also included in the regressions in Table 7. However, to conserve space only the relevant variables are shown. Similar to Table 6, Regressions 7.1 through 7.7 show that the presence or absence of a powerful CEO does not significantly correlate with shareholder valuations. Neither do indicators for a non-CEO Chair and a predominantly legally independent board. In contrast, a powerful non-CEO chair insignificantly corresponds to shareholder valuations and a powerful independent board attracts a coefficient signaling a 5.4% boost in shareholder valuation.

2. The Direction of Causality

We wish to preclude reverse causality: CEOs of high Q firms tending to fill their boards with more powerful independent directors or more appointing powerful chairs. Our first approach to investigating this possibility is an event study: how does the stock market react to the sudden deaths of corporate directors?

We collect a sample of news stories about sudden accidental director deaths. We confirm each death event date and obtain details of the cause of death through LexisNexis and Google searches. We exclude death events coincident with confounding events, such as earnings or M&A announcements, the 9-11 attacks, etc.; as well as death events following a long-term
illness. Each deceased director is classified as independent or not, and if independent, powerful or not. These events provide cleanly exogenous changes to the power of independent directors in the affected firms’ boards, and measure the impact on shareholder valuation by the stock price reactions.

Figure 1 represents the results of this exercise graphically. The figure shows that firms’ stock prices rise when an insider-director or a non-PID suddenly passed away. The deaths of PIDs, in contrast, result in negative cumulative abnormal returns.

Table 8 Panel A compares mean cumulative abnormal returns (CARs), in percentage points, around director sudden deaths. The CARs are measured from one day prior to the event date, time -1, to the day after, and denoted CAR[-1,1]; and through 2 or 3 days later, denoted CAR[-1,2] or CAR[-1,3]. The first two columns contrast independent directors to non-independent directors, and the next two columns, powerful independent directors to non-powerful independent directors. On average, CARs are negatively associated with the sudden deaths of independent directors (Nguyen and Nielsen (2010)) and powerful independent directors, but turn positive for non-independent or non-PIDs. Weighting the CARs equally or by the total assets of firms does not alter the results.

Panel B regresses cumulative abnormal returns on the IB or PIB dummy of the deceased director. The negative coefficients indicate that shareholders value the presence of powerful independent directors: their deaths, over a three day window, trigger a 1.6% drop in shareholder value. Given an average market capitalization of $11.64 billion, the death of a powerful independent director costs shareholders an average of $186 million over a 3 day window. Panel C shows that shareholders appreciate the high rank of an independent director on the social
network. Panel D and E shows that market reacts to the importance of each centrality on sudden death of a independent director.

Event studies of this sort are reliable measures of the direction of causality, but unreliable as to the magnitudes of the effects. This is because subsequent events, often with uncertain event dates, also contribute to the overall cumulative value change. For example, the death of a non-powerful independent director enhances board power if the replacement is a very powerful independent director, but might weaken the board if the replacement is an insider or an even less powerful nominally independent director. Because these events are widely distributed across uneven time intervals, and may not be associated with any specific event dates, event study methodology leaves unanswered questions.

We therefore next turn to Granger causality tests. In these tests, X is said to Granger-cause Y if lagged values of X significantly explain Y after controlling for lagged values of Y. Here, the X are indicator variables for powerful independent boards and powerful non-CEO chairs and the Y are Tobin’s Q ratios. The exercise thus runs firm-year panel regressions of Q ratios on its own lags and on lagged values of the board power indicators, adjusted for firm-level clustering and including industry and year dummies. The left panel of Table 9 shows the lagged powerful board variables are jointly highly statistically significant in regressions explaining Q, with one, two, or three lags included for both these variables and Q. F-statistics for non-CEO chair are similarly significant, except when three lags are included.

The right panel of Table 9 reverses the analysis, now using the board variables on the left-hand side. The results indicate lags of Tobin’s Q, beyond the one lag, jointly insignificant in explaining PIB or PNC.
Substituting the mean power centrality of independent directors and of the non-CEO chair for the powerful independent board and powerful non-CEO chair dummies yields mostly qualitatively similar Granger causality results with one exception: a 6% significance is found in two Q lags in explaining the continuous version of the non-CEO Chair power measure.

Overall, the results suggest that powerful board granger cause Tobin’s Q. While the significance of single lags of Q indicate that bidirectional causality cannot be precluded, the Granger causality results are consistent with powerful independent voices on the board causing high Q ratios.

Lastly, Table 10 shows changes in Tobin’s Q after a new PID joins the board or a previously serving PID leaves the board. Indicator variables are set to one to flag firm-year observations with such events and to zero otherwise. A positive and significant coefficient shows that adding a new PID to the board correlates with a 6.8 percentage point rise in Q by the next year. This positive effect swamps the significant negative effect associated with a larger board in cases where the board size rises. In contrast, the departure of a PID presages an 8.4% lower Q ratio by the following year. Adding an independent director who is not also a powerful, director does not result in a significant change in market valuation in any of the regressions.

While this exercise is conceptually an event study, the annual frequency of observations of Q makes causal inference problematic. However, this exercise arguably provides a high estimate of the value increase associated with powerful independent voices on the board to counterbalance the CARs in Table 8, which can underestimate magnitudes if their windows are too short and become unreliable over longer windows because other characteristics of the firm and its environment change. Estimated Q reflects changed firm characteristics captured in the
balance sheet, and so arguably provides a meaningful low-frequency valuation metric.

In summary, the empirical evidence appears more consistent with powered independent directors elevating shareholder value than with higher shareholder value attracting powerful independent directors.

3. How Powerful Independent Directors Matter

The previous section provides both event study and panel evidence of a causal relationship between more powerful independence directors on the board and higher shareholder valuation. This section considers channels through which this effect might operate.

Boards are often said to have two duties: advising and monitoring the CEO. Boards need not be equally effective in both roles: for example Schwartz-Ziv and Weisbach (2012) find Israeli boards mainly engaging in monitoring, while Faleye et al., (2012) report US boards delegating monitoring to committees. We therefore consider these factors in investigating situations where one or both of these duties are plausibly very important. Our objective is to see if powerful non-CEO chairs and powerful independent directors are associated with evidence of enhanced board effectiveness in situations where their role can potentially be economically significant.

a. M&A

Mergers and acquisitions often rank among the most economically important decisions CEOs make. Many acquisitions result in substantial bidder shareholder value losses, and boards’ failure to provide sound advice or to rein in CEOs who ignore it are often blamed (Morck et al.
(1990b), Moeller et al (2004, 2005)). If powerful non-CEO chairs and powerful independent directors render boards more effective, their presence ought to decrease the incidence of shareholder value-destroying M&A.

A sample of acquisitions by S&P 1500 firms from 2000 to 2009 for which Securities Data Company (SDC) data are available let us identify takeovers of listed firms by listed firms and estimate their value to the acquiring firm (the bidder’s CAR) and to shareholders (the size-weighted average of the two firms’ announcement CARs). This exercise excludes acquirers with pre-acquisition majority ownership and a post-acquisition ownership below 100% to eliminate effects associated with stalled takeovers. This leaves 632 takeovers by 379 distinct acquirers.

Table 11 presents OLS regressions of bidder and combined cumulative abnormal returns around the merger announcement – specifically, from three days prior to three days after the announcement date, and denoted CAR[-3, 3] – on PCEO, PIB, and PNC indicators. Consistent with El-Khatib, Fogel, and Jandik (2013), firms with more powerful CEOs make deals make worse acquisitions: both the acquirer firm CAR and the combined acquirer-plus-target are lower. However, acquirers with powerful independent boards make significantly better M&A decisions, especially in cases where a powerful CEO is present. A powerful independent board correlates with a bidder CAR higher by 2.2% and a combined CAR higher by 2.0. Given number and sizes of the deals in our sample, this constitutes an economically significant addition of $640 million to acquirer shareholder wealth and of $1174 million to overall shareholder wealth. In panel B, we divided the sample into related and unrelated subsamples whether a deal is horizontally or vertically related or not. Compared with related deals, a powerful independent board more correlates with a bidder CAR or combined CAR.
The coefficients on the control variables in Table 11 are consistent with prior studies. Profitable acquirers with high leverage gain more in M&A. The bidder, target and the combined entity are more apt to lose value if the deal is stock financed or larger.

b. Free Cash Flow

Jensen (1986) argues that self-interested managers are apt to retain earnings excessively from shareholders perspective, and thus to pay lower dividends than shareholders would prefer. This free cash flow agency problem, Jensen argues, is worse in firms where boards are less effective in advising and monitoring the CEO.

We define a proxy for the likelihood of free cash flow problems as an indicator variable set to one if the firm has all of a below median Tobin’s Q, an above median cash flow to property, plant and equipment ratio, and a below median dividend payout ratio; and to zero otherwise. On average, our data indicate that 6.72% of firms suffer a free cash flow problem.

Table 12 presents probit regressions of the likely free cash flow problem dummy variable on the PIB dummy, the PID ratio, and the average power of independent directors variable, all as described above. The regressions show that a PIB corresponds to an 9.2% lower likelihood of free cash flow problems. Consistent with Jensen’s (1986) hypothesis, and with previous studies, leverage is negatively correlated with the likelihood of free cash flow problems proxy. Firms with more entrenched boards are more apt to have likely free cash flow problems. In panel B of table 12, we redefine the likely free cash flow problem as a dummy which takes the value of one if a firm’s cash flow is the top quartile by two digit SIC industry and year, and zero otherwise. Sample. The results are consistent to the results in Panel A.
c. CEO Turnover

Boards fulfill their monitoring duties by, among other things, firing CEOs who oversee persistently poor firm performance. Weisbach (1988) shows poor past financial performance to increase the likelihood of a forced CEO exit in firms with more independent boards. To see if Weisbach’s effect is stronger where independent directors are more powerful, we examine a sample of forced CEO exit events collected by Jenter and Kanaan (2011) and Peters and Wagner (2010). This sample provides a defensibly clean identification of involuntary exits, but is limited primarily to events occurring before 2006.

Table 13 presents the results of this exercise. The left-hand side variables in its probit regressions are a dummy set to one for a forced CEO exit, and to zero otherwise; and a dummy set to one if an outside CEO is replaced the ejected CEO, and to zero otherwise. The right-hand side variables of interest are a PIB or PIBN indicator variable, reflecting the structure of the full board or the nominating committee, and a PNC indicator variable, representing the presence of a powerful independent chair. Following Weisbach (1988), interactions of these dummies with the firm’s past stock returns are employed to see if more powerful independent directors make CEO hiring and firing decisions with more regard to past stock returns.

Large and negative coefficients on the interaction of powerful non-CEO chair (PNC) with the prior year’s stock return indicate that large negative stock returns in the previous year are more likely to lead to old CEO being fired and replaced by an outsider where boards are chaired by a more powerful independent director, the independent directors are powerful, and the

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15 We are extremely grateful to Professors Jenter, Peters, and Wagner for kindly sharing the data with us.
nominating committee contains powerful independent directors.

d. CEO Compensation

We collect data from ExecuComp on the cash, equity, and total compensation of CEOs, and take log transformations of these as dependent variables. The key variable of interest on the right hand side of our regressions is the sensitivity of the CEO’s compensation components to past stock return performance in PIB boards versus other boards. Table 14 presents the regression coefficients and significance levels.

Panel A examines the link between powerful independent boards (PIBs) and total compensation. Panel B examines how the composition of the compensation committee affects CEO incentive-based pay. We define a Compensation Powerful Independent Board (PIBC) to be one with a majority of PIDs on its compensation committee. More powerful CEOs receive higher compensation across the board; as do CEOs running larger firms and CEOs serving in the wake of higher past returns. Older CEOs receive more cash and less equity-based compensation.

PID dominated boards and compensation committee generally award CEOs higher total compensation package. However, table 14 reveals a highly significant positive interaction between powerful directors on the Compensation Committee and past stock returns in explaining the equity component of CEO compensation. Powerful independent compensation committees (PIBCs) are associated with 50% more overall pay-performance sensitivity, particularly if the CEO is also powerful.

e. Earnings Management
Jensen and Meckling (1976) posit that boards use firms’ internal control mechanisms, such as their financial reporting systems, to monitor CEOs. However, much recent work shows that CEOs can and do manipulate earnings, a key performance indicator. A large body of empirical work links more extensive earnings management to less effective internal control procedures (Doyle et al. (2007)), less disciplinary executive turnover (DeAngelo (1988), Dechow and Sloan (1991), and less independent boards and audit committees (Klein (2002)).

This section examines whether or not more powerful independent directors on the board, and on the audit committee, correlates with earnings management. We also examine whether a powerful non-CEO chair might correlate with less earnings management. Abnormal earnings accruals are estimated as in Jones (1991), but adjusting for growth in credit sales (Dechow et al. (1995)), and benchmarking against a control firm – that with the closest ROA in the same industry that year (Kothari et al. (2005)).

Table 15 reveals abnormal accruals 0.043% lower if the firm has a powerful independent board, roughly the same amount lower if a powerful independent director chairs the board. These decreases are each more than 50% of the overall 84% mean value of abnormal accruals, and so are highly economically significant. The proportion of powerful independent directors on the audit committee is also negatively and marginally significant in explaining earnings management.16

4. Robustness Checks

16 As a robustness check, abnormal accruals are also estimated using an alternative variant of the method in Jones (1991) that benchmarks accruals against a control firm – that with the closest ROA in the same industry that year (Kothari et al. (2005)). Qualitatively similar results ensue.
The results presented above survive a battery of robustness checks. Throughout the analysis, we test for outliers and windsorize the continuous variables to mitigate outlier influence in the results.

The precise way the PIB dummy is constructed does not drive these results. First, the exact fraction of independent directors we require to be PIDs in order for PIB to be set to one does not greatly affect our results: other reasonable values, such as 3/5, 2/3, 3/4, or 4/5, yields qualitatively similar results, by which we mean identical patterns of signs and significance to those in the tables, along with plausible coefficient point estimates given the specific robustness exercise.

Continuous power centrality measures tell much the same story as the indicator variables do, through the substitutes a PID ratio, the number of PIDs divided by the number of independent directors, for the PIB indicator variable. This is a continuous variable ranging from 0 to 1, with 1 indicating all independent directors are also PIDs, and 0 indicating none is. This exercise also yields results qualitatively similar to those in the tables.

Further robustness checks utilize yet other continuous analogs of PID, PNC, and PCEO, defined as the arithmetic mean of the individual’s three highest centrality measures, expressed in percentiles. For example, for individual i, a CEO, the continuous CEO centrality measure is

\[
\text{CEOC}_i = \frac{1}{3}(d_i + b_i + c_i + e_i - \min[d_i, b_i, c_i, e_i])
\]

The continuous variables mean independent director centrality (IDCi) and non-CEO chair centrality (NCCi) are defined analogously. These variables are all also percentile measures,
ranging from 1 to 100, with 100 indicating the highest and 0 indicating the lowest power centrality of all business executives in the network. Once again, using these measures generates qualitatively similar results to those shown.

E. Conclusions

Boards dominated by powerful independent directors increase shareholder’s valuations of those companies. Sudden director death event study regressions show causation to flow from powerful independent directors to shareholder valuations. These results validate measuring not just directors’ status as independent, but also their power – their ability to access information, draw on external resources, and mobilize support to question and, if necessary, defy CEOs bent on strategies that risk destroying shareholder wealth and exposing directors to lawsuits.

These findings may explain why a robust link between independent directors on boards and firm value has proved so elusive. Nominally independent directors who lack a power-base with which to exercise their independence might as well be officers of the company as far as shareholder wealth effects are concerned. That a few very recent studies find some evidence of independent directors mattering may reflect the fact that more independent directors have such power bases in more recent years. Nonetheless, such findings may well be due to variables based on nominally independent directors becoming noisy proxies for measures reflecting effectively independent directors in recent years, not to legal director independence mattering per se..

These findings also suggest a range of public policy and corporate governance strategy considerations. First, public policy should recognize two sorts of agency issues in corporate governance: compromised director loyalty to shareholders and uncompromised director loyalty
to powerful CEOs. Directors’ loyalty to shareholders may well be adequately ensured by a fiduciary duty to shareholders limited by a business judgment rule. However, additional measures designed to disrupt directors’ loyalty to a powerful CEO might be considered if the goal of corporate governance reform is greater value creation by corporations. Specifically, attention might be given to recruiting independent directors with independent power bases that let them challenge a CEO if necessary.

CEOs who lead their firms into corporate governance disasters also destroy their own wealth and careers, and so might welcome powerful dissenting voices that protect them from mistakes. Bernardo, Antonio and Welch (2001), Adams, Almeida, and Ferreira (2005) and others identify overconfident and powerful CEOs who turn out to be right as valuable trailblazers; and boards that become debating societies could plausibly be as problematic as a board of loyal “yes men”. Nonetheless, the tables above suggest that, at present in the United States, more capacity for debate in boards elevates shareholder valuations and limits strategic mistakes such as value destroying takeover bids, cash flow retention in excess of liquidity and capital spending needs, or a failure to keep up with technological change.

This may not be true in every circumstance. Different issues may matter more in different firms, industries, time periods, or countries. For example, where controlling shareholders – tycoons or business families, rather than professional hired CEOs – dominate corporate governance, large-shareholder entrenchment (Stulz (1988)) and self-dealing (Johnson et al. (1999)) may attain greater economic importance and directors with power bases independent of the controlling shareholder might merit attention. Where state-owned enterprises or listed firms controlled by sovereign investment funds attain more importance than they have in the United
States, attention might be given to mechanisms that allow powerful independent voices within those entities – perhaps to remind political appointees of a duty to taxpayers. We welcome additional research into these and other related questions.
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Standing Audit Committees composed of Outside Directors; Release No. 123


Table 1: Corporate Executives and Directors Social Network Characteristics

Each Node is a director or business executive with at least one connection to other directors or executives. The Listed Network includes all business professionals who ever worked at or served on the board of a listed firm. The Largest Component of the Listed Network includes those connected to the largest sub-network based on ties established in listed firms. The Full Network includes all directors or executives with at least one connection to another business professional who ever worked at any firm, public or private, covered by BoardEx from 1998 through 2010.

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Nodes in Listed Firm Network</th>
<th>No. of Nodes in the Largest Component of the Listed Firm Network</th>
<th>No. of Nodes in the Full Network (Listed &amp; Unlisted Firms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>191,049</td>
<td>167,211</td>
<td>267,979</td>
</tr>
<tr>
<td>1999</td>
<td>200,156</td>
<td>178,209</td>
<td>275,377</td>
</tr>
<tr>
<td>2000</td>
<td>210,220</td>
<td>190,310</td>
<td>283,643</td>
</tr>
<tr>
<td>2001</td>
<td>219,321</td>
<td>201,059</td>
<td>291,002</td>
</tr>
<tr>
<td>2002</td>
<td>228,375</td>
<td>211,299</td>
<td>298,138</td>
</tr>
<tr>
<td>2003</td>
<td>237,980</td>
<td>222,129</td>
<td>305,074</td>
</tr>
<tr>
<td>2004</td>
<td>249,126</td>
<td>234,714</td>
<td>313,040</td>
</tr>
<tr>
<td>2005</td>
<td>261,823</td>
<td>249,123</td>
<td>322,010</td>
</tr>
<tr>
<td>2006</td>
<td>276,237</td>
<td>264,915</td>
<td>332,341</td>
</tr>
<tr>
<td>2007</td>
<td>292,131</td>
<td>281,985</td>
<td>343,779</td>
</tr>
<tr>
<td>2008</td>
<td>305,399</td>
<td>295,763</td>
<td>336,175</td>
</tr>
<tr>
<td>2009</td>
<td>313,958</td>
<td>304,460</td>
<td>384,489</td>
</tr>
<tr>
<td>Mean</td>
<td>248,815</td>
<td>233,431</td>
<td>312,754</td>
</tr>
</tbody>
</table>
Table 2: Officer and Director Power Centrality Measure Characteristics

The social networks described in Table 1 contain nodes representing 15,889 CEO-years with 3,302 unique CEOs, 5,983 non-CEO chairs-year, and 132,000 Director-years with 19,223 unique directors. Other nodes represent corporate executives, bankers, and other business executives included in Boardex, but not serving as a CEO, chair or director of the S&P 1500 sample from 1999 to 2010.
<table>
<thead>
<tr>
<th>Panel A: Characteristics of Raw Power Centrality Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CEOs</strong></td>
</tr>
<tr>
<td><strong>Betweenness</strong> $B_i$</td>
</tr>
<tr>
<td><strong>Closeness</strong> $C_i$</td>
</tr>
<tr>
<td><strong>Degree</strong> $D_i$</td>
</tr>
<tr>
<td><strong>Eigenvector</strong> $E_i$</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
</tr>
<tr>
<td><strong>Std. Dev.</strong></td>
</tr>
<tr>
<td><strong>Min</strong></td>
</tr>
<tr>
<td><strong>25th</strong></td>
</tr>
<tr>
<td><strong>Median</strong></td>
</tr>
<tr>
<td><strong>75th</strong></td>
</tr>
<tr>
<td><strong>Max</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: Characteristics of Power Centrality Measure Percentage Ranks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CEOs</strong></td>
</tr>
<tr>
<td><strong>Betweenness</strong> $b_i$</td>
</tr>
<tr>
<td><strong>Closeness</strong> $c_i$</td>
</tr>
<tr>
<td><strong>Degree</strong> $d_i$</td>
</tr>
<tr>
<td><strong>Eigenvector</strong> $e_i$</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
</tr>
<tr>
<td><strong>Min</strong></td>
</tr>
<tr>
<td><strong>25th</strong></td>
</tr>
<tr>
<td><strong>Median</strong></td>
</tr>
<tr>
<td><strong>75th</strong></td>
</tr>
<tr>
<td><strong>Max</strong></td>
</tr>
</tbody>
</table>
Table 3: Variables and Definitions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measures of CEO Power</strong></td>
<td></td>
</tr>
<tr>
<td>Powerful CEO (PCEO)</td>
<td>Dummy set to one if CEO is <em>powerful</em> – defined as at least three of CEO’s four centrality measures (degree, closeness, betweenness and eigenvector) in their distributions’ top quintiles</td>
</tr>
<tr>
<td>CEO Centrality (CEOC)</td>
<td>Mean of the top 3 centrality measures for the CEO</td>
</tr>
<tr>
<td><strong>Measures of Chair’s Power</strong></td>
<td></td>
</tr>
<tr>
<td>Non-CEO Chair (NCC)</td>
<td>Dummy set to 1 if someone other than the CEO chair’s the board and 0 if the CEO also serves as chair</td>
</tr>
<tr>
<td>Powerful Non-CEO Chair (PNC)</td>
<td>Dummy set to 1 for a non-CEO Chairman whose top three centrality measures average over 80th percentile of all business professionals and 0 otherwise</td>
</tr>
<tr>
<td>Non-CEO Chair Centrality (NCCC)</td>
<td>Mean of the top 3 centrality measures for non-CEO Chair</td>
</tr>
<tr>
<td><strong>Measures of Independent Directors’ Power</strong></td>
<td></td>
</tr>
<tr>
<td>Independent Board (IB)</td>
<td>Dummy set to 1 if more than 50% of directors are independent (as defined in financial statements) and 0 otherwise</td>
</tr>
<tr>
<td>Powerful Independent Director (PID)</td>
<td>A director-level dummy, used to construct firm-level variables, and defined as follows: An independent director is a <em>powerful independent director</em> (PID) if at least three of his four centrality measures are in their distributions’ top quintiles</td>
</tr>
<tr>
<td>Powerful Independent Board (PIB)</td>
<td>Dummy set to 1 if more than 50% of directors are both independent and powerful, and 0 otherwise</td>
</tr>
<tr>
<td>Independent Director Centrality (IDC)</td>
<td>Mean of the top 3 centrality measures for all independent directors on board</td>
</tr>
<tr>
<td>PID Ratio on Board (PIDR)</td>
<td>Fraction of powerful independent directors on board</td>
</tr>
<tr>
<td><strong>Regression Variables</strong></td>
<td></td>
</tr>
<tr>
<td>Tobin’s Q (Q)</td>
<td>The book value of total assets minus the book value of equity plus the market value of equity minus deferred tax obligations, divided by total book assets</td>
</tr>
<tr>
<td>CEO Age (CEO\textsubscript{A})</td>
<td>CEO age</td>
</tr>
<tr>
<td>Board Size (BSIZE)</td>
<td>Total number of directors on board</td>
</tr>
<tr>
<td>E-Index (END\textsubscript{X})</td>
<td>Entrenchment Index (Bebchuk, Cohen, and Ferrell, 2009)</td>
</tr>
<tr>
<td>Assets (ASSETS)</td>
<td>Log total assets, in billions of dollars</td>
</tr>
<tr>
<td>Leverage (LEV)</td>
<td>Total debt over total assets</td>
</tr>
<tr>
<td>Probability (PROF)</td>
<td>Net income over total assets</td>
</tr>
<tr>
<td>Tangibility (TANG)</td>
<td>Property, Plant, and Equipment over total assets</td>
</tr>
<tr>
<td>Capital Investment (CAPE\textsubscript{EX})</td>
<td>Net Capital expenditure over last year’s property, plant and equipment</td>
</tr>
<tr>
<td>Cash Flows (CF)</td>
<td>The sum of net income, depreciation, and amortization over last year’s property, plant and equipment</td>
</tr>
<tr>
<td>Research &amp; Development (R&amp;D)</td>
<td>Research &amp; Development expense over total assets</td>
</tr>
<tr>
<td>Advertising (ADV)</td>
<td>Advertising expense over total assets</td>
</tr>
</tbody>
</table>

**Event Study Variables**

| Stock Return (RET) | Annual stock return minus the NYSE/AMSE/NASDAQ market index value weighted return |
| Sudden Death (DEATH) | An indicator variable set to one on the date of a powerful independent director’s sudden death and zero otherwise |

**Measures of Changing Independent Director Power**

| PID Addition (PIDA) | Dummy set to 1 if at least one new PID joins the board and 0 otherwise |
| PID Deletion (PIDD) | Dummy set to 1 if at least one new PID leaves the board and 0 otherwise. |

**Measures of Independent Directors’ Power in Specific Decisions**

| PID Ratio on Nominating Committee (PID\textsubscript{N}) | Ratio of PIDs over total number of directors on nominating committee |
| PID Ratio on Auditing Committee (PID\textsubscript{A}) | Ratio of PIDs over total number of directors on auditing committee |
| PID Ratio on Compensation Committee (PID\textsubscript{C}) | Ratio of PIDs over total number of directors on compensation committee |
| **Centrality of Nominating Comm. Members (IDCN)** | Mean of the top 3 centrality measures for independent directors who serve on nominating committee |
| **Centrality of Auditing Comm. Members (IDCA)** | Mean of the top 3 centrality measures for independent directors who serve on auditing committee |
| **Centrality of Compensation Comm. Members (IDCC)** | Mean of the top 3 centrality measures for independent directors who serve on compensation committee |

**Other variables**

| **Bidder Return (BRET)** | Cumulative Abnormal Return between [-3, +3] to a bidder upon merger announcement |
| **Combined Return (CRET)** | Cumulative Abnormal Return between [-3, +3] to the combined entity, calculated as the asset weighted CARs of the bidder and the target, upon merger announcement |
| **Free Cash Flow** | Dummy set to 1 if a firm’s cash flow is higher than two digit SIC industry median, dividend payout is lower than two digit SIC industry median, and Tobin’s Q is lower than two digit SIC industry median. |
| **CEO Pay - Total** | Log of total compensation (tdc1), defined as the sum of salary, bonus, stock grants, and option grants. |
| **CEO Pay - Base** | Log of cash compensation |
| **CEO Pay – Performance-based** | Log of stock and option compensation |
| **Earnings Manipulation** | The absolute value of discretionary accruals generated from the modified Jones model |
Table 4: Characteristics of CEOs, Independent Directors, Chairs, and Committees

**No. firms** is number of S&P 1500 firms in sample each year. Board characteristics include: PCEO is set to one if the CEO is designated as powerful, that is having at least three of her four power centrality measures lying in the top quintiles of their overall distributions. PCEO is one if the CEO is designated as powerful. BSIZE, mean directors per board; NID is the number of a firm’s directors designated independent in SEC filings and IB is one for firms with a majority of independent directors so defined and zero otherwise. NPID/ID is the fraction of independent directors designated as powerful and PIB is one for firms for whom a majority of independent directors are powerful Board chair characteristics are: NCC, set to one if the CEO is not the chair and to zero otherwise and PNC set to one if NCC is one and if the chair is designated as powerful, and PNCs, the fraction both not serving as CEO and also designated powerful Board committee characteristics are the means of dummies set to one if majorities of the Audit, Compensation and Nominating committee members are powerful.

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<th>Year</th>
<th>Number of Firms</th>
<th>PCEO</th>
<th>BSIZE</th>
<th>NID</th>
<th>BSIZE</th>
<th>IB</th>
<th>ID</th>
<th>PIB</th>
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<th>PNC</th>
<th>PIDA</th>
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<td>40.9</td>
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<td>43.0</td>
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<td>39.8</td>
<td>25.7</td>
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<td>43</td>
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<td>55.7</td>
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Table 5: Summary Statistics: Firm Characteristics

Panel A reports comparisons of financial and board characteristics of all firms in the sample. **Tobin’s Q** is the book value of total assets minus the book value of equity plus the market value of equity minus deferred tax obligations, divided by total book assets. **Independent director centrality** is the average centrality of all independent directors satisfying SEC definitions. **CEO Centrality** is the average value of the highest three centrality measures for CEOs. **CEO age** is measured in years. **PID age** is the average age of all PIDs on board. **Board size** is the total number of directors for each board. **E-Index** is Bebchuk, et al. (2009) Entrenchment Index that adds 1 for each of the six index components of poison pills, staggered board, golden parachute, supermajority vote in charter and bylaw amendments and calling special meetings. **Total Assets** is firm’s asset. **Leverage** is Total Debt/Total Assets. **Capital Expenditure** is net capital investments over last year’s net PPE. **Cash Flow** is the sum of net income and depreciation and amortization divided by last year’s net PPE. **R&D** is R&D expenses over total assets **Advertising** is Advertising expenses over total assets. Panel B compares financial characteristics of firms whose CEO is a PCEO or not; boards have a majority of PIDs and those that do not; and boards who has a PNC or not. Numbers in parentheses in Panels B are probability levels adjusted for firm-level clustering.
### Panel A: Univariate Statistics

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<th>Standard deviation</th>
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<th>Q3</th>
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<td>65.3</td>
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<td>93</td>
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<td>Powerful Non-CEO Chair</td>
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<td>86.2</td>
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<td>92.8</td>
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<td>1.55</td>
<td>0.848</td>
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<td>56</td>
<td>60</td>
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<td>11</td>
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## Panel B. Comparisons of Means and Medians

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<th>Non-PCEO firms</th>
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<th>Non-PIB firms</th>
<th>PNC firms</th>
<th>Non-PNC firms</th>
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<td>Mean</td>
<td>Median</td>
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<td>Median</td>
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<td>1.26 (0.00)</td>
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<td>0.737</td>
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**Notes:**
- Means and medians are reported for each variable.
- Observations for each category are provided at the bottom of the table.
Table 6: Firm Value Explained by CEO, Chair, and Director Characteristics

Shareholder valuation, measured by Tobin’s average Qratios (Q), explained by OLS regressions on measures of CEO, chair, and independent director presence and power as well control variables including industry and year fixed effects. Variables are as described in Table 3. Sample is 13,933 firm-year panel of S&P 1500 firms from 1999 to 2010. Numbers in parentheses are robust probability levels with clustering by firm. Boldface denotes significance at 10% or better.

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<td>(0.01)</td>
<td>(0.02)</td>
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Table 7: Firm Value Explained by Combinations of CEO, Chair and Director Characteristics

Tobin’s Q (Q) explained by measures of CEO, chair, and independent director power and control variables in OLS with industry and year fixed effects. Variables are as described in Table 3. Sample is 13,933 firm-year panel of S&P 1500 firms from 1999 to 2010. All regressions include the controls and fixed effects used in Table 7, whose coefficients and p-levels are suppressed for brevity. Numbers in parentheses are robust probability levels with clustering by firm. Boldface denotes significance at 10% or better.

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Table 8: Cumulative Abnormal Returns when a PID Suddenly Died

This table reports t-test statistics and OLS regressions of Cumulative Abnormal Returns when a director suddenly died. The abnormal returns are calculated after the director death over four event windows including [-3, 3], [-1, 1], [-1, 2], and [-1, 3], respectively. Numbers in Panel A are percentages of CARs over these windows. Boldface indicates t-test statistics with p-values rejecting equal means at 10% significance or less. Panel B are regressions of CARs on dummies of IB and PID and controls. Controls include director age at death plus firm characteristics as in Table 6. Numbers in parentheses are probability levels rejecting the null hypothesis of zero coefficients. Boldface indicates significance at 10% or better.

Panel A: Mean CAR comparisons surrounding the sudden deaths of independent directors (IB=1) versus other directors (IB = 0) and of powerful independent directors (PID=1) versus other directors (PID = 0)

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<td>Powerful Independent Director</td>
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<td>101 71</td>
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Panel B: Regressions of CARs on dummies for sudden death of an independent director (IB) and of a powerful independent director (PID).

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<td>p-value</td>
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<tr>
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<td>172</td>
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Panel C: Regressions of CARs on centralities for sudden death of an independent director (IB).

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Panel D: Regressions of CARs on dummies for sudden death of a powerful independent director (PID) for each centrality measure.

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<td>(0.23)</td>
</tr>
<tr>
<td>Observations</td>
<td>172</td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>

Panel E: Regressions of CARs on centralities for sudden death of an independent director (IB) for each centrality measure.

<table>
<thead>
<tr>
<th>Event Window</th>
<th>Degree</th>
<th>Betweenness</th>
<th>Closeness</th>
<th>Eigenvector</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>coeff.</td>
<td>p-value</td>
<td>coeff.</td>
<td>p-value</td>
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<tr>
<td>Equally weighted mean CARs:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[-1, +1]</td>
<td>-0.000304</td>
<td>(0.11)</td>
<td>-0.000313</td>
<td>(0.06)</td>
</tr>
<tr>
<td>[-1, +2]</td>
<td>-0.000292</td>
<td>(0.02)</td>
<td>-0.000134</td>
<td>(0.23)</td>
</tr>
<tr>
<td>[-1, +3]</td>
<td>-0.000264</td>
<td>(0.05)</td>
<td>-0.000142</td>
<td>(0.22)</td>
</tr>
<tr>
<td>[-3, +3]</td>
<td>-0.000358</td>
<td>(0.03)</td>
<td>-0.000230</td>
<td>(0.16)</td>
</tr>
<tr>
<td>Firm value weighted mean CARs:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[-1, +1]</td>
<td>-0.000323</td>
<td>(0.07)</td>
<td>-0.000292</td>
<td>(0.04)</td>
</tr>
<tr>
<td>[-1, +2]</td>
<td>-0.000280</td>
<td>(0.04)</td>
<td>-0.000164</td>
<td>(0.16)</td>
</tr>
<tr>
<td>[-1, +3]</td>
<td>-0.000283</td>
<td>(0.05)</td>
<td>-0.000193</td>
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<td>[-3, +3]</td>
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<td>(0.03)</td>
<td>-0.000280</td>
<td>(0.14)</td>
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<tr>
<td>Obs.</td>
<td>172</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 9: Granger Causality Tests

The left panel runs regressions of y’s on lags of y’s and lags of x’s and the right panel runs x’s on lags of y’s and lags of x’s. In both panels, y is Tobin’s Q and x’s are one of the PIB dummy, PNC dummy, average centralities of independent directors, or centrality of PNC. Table reports F-statistics on the joint significance of x lags in the left panel, and the joint significance of y lags in the right panel. Numbers in the parentheses are probability levels rejecting the null hypothesis that the x lags are unrelated to y in the left panel, and that the y lags are unrelated to x in the right panel.

<table>
<thead>
<tr>
<th>Panel A:</th>
<th>Board power Granger causes shareholder value</th>
<th>Shareholder value Granger causes board power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Board power indicator</td>
<td>$X_{i,t}$</td>
<td>$Q_{i,t} = \sum_{s=1}^{S} a_s Q_{i,t-s} + \sum_{s=1}^{S} b_s X_{i,t-s} + u_{it}$</td>
</tr>
<tr>
<td></td>
<td>1 lag</td>
<td>2 lags</td>
</tr>
<tr>
<td>PIB</td>
<td>6.79</td>
<td>3.33</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>PCEO</td>
<td>0.33</td>
<td>0.56</td>
</tr>
<tr>
<td></td>
<td>(0.57)</td>
<td>(0.57)</td>
</tr>
<tr>
<td>PNC</td>
<td>2.77</td>
<td>1.50</td>
</tr>
<tr>
<td></td>
<td>(0.10)</td>
<td>(0.22)</td>
</tr>
<tr>
<td>IDC</td>
<td>4.33</td>
<td>3.97</td>
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<tr>
<td></td>
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<td>(0.02)</td>
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<td>CEOC</td>
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<tr>
<td></td>
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<td>(0.45)</td>
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<tr>
<td>NCCC</td>
<td>4.15</td>
<td>2.87</td>
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<tr>
<td></td>
<td>(0.04)</td>
<td>(0.06)</td>
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### Panel B-1: Degree

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<th>2 lags</th>
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<th>1 lag</th>
<th>2 lags</th>
<th>3 lags</th>
<th>1 lag</th>
<th>2 lags</th>
<th>3 lags</th>
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<td>1.04</td>
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<td>2.54</td>
<td>1.98</td>
<td>1.94</td>
<td>3.3</td>
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<td>2.08</td>
<td>0.58</td>
<td>1.12</td>
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<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.37)</td>
<td>(0.11)</td>
<td>(0.08)</td>
<td>(0.12)</td>
<td>(0.16)</td>
<td>(0.04)</td>
<td>(0.49)</td>
<td>(0.15)</td>
<td>(0.56)</td>
<td>(0.34)</td>
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<tr>
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<td>0.07</td>
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<td>1.48</td>
<td>0.15</td>
<td>0.16</td>
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<td>(0.59)</td>
<td>(0.42)</td>
<td>(0.30)</td>
<td>(0.43)</td>
<td>(0.98)</td>
<td>(0.70)</td>
<td>(0.79)</td>
<td>(0.91)</td>
<td>(0.22)</td>
<td>(0.69)</td>
<td>(0.85)</td>
<td>(0.72)</td>
</tr>
<tr>
<td><strong>PCEO</strong></td>
<td>1.82</td>
<td>1.93</td>
<td>0.63</td>
<td><strong>4.17</strong></td>
<td>1.27</td>
<td>1.72</td>
<td><strong>3.45</strong></td>
<td>2.20</td>
<td><strong>2.18</strong></td>
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<td>(0.60)</td>
<td>(0.12)</td>
<td>(0.10)</td>
<td>(0.10)</td>
<td>(0.14)</td>
<td>(0.06)</td>
<td>(0.09)</td>
<td>(0.16)</td>
<td>(0.34)</td>
<td>(0.52)</td>
</tr>
<tr>
<td></td>
<td>1.43</td>
<td><strong>3.05</strong></td>
<td><strong>3.67</strong></td>
<td>2.46</td>
<td><strong>2.31</strong></td>
<td><strong>2.09</strong></td>
<td>2.18</td>
<td><strong>2.74</strong></td>
<td><strong>3.56</strong></td>
<td>0.51</td>
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<tr>
<td></td>
<td>(0.23)</td>
<td>(0.05)</td>
<td>(0.01)</td>
<td>(0.12)</td>
<td>(0.10)</td>
<td>(0.10)</td>
<td>(0.14)</td>
<td>(0.06)</td>
<td>(0.01)</td>
<td>(0.47)</td>
<td>(0.94)</td>
<td>(0.87)</td>
</tr>
<tr>
<td><strong>PNC</strong></td>
<td>0.28</td>
<td>0.13</td>
<td>0.83</td>
<td>0.71</td>
<td>0.38</td>
<td>0.64</td>
<td>0.68</td>
<td>0.28</td>
<td>1.74</td>
<td>0.16</td>
<td>0.13</td>
<td>0.91</td>
</tr>
<tr>
<td></td>
<td>(0.60)</td>
<td>(0.88)</td>
<td>(0.48)</td>
<td>(0.40)</td>
<td>(0.68)</td>
<td>(0.59)</td>
<td>(0.41)</td>
<td>(0.76)</td>
<td>(0.16)</td>
<td>(0.69)</td>
<td>(0.88)</td>
<td>(0.44)</td>
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<tr>
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<td>0.82</td>
<td>0.88</td>
<td>0.81</td>
<td>1.68</td>
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<tr>
<td><strong>IDC</strong></td>
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<td>(0.25)</td>
<td>(0.49)</td>
<td>(0.15)</td>
<td>(0.39)</td>
<td>(0.19)</td>
<td>(0.12)</td>
<td>(0.24)</td>
<td>(0.48)</td>
<td>(0.35)</td>
<td>(0.45)</td>
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### Panel B-2: Closeness

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<th>2 lags</th>
<th>3 lags</th>
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<th>3 lags</th>
<th>1 lag</th>
<th>2 lags</th>
<th>3 lags</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PIB</strong></td>
<td>5.52</td>
<td>3.19</td>
<td>0.91</td>
<td>0.29</td>
<td>2.09</td>
<td>2.85</td>
<td>3.26</td>
<td>2.2</td>
<td>1.10</td>
<td>0.17</td>
<td>0.89</td>
<td>1.99</td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
<td>(0.04)</td>
<td>(0.43)</td>
<td>(0.59)</td>
<td>(0.12)</td>
<td>(0.04)</td>
<td>(0.07)</td>
<td>(0.11)</td>
<td>(0.35)</td>
<td>(0.68)</td>
<td>(0.41)</td>
<td>(0.11)</td>
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<tr>
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<td>0.80</td>
<td>0.64</td>
<td>0.22</td>
<td>0.18</td>
<td>0.92</td>
<td>0.77</td>
<td>0.88</td>
<td>2.11</td>
<td><strong>4.19</strong></td>
<td><strong>3.06</strong></td>
</tr>
<tr>
<td></td>
<td>(0.48)</td>
<td>(0.26)</td>
<td>(0.49)</td>
<td>(0.42)</td>
<td>(0.80)</td>
<td>(0.91)</td>
<td>(0.34)</td>
<td>(0.46)</td>
<td>(0.45)</td>
<td>(0.15)</td>
<td>(0.02)</td>
<td>(0.03)</td>
</tr>
<tr>
<td><strong>PCEO</strong></td>
<td><strong>3.59</strong></td>
<td>1.43</td>
<td>0.52</td>
<td><strong>4.29</strong></td>
<td>1.27</td>
<td>1.32</td>
<td><strong>3.77</strong></td>
<td>0.83</td>
<td>0.58</td>
<td><strong>6.72</strong></td>
<td>1.71</td>
<td>1.37</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td>(0.24)</td>
<td>(0.67)</td>
<td>(0.04)</td>
<td>(0.28)</td>
<td>(0.27)</td>
<td>(0.05)</td>
<td>(0.43)</td>
<td>(0.63)</td>
<td>(0.01)</td>
<td>(0.18)</td>
<td>(0.25)</td>
</tr>
<tr>
<td></td>
<td><strong>6.19</strong></td>
<td><strong>3.57</strong></td>
<td><strong>3.36</strong></td>
<td><strong>3.43</strong></td>
<td><strong>2.27</strong></td>
<td>1.79</td>
<td><strong>5.91</strong></td>
<td><strong>3.96</strong></td>
<td><strong>2.92</strong></td>
<td><strong>4.98</strong></td>
<td><strong>3.32</strong></td>
<td><strong>2.54</strong></td>
</tr>
<tr>
<td><strong>PNC</strong></td>
<td>(0.01)</td>
<td>(0.03)</td>
<td>(0.02)</td>
<td>(0.06)</td>
<td>(0.10)</td>
<td>(0.15)</td>
<td>(0.02)</td>
<td>(0.02)</td>
<td>(0.03)</td>
<td>(0.03)</td>
<td>(0.04)</td>
<td>(0.05)</td>
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<td>0.42</td>
<td>1.55</td>
<td><strong>2.14</strong></td>
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<td>0.43</td>
<td>0.20</td>
<td>0.64</td>
<td><strong>2.68</strong></td>
<td>2.04</td>
<td><strong>4.75</strong></td>
<td>1.54</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>IDC</strong></td>
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<td>(0.21)</td>
<td>(0.09)</td>
<td>(0.25)</td>
<td>(0.65)</td>
<td>(0.90)</td>
<td>(0.42)</td>
<td>(0.07)</td>
<td>(0.11)</td>
<td>(0.03)</td>
<td>(0.22)</td>
<td>(0.39)</td>
</tr>
<tr>
<td></td>
<td><strong>3.51</strong></td>
<td>1.62</td>
<td>0.92</td>
<td><strong>2.92</strong></td>
<td>1.14</td>
<td>1.66</td>
<td><strong>3.37</strong></td>
<td>1.49</td>
<td>0.88</td>
<td><strong>3.37</strong></td>
<td>1.38</td>
<td>1.69</td>
</tr>
<tr>
<td><strong>CEOC</strong></td>
<td>(0.06)</td>
<td>(0.20)</td>
<td>(0.43)</td>
<td>(0.09)</td>
<td>(0.32)</td>
<td>(0.17)</td>
<td>(0.07)</td>
<td>(0.23)</td>
<td>(0.45)</td>
<td>(0.07)</td>
<td>(0.25)</td>
<td>(0.17)</td>
</tr>
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</table>
### Table 10: Additions and Departures of PIDs

Change in Tobin’s Q explained by OLS regressions on measures of PID additions to or departures from the board in the prior year. Controls are one year changes of the variables described in Table 3. Numbers in parentheses are robust probability levels with clustering by firm. Boldface denotes significance at 10% or better.

<table>
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<tr>
<th>Change in Tobin’s Q</th>
<th>10.1</th>
<th>10.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net addition of PIDs</td>
<td>0.0676</td>
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</tr>
<tr>
<td></td>
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<td>(0.02)</td>
</tr>
<tr>
<td>Net deletion of PIDs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Δlog(ceo age)</td>
<td>0.0680</td>
<td>0.0617</td>
</tr>
<tr>
<td></td>
<td>(0.15)</td>
<td>(0.19)</td>
</tr>
<tr>
<td>Δlog(board size)</td>
<td>-0.0477</td>
<td>-0.0479</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Δlog(assets)</td>
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<td>-0.384</td>
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<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
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<tr>
<td>Δbook leverage</td>
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<tr>
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<td>(0.84)</td>
<td>(0.83)</td>
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<tr>
<td>Δprofitability</td>
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<td>(0.30)</td>
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<td>Δinvestments</td>
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<td>-0.105</td>
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<tr>
<td></td>
<td>(0.44)</td>
<td>(0.45)</td>
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<tr>
<td>ΔR&amp;D</td>
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<td>-1.126</td>
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<tr>
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<td>(0.05)</td>
<td>(0.05)</td>
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<tr>
<td>ΔAdvertising</td>
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<tr>
<td></td>
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<td>(0.42)</td>
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<tr>
<td>R²</td>
<td>0.0248</td>
<td>0.0249</td>
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</table>
Table 11: PIDs and M&A Performance

Cumulative abnormal returns around -3 and +3 days of M&A announcement dates explained by OLS regressions on measures of CEO, chair, and independent director presence and power as well control variables including industry and year fixed effects. Sample includes 632 mergers and acquisitions by S&P 1500 firms that took place between 1999 and 2009. Variables are as described in Table 3. Sample is 13,933 firm-year panel of S&P 1500 firms from 1999 to 2010. Panel A reports the results for all deals, Panel B reports the results for deals which are either horizontal or vertical related. Panel C reports the results for deals which are neither horizontal nor vertical related. Numbers in parentheses are robust probability levels with clustering by firm. Boldface denotes significance at 10% or better.

<table>
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<th>Panel A:</th>
<th>Bidder CAR [-3, 3]</th>
<th>Combined CAR [-3, 3]</th>
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<tr>
<td></td>
<td>11.1</td>
<td>11.2</td>
</tr>
<tr>
<td>PIB</td>
<td>0.0101 (0.24)</td>
<td>0.0220 (0.01)</td>
</tr>
<tr>
<td>PCEO</td>
<td>-0.0342 (0.00)</td>
<td>-0.0339 (0.00)</td>
</tr>
<tr>
<td>PNC</td>
<td>0.00335 (0.66)</td>
<td>-0.000076 (0.02)</td>
</tr>
<tr>
<td>IDC</td>
<td>4.94e-05 (0.52)</td>
<td>4.94e-05 (0.52)</td>
</tr>
<tr>
<td>CEOC</td>
<td>0.000865 (0.09)</td>
<td>0.00107 (0.03)</td>
</tr>
<tr>
<td>NCCC</td>
<td>-0.000437 (0.77)</td>
<td>-0.0145 (0.33)</td>
</tr>
<tr>
<td>log(ceo age)</td>
<td>0.00228 (0.34)</td>
<td>0.00328 (0.16)</td>
</tr>
<tr>
<td>log(board size)</td>
<td>-0.00242 (0.34)</td>
<td>0.000142 (0.59)</td>
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<td>e-index</td>
<td>0.0348 (0.12)</td>
<td>0.0187 (0.40)</td>
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<td>profitability</td>
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<td>0.141 (0.10)</td>
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<td>(0.00)</td>
<td>(0.00)</td>
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<tr>
<td>----------------------</td>
<td>--------</td>
<td>--------</td>
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<tr>
<td>investment</td>
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### Panel C: Eigenvector

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\( R^2 \) values range from 0.0556 to 0.0986, with some values in parentheses.
Table 12: PIDs and the Free Cash Flow Problem

Probit regression of free cash flow problem on measures of CEO, chair, and independent director presence and power as well control variables including industry and year fixed effects. Variables are as described in Table 3. In panel A, the free cash flow is a dummy which takes the value of one if a firm’s cash flow is higher than two digit SIC industry median, dividend payout is lower than two digit SIC industry median, and Tobin’s Q is lower than two digit SIC industry median, and zero otherwise. In panel B, the free cash flow is a dummy which takes the value of one if a firm’s cash flow is the top quartile by two digit SIC industry and year, and zero otherwise. Sample is 13,933 firm-year panel of S&P 1500 firms from 1999 to 2010. Numbers in parentheses are robust probability levels with clustering by firm. Boldface denotes significance at 10% or better.

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<td>profitability</td>
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<td>investment</td>
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<td>Year fixed effects</td>
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### Industry fixed effects

| Y | Y | Y | Y | Y | Y |

### Year fixed effects

| Y | Y | Y | Y | Y | Y |

### $R^2$

<p>| 0.251 | 0.251 | 0.251 | 0.251 | 0.251 | 0.251 |</p>
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- **R²**: 0.251

### Closeness

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- **R²**: 0.251
Table 13: Forced CEO Turnover and Selection of an Outside CEO

The likelihoods of forced CEO turnover and external CEO explained by Probit regressions on measures of CEO, chair, and independent director presence and power as well control variables including industry and year fixed effects. Variables are as described in Table 3. Sample is 13,933 firm-year panel of S&P 1500 firms from 1999 to 2010. Numbers in parentheses are robust probability levels with clustering by firm. Boldface denotes significance at 10% or better.

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Numbers in parentheses are robust probability levels with clustering by firm. Boldface denotes significance at 10% or better.
Forced Turnover

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Table 14: PIDs and CEO Compensation

CEO compensation explained by OLS regressions on measures of CEO, chair, and independent director presence and power as well as control variables including industry and year fixed effects. The dependent variable in the first panel is natural log of total compensation (tdc1), defined as the sum of salary, bonus, stock grants, and option grants. The dependent variable in the second panel is the natural log of equity-based compensation. The dependent variable in the third panel is natural log of cash compensation. Variables are as described in Table 3. Sample is 13,933 firm-year panel of S&P 1500 firms from 1999 to 2010. Numbers in parentheses are robust probability levels with clustering by firm. Boldface denotes significance at 10% or better.

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|        | 0.914 | 0.867 | 0.860 |       |       |       |       |       |       |       |       |       |       |
|        | 0.217 | 0.235 | 0.179 |       |       |       |       |       |       |       |       |       |       |
|        | 0.28  | 0.24  | 0.41  |       |       |       |       |       |       |       |       |       |       |

**PIB×Ret**

|        | 0.217 | 0.235 | 0.179 |       |       |       |       |       |       |       |       |       |       |
|        | 0.28  | 0.24  | 0.41  |       |       |       |       |       |       |       |       |       |       |

**PIBC×Ret**

|        | 0.258 | 0.208 | 0.222 |       |       |       |       |       |       |       |       |       |       |
|        | 0.26  | 0.39  | 0.36  |       |       |       |       |       |       |       |       |       |       |

**PCEO×Ret**

|        | 0.255 | 0.278 |       |       |       |       |       |       |       |       |       |       |       |
|        | 0.27  | 0.23  |       |       |       |       |       |       |       |       |       |       |       |

**PNC×Ret**

|        | 0.0984|       |       |       |       |       |       |       |       |       |       |       |       |
|        | 0.48  |       |       |       |       |       |       |       |       |       |       |       |       |

**IDC×Ret**

|        | 0.0106| 0.00766| 0.00604|       |       |       |       |       |       |       |       |       |       |
|        | 0.31  | 0.47  | 0.58  |       |       |       |       |       |       |       |       |       |       |

**IDCC×Ret**

|        | 0.0143| 0.0131| 0.0133|       |       |       |       |       |       |       |       |       |       |
|        | 0.06  | 0.09  | 0.09  |       |       |       |       |       |       |       |       |       |       |

**CEOC×Ret**

|        | 0.00491| 0.00558| 0.00259| 0.00287|       |       |       |       |       |       |       |       |       |
|        | 0.38  | 0.33  | 0.64  | 0.60  |       |       |       |       |       |       |       |       |       |

**NCCC×Ret**

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Table 15: PIDs and Earnings Management

The absolute value of discretionary accruals generated from the modified Jones model explained by OLS regressions on measures of CEO, chair, and independent director presence and power as well control variables including industry and year fixed effects. Variables are as described in Table 3. Sample is 13,933 firm-year panel of S&P 1500 firms from 1999 to 2010. Numbers in parentheses are robust probability levels with clustering by firm. Boldface denotes significance at 10% or better.

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Figure 1

Cumulative abnormal returns surrounding the sudden deaths of directors, by status of decedent as independent or insider, and either powerful or not powerful if independent.
III. Income Inequality, Leverage and the Mortgage Crisis

Abstract: Mian and Sufi (2009) show that a securitization-driven surge in the supply of credit to households in subprime zip codes was the proximate cause of the mortgage crisis. It is unclear, however, why rational households increased debt beyond their ability to repay. Rajan (2010) advances a credit for income substitution thesis, namely that rising income inequality spurred a demand for credit among households with stagnant income growth. Using household level data on mortgage default, we provide empirical support for this thesis. Default is highest among middle-income, low-educated borrowers, and the rate of default rises in urban counties with greater income inequality.

A. Introduction

Rajan (2010) argues that understanding the deep underlying causes – the fault lines – of the recent financial crisis is crucial to advance appropriate policy solutions that make future crises less likely. A deep analysis of the financial crisis must explain why households, especially those with poor credit scores, demanded so much mortgage credit and why banks and other financial institutions were willing to supply it.

Mian and Sufi (2009) establish that the mortgage crisis centered around subprime borrowers. The sharp rise in 30-day mortgage delinquencies was concentrated in subprime zip code quartiles where the fraction of households with credit scores below 660 was highest. Moreover, the dramatic expansion of mortgage credit in the 2000s cannot be explained by higher expected home prices or better income prospects among subprime households, but rather, by an
increased willingness of lenders to extend mortgage credit.

Why would financial institutions take on such risk? One possibility is that asset securitization created moral hazard. Indeed, Mian and Sufi (2009) find that the growth in subprime mortgage credit coincided with increased financial institution purchases of subprime mortgages originated by unaffiliated mortgage brokers to support asset securitization. Subprime mortgage securities were predominantly purchased by non-government sponsored entities and default rates were higher in mortgages sold in private asset securitization and to non-commercial bank finance companies. Mortgage brokers and bankers had less incentive to closely monitor the quality of mortgages intended for package and sale to third parties (Purnanandam, 2011; Keys, 2010). Banks as well as credit rating agencies overestimated the risk diversification benefits from asset securitization. Moreover, opacity likely played a role. Not only did investors fail to discipline excessive risk-taking by banks during the housing bubble, banks were awarded higher stock prices. The growing complexity of large banking organizations made it more difficult for investors to assess bank risk (Morgan, 2002; Jones, Lee, Yeager, 2011). Lastly, performance-based CEO compensation may have contributed to the surge in mortgage credit. However, as Fahlenbrach and Stulz (2011) show, the aggregate stock and option holdings of bank CEOs averaged eight times the value of their annual compensation. The amount of personal wealth at risk prior to the financial crisis makes it unlikely that rational CEOs either knowingly engaged in excessively risky behavior or foresaw an impending financial crisis.

The surge in the supply of subprime credit does not explain why (rational) subprime households took on added debt which, in the absence of better income prospects, greatly exceeded their repayment capacity. Rajan (2010) proposes a credit substitution thesis: rising
income inequality in the U.S. since the 1970s stimulated a substitution of credit for income among households with stagnating incomes. Rising inequality combined with easy access to credit induces less affluent households to increase leverage. Analyzing spending patterns in the 1980 and 2008 Consumer Expenditure Surveys between the top 20% and bottom 80% of households across geographic markets, Bertrand and Morse (2012) find that less affluent households spend relatively more on luxury goods and services than their more affluent neighbors. Moreover, in states where the highest earners were also the wealthiest, less affluent households were more likely to report financial duress. A higher percentage of upper income households predicts increased personal bankruptcy filings.

Similar patterns of financing and consumption preceded the Great Depression. Kumhof and Rancière (2010) note that rising income inequality in the years prior to the Great Depression starting in 1929, and prior to the Great Recession starting in 2007, were accompanied by sharp increases in debt-to-income ratios among lower and middle income households. Using a simple theoretical construct, they show that income inequality can systematically lead to crisis. The shift in incomes that results when an investor class becomes better at capturing the returns to production slows the wage growth of the working class. Workers borrow from investors to fund consumption. Increased saving at the top and increased borrowing at the bottom causes consumption inequality to fall but at a rate significantly less than income inequality. More importantly, the saving and borrowing patterns of both groups expands the need for financial services and intermediation. As a result, the size of the financial sector, embeded in the ratio of banks’ liabilities to GDP, increases. The large and persistent growth in leverage creates financial fragility that eventually leads to a financial crisis when an output shock occurs.
As the credit substitution theory predicts, many subprime borrowers used mortgage debt to finance consumption during the recent housing bubble. Using detailed credit report information from Equifax for 74,149 homeowners in 2,307 zip codes located in 68 MSAs over the period 1997 to 2008, Mian and Sufi (2011) find that borrowing against the increase in home equity by existing homeowners was responsible for a significant fraction of both the rise in U.S. household leverage from 2002 to 2006 and the increase in defaults from 2006 to 2008. Home equity-based borrowing was stronger among younger households, and among households with lower credit scores and higher rates of credit card use. Money extracted from increased home equity was not used either to purchase new real estate or pay down high credit card balances. Instead, borrowed funds were most likely used to finance consumption. Default rates from 2002 to 2006 declined as lower credit quality households living in high home price appreciation areas borrowed heavily against their home equity, but from 2006 to 2008, their default rates rose significantly.

In this paper, we provide empirical support for the credit substitution thesis. Across the U.S., households with stagnant incomes were inclined toward debt to finance current consumption. Access to inexpensive mortgage credit in the 2000s presented the opportunity. Stagnant-income households residing in urban counties with more unequal income distributions increased leverage the most. The resulting mortgage defaults in these counties accounts for the high concentration of foreclosures in relatively wealthy counties.

Mian and Sufi (2009) stress the importance of using disaggregated data to detect credit patterns during the housing boom and bust. We combine three nationwide, household-level datasets to analyze the pattern of nationwide mortgage defaults in the third quarter of 2008, prior to a widely acknowledged financial crisis peak in the fourth quarter of 2008. We show that low
income, middle-income and low-education households – precisely the households with stagnating incomes – consistently had the highest mortgage leverage and the highest mortgage foreclosure rates. Further, the leverage and default rates of these households were significantly higher in urban counties with high income inequality. Our evidence is consistent with the Rajan conjecture that high levels of income inequality combined with access to credit was the fault line in the U.S. financial system.

We proceed by describing the data in Section B. Section C discusses factors that influence foreclosures, and it presents summary statistics. The research design and empirical analysis follow in Section D. Section E concludes.

**B. Household Data Sources**

We merge two nationwide datasets to assemble a comprehensive database of U.S. households that identifies those in foreclosure during the third quarter of 2008. Our first dataset, compiled by RealtyTrac, is a foreclosure database with continuously updated listings of homes in all three stages of foreclosure: notice of default, notice of sale, and repossession. A notice of default occurs when the homeowner is notified by the lender that the mortgage is in default (also called a *lis pendens* in judicial proceedings). The notice is usually sent after the homeowner has missed three or more monthly payments. The homeowner must make restitution or otherwise modify the terms of the mortgage to re-establish good standing. If the mortgage remains in default, the lender issues a notice of sale (or notice of transaction). The notification includes the time, place, and date when the home will be sold. In the third and final stage, the home is auctioned. Should the bank end up with the winning (or only) bid, the property is held as real estate owned (REO). We restrict mortgages in foreclosure to households served with notices of
default or notices of sale.\textsuperscript{17} For the third quarter of 2008, the total number of foreclosures is 217,088.

The second dataset merges Real Property and Consumer databases compiled by Acxiom Corporation in Little Rock, Arkansas.\textsuperscript{18} The Real Property database contains 59.5 million observations, and the Consumer database, 191 million observations. The Real Property database includes important property characteristics such as loan value, interest rate type, year built, and estimated market value of the home. The Consumer database contains household attributes such as estimated income, education, net worth, marital status, age, number of children, and length of residency. The key identifiers used to combine these databases are property address and the first and last name of the head of household. The merged dataset includes 44 million individual properties over 45 states and the District of Columbia.\textsuperscript{19} Combining the RealtyTrac and Acxiom databases by address for the third quarter 2008 results in a foreclosure dataset with 13.2 million households, of which 46,584 are in foreclosure, representing an average nationwide default rate of 3.53 per 1,000 households.

\textbf{C. Household and Regional Influences on Mortgage Foreclosure}

The ultimate objective of our analysis is to provide evidence that, all else equal, households with stagnating income – especially those that live in counties with high income inequality – are more likely to highly leverage their homes and subsequently default. We

\textsuperscript{17}We exclude real estate owned properties because by the time a bank repossesses a property, the home is no longer technically in foreclosure.
\textsuperscript{18}Acxiom uses these databases either to customize mailing lists or target advertising to specific consumer segments for its clients.
\textsuperscript{19}Five of the least populated states are missing from the database: Maine, Vermont, New Hampshire, South Dakota, and Kansas.
carefully control for other factors that might influence default such as household and county characteristics. Using spatial statistics, we also control for latent factors such as the social stigma of foreclosure that may lead to differences in default across geographical areas.

To distinguish households with stagnating income from households with growing income, we categorize households by education and income. Census data clearly show that all of the income gains between 1974 and 2003 accrued to households with at least some college education. The Acxiom dataset provides the total number of years of education of the head of household ranging from 12 (completed high school) to 20 (completed graduate school). We classify households as highly educated (HE) if the head of household at least completed vocational or technical school (a value of 14). Households where the head of household only completed high school are those with low education (LE).

Census data also clearly show that income inequality increased significantly between 1974 and 2003. Reconciling Census patterns with Acxiom’s income groupings, we divide households into three income categories. Low income households (LI) are those that earned less than $30,000 annually. In 2008, this category accounted for 30.3% of all households. Middle-income households (MI) are households that earned between $30,000 and less than $75,000.

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20The mid-1970s are often viewed as the period when the returns to blue-collar workers peaked, and 2003 is a non-recession year in the midst of the housing bubble. Our conclusions are not sensitive to the beginning and ending years that we select for analysis. Census Bureau Table H-13 “Educational Attainment of Householder--Households with Householder 25 Years Old and Over by Median and Mean Income: 1991 to 2010” and Table H-14, “Years of School Completed--Households with Householder 25 Years Old and Over by Median and Mean Income: 1967 to 1990.”

21Data for historical household income trends come from U.S. Census Bureau Table H-1 “Income Limits for Each Fifth and Top 5 Percent of All Households: 1967 to 2010,” Table H-2 “Share of Aggregate Income Received by Each Fifth and Top 5 Percent of Households, All Races: 1967 to 2010,” and Table HINC-01 “Selected Characteristics of Households, by Total Money Income in 2008.”
This group accounted for 37.4% of all households in 2008. High-income households (HI) earned more than $75,000 and accounted for 32.4% of all households. We considered classifying the high-income households as those earnings more than $100,000 because even stronger income growth over the last three decades occurred for these households. The lower threshold, however, results in a more even number of Census households in each category, and if anything, biases our tests against finding support for the credit substitution thesis because more households with relatively low-growth incomes that may have inappropriately leveraged up during the housing boom are included.

1. Household Attributes and Property Characteristics: Profiles of Mortgage Default

Table 1 details the household attributes and property characteristics that describe the profiles of mortgage default as of the 3rd quarter of 2008. Although our income categories correspond to Census household distributions, our dataset is highly skewed towards middle and upper income households because many low-income households do not own property or reside in less densely populated regions that Acxiom does not track. Low-income households account for just 9.3% of our sample whereas high-income households make up 44.4%. In addition, 55.5% of the households in our sample are classified as highly educated.

Panel A of Table 1 reports mean values for foreclosed households, and Panel B, mean values for none-foreclosed households. Households in foreclosure are relatively less educated and have relatively less income and net worth; not surprising, since the heads of households in foreclosure are far more likely to be single and nearly an average nine years younger.

Normalizing by median home purchases of households in similar income or education
groups in the same year, defaulted households spent an average 4.39% less on purchasing a home. But households in default are significantly more leveraged. Their loan to income ratio is 440.7% versus 269.5% for non-defaulting households. Mean loan to value is 87.6%, far above the 63.0% for households not in foreclosure. And the mean loan to purchase is nearly 13% higher for defaulting households. Further, the average residency for foreclosed households of 6.69 years, which is at least three years shorter than the average 9.73 years for non-foreclosed households, suggests that foreclosed households purchased their homes more recently and likely at higher average prices than non-foreclosed households but much before the onset of the financial crisis. Higher average levels of loans outstanding for defaulting households were almost certainly either the result of mortgage refinancing during the housing price bubble period or included home equity loans, both of which were intended to finance consumption. Lastly, defaulting households are far more likely to have chosen variable interest rate loans.

Middle income households spent the most on home purchase, and low income households, the least. For the most part, leverage increased with decreased income regardless of household income or education as expected. The one exception is loan to value which is lowest for low income households.

Table 1 also presents mortgage default rates by household income and education groups. The overall default rate is 3.52 per 1000 (we use the symbol ‰ to express per 1000 units). The mortgage default rate is highest among middle income households at 4.14‰, and highest among low educated households at 4.33‰, precisely the household groups with stagnating incomes. However, even the high-income and high-educated households participated in the mortgage crisis. The housing bubble was widespread, affecting every household group.
2. County Influences on Mortgage Default

Household attributes and property characteristics aside, mortgage default are influenced by broader regional factors. In particular, we argue that households in counties with greater income inequality demanded relatively more mortgage credit in order to stay abreast of their wealthier neighbors. From the 2000 Census data, GINI coefficients that range from 0 to 1, are used to proxy for income inequality, where higher values imply more income inequality.\textsuperscript{22} We distinguish between rural and urban counties using the 2003 Rural-Urban Continuum Code computed by the Economic Research Service of U.S. Department of Agriculture.\textsuperscript{23} The variable takes values from 1 (urban) to 9 (rural) based on population and adjacency to metropolitan areas.

Regional economic conditions can also be a causal factor in mortgage default. All else equal, we expect counties with stronger economies to experience fewer foreclosures. We use the mean county household income from the U.S. Bureau of the Census, monthly county unemployment from the Bureau of Labor Statistics, and state GDP per capita growth rates from the Bureau of Economic Analysis as proxies for regional economic conditions. Each of these variables is evaluated between the years 2000 and 2007.

Lastly, differences in housing market dynamics across counties can impact the prospective for mortgage default. The housing bubble may be stronger in some areas because high population and housing unit growth result in higher price appreciation during the property boom. We calculate annual house price appreciation, population growth, and housing unity between

\textsuperscript{22}GINI index is from Burkey, M., 2006. *Gini Coefficients for the 2000 Census.* (www.ncat.edu/~burkeym/Gini.htm).

\textsuperscript{23}Rurality data can be obtained from http://www.ers.usda.gov/data-products/rural-urban-continuum-codes.aspx.
2000 and 2007 by averaging the annual price changes. Quarterly house price indices are from the Federal Housing Finance Agency, population growth is from the U.S. Census Bureau, and housing unit growth is from the Home Mortgage Disclosure Act (HMDA) database.

Summary statistics at the county level are presented in Table 2. For each variable, we classify counties as above or below median. Aggregating households across the entire sample, we compute household shares and default rates per 1000 households for counties above and below the median. For example, counties with above median GINI (higher income inequality) between 2000 and 2007 account for 61.5% of all households in the sample but 70.0% of all foreclosures, and the foreclosure rate is 4.01‰. In contrast, 38.5% of sample households reside in counties with below median GINI, and their foreclosure rate is 2.74‰. The pattern of household shares and default rates support Rajan’s credit substitution thesis that households in areas with high income inequality are more likely to obtain credit they have difficulty repaying.

Table 2 also shows that, as expected, foreclosure rates are higher in counties that are more urban with relatively high unemployment, house price appreciation, population growth, and housing unit growth. Housing markets were the hottest, and crashed the hardest, in the high growth areas. Surprisingly, default rates are higher in counties with higher average income. However, many counties where income inequality are highest, are situated in the southeast where large fractions of the population live below the poverty level. The homeownership rate in these areas is relatively low.

We argue that given broad access to mortgage credit, households in counties where income inequality is greater, are more likely to increase leverage. But higher leverage can simply be the result of higher average home prices in high income inequality counties rather than
by a desire of households to consume more from limited incomes.

Table 3 examines how the households attributes and property characteristics of mortgage default differ between high (above median) and low GINI counties. For each variable, we subtract the values for low from high GINI counties, and test whether the differences are statistically significant. We expect households in high GINI counties to be more leveraged.

Panel A of Table 3 reports the differences in household attributes and property characteristics between defaulted and non-defaulted households as of the 3rd quarter of 2008. The differences in household attributes are modest. For example, household income registers -0.1, which indicates that households in high GINI counties earned approximately $750 less in annual income than households in low GINI counties. The most significant difference is the percent of singles as heads of households. Defaulting households in High GINI counties are 3.6% more likely to have singles as heads of household. The differences in property characteristics between foreclosed and non-foreclosed households are larger in magnitude and more economically significant.

Households in high GINI counties are far more leveraged than households in low GINI counties. In high GINI counties, the household mean loan to income is 77.9% higher, loan to value is 2.2% higher, and loan to purchase is 5.8% higher. In addition, the number of foreclosed properties with variable interest rate loans is 6.1% higher for households in high GINI counties.

Some of the differences in household attributes and property characteristics shown in Panel A are not unique to defaulted households. Panel B of Table 3 reports differences in high GINI and low GINI counties for non-defaulted households. Again, differences in household
attributes are not large, but even non-foreclosed households in high GINI counties take on more mortgage debt. The loan to income ratio is 31% higher, and the loan to purchase ratio, 6.6% higher. In sum, both foreclosed and non-foreclosed households exhibit a pattern of leverage consistent with the credit substitution thesis.

We repeat the same analysis for high versus low urban counties and find that urban households had far higher leverage. The housing crisis was clearly centered in urban areas. However, we avoid drawing strong conclusions from this evidence because 94% of households in the sample reside in urban areas.

3. Contagion in Household Defaults

Aside from broad regional factors that influence foreclosure, there are latent factors that surely played a role. Indeed, the sizable concentration of foreclosures in certain areas such as the southwest and Florida suggest a contagion effect. Latent factors can include network effects where family and friends that purchase homes they ultimately cannot afford encourage their social networks to also purchase homes. In addition, the social stigma from losing one’s home can vary across regions and almost certainly decline with the ubiquity of foreclosures in a given area. The role of speculators (“flippers”) is also important because speculative investors purchased many more homes in bubble states than others. The dynamic changes in the composition of mortgage borrowers amplified the upward pressure on house prices during the boom (Haughwout et al, 2011). Finally, mortgage brokers and bankers may have marketed mortgage products much more aggressively in certain areas, drawing in marginal home buyers.

Spatial statistics capture the latent effects of contagion on foreclosure. Local Indicators of
Spatial Association (LISA) (Anselin, 1995) assess significant local clustering patterns around an individual location and identify local pockets of nonstationarity – the “hot spots.” The LISA statistic defined in (1) quantifies the spillover effect of county foreclosures on neighboring counties.

\[
I_i = \frac{(y_i - \bar{y}) \sum_j W_{ij} (y_j - \bar{y})}{\sum_i (y_i - \bar{y})^2 / N}
\]

where \( y \) is the vector of mortgage default rate deviations from the average across counties; \( \bar{y} \) is the mean of \( y \); \( W \) is a proximity weight matrix, and \( N \) is the total number of counties. We construct the weight matrix in one of two ways. In an adjacency weight matrix, weights are dummy variables based on the contiguity of two counties that take on values of 1 if two counties share a boundary, and 0 otherwise. In a centroid distance weight matrix, weights are the inverse distances squared in miles between pairs of counties.

LISA ranges from -1 (perfectly negative) to +1 (perfectly positive) spatial correlation. High spatial correlation represents counties where the LISA statistic is significant at the 5% level expressed as a percentage of the counties where similar households reside. The test statistic used to determine significance is a \( z \)-statistic under the null hypothesis that default rates are randomly distributed across counties.

A map of U.S. counties is displayed in Figure 1 where shaded counties indicate statistically significant spatial contagion. Mortgage defaults in these counties are significantly correlated with mortgage defaults in neighboring counties. The high default rates in ‘hot spots’
reflect the combined effects of social networks and social stigma, as well as, aggressive marketing of mortgage products and speculative residential purchases in local housing markets.

Table 4 compares foreclosure rates by household income and education groups between counties with high and low spatial contagion. Using adjacency to capture proximity, the household shares in counties with high and low spatial contagion are 27% and 73%, respectively. The overall default rate is 7.10 per 1000 in high spatial contagion counties vs. 2.60 per 1000 in low spatial contagion counties. Across household income groups, default rates in counties with high spatial contagion are more than three times greater in magnitude than default rates in counties with low spatial contagion. Regardless of household education, the default rate is more than twice as high in “hot spot” counties. The results are consistent when proximity is determined by centroid distance.

D. Income Inequality, Leverage, and Mortgage Default

Our multivariate analysis of the mortgage crisis involves two separate but related facets. First, we wish to show that, all else equal, households who experience stagnant income growth, and at the same time, reside in counties with higher income inequality, will take on increased leverage. Second, we wish to show that more leveraged households suffer higher rates of mortgage default. Note that evidence consistent with the first objective provides support for Rajan’s credit substitution thesis, and with the second objective, that credit substitution by stagnant income growth households contributed to the recent mortgage crisis.

We proceed with a two-stage least squares regression using the GINI index, household attributes, and their interactions as instrumental variables. In the first stage, we regress measures
of leverage on the GINI index and all the control variables included in the second stage. In the second stage, we regress foreclosure status on predicted leverage and control variables. The GINI index is an ideal instrument because the credit substitution thesis suggests that income inequality should be positively correlated with leverage, but not necessarily, with the incidence of foreclosure.

The credit substitution theory suggests that households with less income and education should be relatively more leveraged. Moreover, the combined effects of income, education, and other household attributes may predict credit scores, and thereby, mortgage default. But there are reasons other than leverage that may explain why some households default more often. In this regard, we also use property characteristics also as instruments recognizing their potential weakness.

1. Income and Education Interactions

As a first pass, we create household profiles by interacting income and education. We create six interactive dummy variables from the three household income classifications (HI, MI, LI) and the two education classifications (HE, LE). For example, a middle income household with low education is labeled MILE, and so on. These interactions allows us to assess simultaneously the effects of income and education on leverage rather than assuming that each affects leverage independently. The five other household characteristics remain as single instrumental variables. The resulting first-stage regression is expressed in equation (2).

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24 Ultimately, we create 72 unique profiles interacting most of the household attributes, and we present those results below in a more succinct format. This simplification of interacting only income and education allows us to present a full set of results using the most important variables.
Leverage for household $i$ are proxied by loan to income; loan to value; loan to purchase; and a loan interest indicator that equals 1 if the loan has a variable interest rate, and 0 otherwise. All leverage variables are expressed as percentages. We use a dummy variable for GINI where a value of 1 is assigned if the county has above-median income inequality, and 0, otherwise.\textsuperscript{25} We opt for this specification rather than a continuous variable because the credit substitution theory specifies a positive, but not necessarily monotonic, relationship between income inequality and leverage. $HH$ is a five-dimension vector of household income and education profiles. To avoid multicollinearity, we exclude the high income, high education (HIHE) household group from the regressions, and consequently, coefficients are interpreted relative to household reference group. $GINI \otimes HH$ is a vector of interaction variables that capture the marginal effects of income inequality on leverage for a given income and education profile. $OH$ is a vector of other household attributes. Finally, $CC$ is a vector of county characteristics (including the neighborhood spatial contagion effects) of the county in which the household resides.

\begin{equation}
Leverage_i = \alpha + \beta_1 GINI_i + \beta_2 HH_i + \beta_3 GINI_i \otimes HH_i + \beta_4 OH_i + \beta_5 CC_i + \epsilon
\end{equation}  

Regression results shown in Table 5 largely confirm the credit substitution thesis. The dependent variable in column 1 is loan to income. Because we expect the majority of MILE households experienced stagnant income growth in the past two decades, and (compared to lower income households) represent a large fraction of households in our sample, attention is focused on this household group. But other household groups can be evaluated similarly.

MILE households in counties with below median income inequality (low-Gini counties)

\textsuperscript{25}We also ran the tests splitting the Gini index into quintiles and the results are essentially unchanged.
have, on average, loan to income 109% higher than HIHE households. The marginal effect of county income inequality is captured by summing the coefficients from $GINI$ and $MILE \otimes GINI$ . The summed value of 29.7 indicates that, on average, MILE households in counties with above median income inequality (high-Gini counties) have loan to income ratios nearly 30% higher than MILE households residing in below median counties. This result is consistent with the credit substitution thesis but suggests that household attributes play a more important role than county income inequality in determining loan to income ratios.

Loan to value results in column 2 of Table 5 reveal a different leverage dynamic. MILE households in below median counties have loan to value 48% below HIHE education households, a statistically significant but economically small difference. However, MILE households in high Gini counties have loan to value 2% higher than their peers in low Gini counties. Loan to value for these households are affected more by income inequality in a given county. Loan to purchase results also support the credit substitution thesis. MILE households have loan to purchase 8.8% above HIHE households, and the marginal effect of income inequality is an additional increase in loan to purchase of 7.4%.

The final leverage proxy, the variable interest rate dummy, also points to strong effects from county inequality. Although there is no statistical difference in the percentage of variable interest rate loans between MILE and HIHE households in low Gini counties, MILE households in high Gini counties are 9% more likely to have variable interest rate loans than their peers in low Gini counties.

With one exception, our results hold up when we consider all low- and middle-income households, regardless of education levels. The exception is that low income households have
relatively low loan to value relative to HIHE households. However, even in this case, low income households in high Gini counties are more leveraged than similar households in low Gini counties. The bulk of the evidence is consistent with the credit substitution thesis.

Control variables in Table 5 are all statistically significant signs vary across regressions. Contagion is consistently positive, reflecting increased leverage in ‘hot spots’; and rurality is negative, reflecting the urban nature of the housing crisis. Coefficients are mixed on county economic variables – such as household income, population growth, and unemployment, and suggests that regional economic conditions are relative unimportant in driving the housing bubble.

In the second stage regressions, the logit model expressed in (3) regresses a limited dependent variable – household mortgage ($F$) in the 3rd quarter of 2008, on predicted leverage (Leverage*) from the first stage regressions together with the same county variables included in first stage regressions.\(^{26}\) $F$ equals 1 if the household is in foreclosure, and 0, otherwise.

\[
F_i = \alpha + \beta_1 \text{Leverage}_i^* + \beta_2 \text{CC}_i + \epsilon_i \tag{3}
\]

Second stage regressions results shown in Table 6 are consistent for the leverage variables. Panel A the results for each predicted leverage measure based on income and education groups separately, while Panel B1 includes the interaction of income and education for each leverage variable. When viewed separately, the coefficients on the predicted values of loan to income, loan to value and loan to purchase are positive for both middle income and low income groups compared with high income group. For the low education group, the default likelihood is

\(^{26}\)Because the floating rate measure is a binary variable, we use the inverse Mills ratio instead of the predicted value in that second stage regression.
significantly positively correlated with each leverage variable. The results are consistent when we interact income and education. In sum, for middle and low class households, the default likelihood is more highly correlated with their leverage. County control variables are consistent across all columns, and generally have the expected signs.

This measure computes the post-acquisition leverage on the house assuming that the original loan(s) to purchase the house was amortized and no new loans were taken. We can debate the exact formula to use, but the methodology is the following.

Panel A and Panel B of Table 6 also implies that a household who purchased a expensive house is \(1.65 \times \exp(0.5)\) times more likely to default than those who purchased less. The results are consistent regardless of each leverage variable. Moreover, households who use variable loans are more likely to default than those who use fixed-term loans. The odds ratios of defaults are 3.0 for households with variable loans after year 2005, vs. 1.9 for those with variable loans before year 2005.

We compute odds ratios in Panel B2 of Table 6 to provide economic significance metrics for the second stage regression coefficients. The odds ratios are computed relative to the HIHE household group by \(GINI\). Specifically, for MILE households in low \(GINI\) counties, we multiply the loan to income coefficient of 0.002 from second stage regressions by the MILE coefficient (109.0) from first stage regressions, which are the marginal changes in leverage relative to HIHE households. The resulting 1.21 value for loan to income implies that MILE households in low Gini counties are 1.21 times as likely to default than HIHE households. For MILE households in high \(GINI\) counties, we multiply the second stage coefficients by the marginal change in leverage, which is the sum of first stage coefficients on MILE, \(GINI\), and
The economic significance of coefficients on other leverage proxies is consistent. Odd ratios for loan to value show that MILE households in below median GINI counties are just 100% as likely as HIHE households to default. However, MILE households in above median GINI counties are 1.1 times as likely to default. For loan to purchase, the odds ratios consistently show that households are more likely to default relative to HIHE households, and households in above median GINI counties are more likely to default than households in below median GINI counties.

We decompose leverage into two components, acquisition leverage and post-acquisition leverage to distinguish household purchase and consumption components. First, we estimate what the remaining principal balance of the mortgage would be as of the 3rdQ 2008 if the borrower put down a relatively small down payment at purchase and financed the rest (either through one or more loans). We posited that a 5% downpayment with a 25 year maturity. The interest rate at origination was taken from the Fannie Mae website for 30 year fixed rate mortgages. Second, we subtract the current loan balance from the estimate remaining principal balance of the mortgage to get the post-acquisition leverage. We would expect it to be positively correlated with the variables that represent stagnant-income households in Table 5. This measure captures the marginal leverage—in other words, it approximates the leverage a household uses for consumption instead of home purchases.

Panel C1-3 of Table 6 examines how post-acquisition leverages are related to mortgage
defaults. We find that the coefficients of post-acquisition leverages are comparable to those of leverages respectively. Households who borrow more after purchasing a house are more likely to default that those who borrow less.

In sum, we find strong evidence for the credit substitution thesis and the evidence shows that post leverage plays a role in a higher incidence of mortgage foreclosure.

2. Detailed Household Interactions

In the analysis above, we created household profiles by interacting income and education, but the other household attributes entered the first stage regressions as stand-alone variables. This approach assumes that variables such as age and marital status affect the leverage of all households equally. Instead, we create 72 unique household profiles by interacting income and education with marital status, age, and tenure of residence.\textsuperscript{27} The trade-off for this more precise approach is that we are unable to present the full regression results in a tabular format because of the large number of variables. The base household, excluded from the regression to avoid multicollinearity, is high income, high education, married, elderly, and long tenure. We anticipate that such a household should have relatively low leverage.

We run the same regressions as in equations (2) and (3), except that the \textit{HH} vector contains 72 variables, and the \textit{OH} vector are combinations of net worth and household size. Of the 154 coefficients for the loan to income (loan to value) regression, 135 (130) are statistically

\textsuperscript{27}A household is classified as young if the head of household is less than 45 years old; elderly if more than 65 years old; and middle otherwise. Households that purchased a home before (after) the year 2000 have long (short) tenure. The 72 categories are created by the variable dimensions of 3x2x2x3x2. We omit from the interactions net worth and number of persons in the household because these variables are highly correlated with net income, and it helps to keep the results tractable.
significant, mostly at the 1% level, and the $R^2$ for both regressions is 22.9. First stage regression results are presented in Figures 2 and 3.

Figure 2 plots the average values of loan to income by household profile, tenure, and $GINI$. Values represent relative differences in loan to income by household profile using HIHE-Married-Elderly long-tenure households as the reference group. This profile was chosen as the reference group because we expect this household group to have the lowest leverage. Instead of plotting all 72 profiles on the horizontal axis, we split the sample by tenure because short tenure has a large positive effect on leverage. We also split the sample by median $GINI$. In all, four series are plotted, and loan to income values are sorted in descending order for short tenure, high $GINI$ households. Because loan to income for low income households are so much higher than for the other households, we split the chart at 350% loan to income and rescale it for middle-income and high-income households. Note that a short-tenure, high $GINI$ LIHE-Married-Middle (age) household has the highest leverage. As we observe household profiles from highest to lowest leverage, household income dominates the rankings. Indeed, the most leveraged high income household (HIHE, single and young) ranks in the top 24 out of the 36 profiles. Age is also important. Half of the top 18 households with high leverage are young, and just four are elderly. For a given tenure, the vertical distance between any two points represents the marginal effect of living in a high $GINI$ county relative to a low $GINI$ county. Loan to income across household profiles in high $GINI$ (70 of 72) counties are nearly always higher than in low $GINI$ counties. In addition, the marginal income inequality effect is the smallest for high income households.

Figure 3 repeats the exercise for loan to value. Again, loan to value for short tenure, high
GINI households are sorted in descending order. This time, age dominates the rankings. With just one exception, young households have higher leverage, followed by middle age and elderly. Beyond that, there is no clear pattern other than high- and middle-income households have higher loan to value than low-income households. Households who reside in high GINI counties have higher leverage than their low GINI peers in 63 of 72 cases.

The (unreported) results of second stage logit regressions of foreclosure status against predicted leverage are nearly identical to those shown in Table 6. Leverage estimates from more detailed household profiles contain little additional information about the likelihood of foreclosure. In sum, with the more detailed household profiles, we find that households in counties with more income inequality are more leveraged than similar households in counties with less income inequality in support for the credit substitution thesis. But the evidence that higher leverage leads to a higher incidence of mortgage foreclosure is still mixed.

E. Conclusion

Rajan (2010) argues that income inequality is a deep cause of the recent U.S. housing crisis because households with stagnant incomes use leverage to maintain consumption. Using nationwide databases on household profiles and foreclosures as of the 3rd quarter of 2008 we find evidence consistent with this thesis. Low and middle income households have relatively high leverage, especially in counties with high income inequality. Moreover, these households are more likely to default.

The central implication of our analysis is that easy access to credit by households with stagnant incomes will likely result in overleverage and defaults. This pattern should play out
regardless of the source of credit, be it mortgage debt, credit card debt, or some other source. Policies that successfully reduce income inequality should also reduce inappropriate demand for credit.
References


Appendix: Data Definitions

Acxiom data on household incomes are assigned values from 1 to 9.

1 = less than $15,000
2 = $15,000 - $19,999
3 = $20,000 - $29,999
4 = $30,000 - $39,999
5 = $40,000 - $49,999
6 = $50,000 - $74,999
7 = $75,000 - $99,999
8 = $100,000 - $124,999
9 = greater than $124,999

Years of education represent the total number of years of education of the head of household. Values range from 12 to 20.

12 = completed high school
14 = completed vocational or technical school
16 = completed college
20 = completed graduate school

Net worth, which is the difference between household assets and liabilities, is assigned a value from 1 to 11.

1 = less than or equal to $0
2 = $1-$4,999
3 = $5,000-$9,999
4 = $10,000-$24,999
5 = $25,000-$49,999
6 = $50,000-$99,999
7 = $100,000-$249,999
8 = $250,000-$499,999
9 = $500,000-$999,999
10 = $1,000,000-$1,999,999
11 = $2,000,000+
Figure 1: Counties with Significant Spatial Contagion
Figure 2: Loan to Income across Households Grouped by Income, Education, Marital Status, and Age

- Long tenure, low Gini
- Long tenure, high Gini
- Short tenure, low Gini
- Short tenure, high Gini
Figure 3: Loan to Value across Households Grouped by Income, Education, Marital Status, and Age

Panel B. Relative difference in LTV ratio by household profile, tenure and income inequality

- Long tenure, below median
- Long tenure, above median
- Short tenure, below median
- Short tenure, above median
Table 1: Households Attributes and Property Characteristics of Mortgage Foreclosure

This table presents household attributes and property characteristics classified by the foreclosure status of households as of the 3rd quarter of 2008. Households with annual incomes above $75,000 are classified as High Income (HI); with annual incomes between $30,000 and $75,000 as Middle Income (MI); and annual incomes below $30,000 as Low Income (LI). Households where the head of household completed at least vocational or technical school are classified as High Education (HE), and where the head of household completed only high school as Low Education (LE). Reported values are averages. a,b,c denote statistical significance at the 1%, 5%, and 10% levels, respectively, from the overall sample. See Appendix for variable definitions.

<table>
<thead>
<tr>
<th>Panel A: Households in Foreclosure</th>
<th>All</th>
<th>HI</th>
<th>MI</th>
<th>LI</th>
<th>HE</th>
<th>LE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household Income</td>
<td>5.97a</td>
<td>7.59a</td>
<td>5.47b</td>
<td>2.29b</td>
<td>6.28a</td>
<td>5.71b</td>
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<td>Education, years</td>
<td>14.16a</td>
<td>14.73a</td>
<td>13.87a</td>
<td>13.58a</td>
<td>16.77a</td>
<td>12.00</td>
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<td>Net Worth</td>
<td>6.58a</td>
<td>7.29a</td>
<td>6.24a</td>
<td>5.71a</td>
<td>6.80a</td>
<td>6.39a</td>
</tr>
<tr>
<td>Single, %</td>
<td>30.4a</td>
<td>22.43a</td>
<td>33.28a</td>
<td>49.21a</td>
<td>29.83a</td>
<td>30.88a</td>
</tr>
<tr>
<td>Age, years</td>
<td>45.25a</td>
<td>46.11a</td>
<td>44.51a</td>
<td>46.30a</td>
<td>46.78a</td>
<td>43.98a</td>
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<tr>
<td>Number of Residents</td>
<td>3.55</td>
<td>3.72b</td>
<td>3.48a</td>
<td>3.31a</td>
<td>3.59</td>
<td>3.52b</td>
</tr>
<tr>
<td>Length of Residence, years</td>
<td>6.69a</td>
<td>6.59a</td>
<td>6.66a</td>
<td>7.21a</td>
<td>6.81a</td>
<td>6.58a</td>
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<td>Purchase to Median Purchase, %</td>
<td>92.60a</td>
<td>90.01a</td>
<td>97.40a</td>
<td>72.16b</td>
<td>92.09a</td>
<td>93.02b</td>
</tr>
<tr>
<td>Loan to Purchase, %</td>
<td>140.06a</td>
<td>137.81a</td>
<td>140.55a</td>
<td>148.11a</td>
<td>139.46a</td>
<td>140.57a</td>
</tr>
<tr>
<td>Loan to Value, %</td>
<td>87.64a</td>
<td>87.58a</td>
<td>88.03a</td>
<td>85.31a</td>
<td>86.83a</td>
<td>88.32a</td>
</tr>
<tr>
<td>Loan to Income, %</td>
<td>440.68a</td>
<td>318.01a</td>
<td>399.07a</td>
<td>1303.13a</td>
<td>429.38a</td>
<td>450.10a</td>
</tr>
<tr>
<td>Variable Interest Loan, %</td>
<td>53.39a</td>
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<td>51.54a</td>
<td>48.52a</td>
<td>54.05a</td>
<td>50.54a</td>
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</table>

<table>
<thead>
<tr>
<th>Panel B: Households not in Foreclosure</th>
<th>All</th>
<th>HI</th>
<th>MI</th>
<th>LI</th>
<th>HE</th>
<th>LE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>6.21</td>
<td>7.82</td>
<td>5.46</td>
<td>2.26</td>
<td>6.64</td>
<td>5.68</td>
</tr>
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<td></td>
<td>All</td>
<td>HI</td>
<td>MI</td>
<td>LI</td>
<td>HE</td>
<td>LE</td>
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<td>---------------------------</td>
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<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td><strong>Education, years</strong></td>
<td>14.87</td>
<td>15.66</td>
<td>14.36</td>
<td>13.68</td>
<td>17.18</td>
<td>12.00</td>
</tr>
<tr>
<td><strong>Net Worth</strong></td>
<td>7.00</td>
<td>7.52</td>
<td>6.64</td>
<td>6.30</td>
<td>7.20</td>
<td>6.75</td>
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<tr>
<td><strong>Single, %</strong></td>
<td>23.17</td>
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<td>43.06</td>
<td>22.11</td>
<td>24.73</td>
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<td>53.12</td>
<td>59.76</td>
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<td><strong>Length of Residence, years</strong></td>
<td>9.73</td>
<td>9.45</td>
<td>9.81</td>
<td>10.70</td>
<td>9.62</td>
<td>9.88</td>
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<td><strong>Purchase to Median Purchase, %</strong></td>
<td>96.99</td>
<td>97.87</td>
<td>99.59</td>
<td>74.17</td>
<td>98.77</td>
<td>94.52</td>
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<td><strong>Loan to Purchase, %</strong></td>
<td>127.22</td>
<td>124.23</td>
<td>130.19</td>
<td>130.74</td>
<td>124.33</td>
<td>131.35</td>
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<tr>
<td><strong>Loan to Value, %</strong></td>
<td>62.97</td>
<td>62.60</td>
<td>64.01</td>
<td>58.79</td>
<td>62.29</td>
<td>63.91</td>
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<td><strong>Loan to Income, %</strong></td>
<td>269.51</td>
<td>212.25</td>
<td>258.25</td>
<td>777.47</td>
<td>267.30</td>
<td>272.61</td>
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<tr>
<td><strong>Variable Interest Loan, %</strong></td>
<td>18.50</td>
<td>19.39</td>
<td>16.96</td>
<td>21.52</td>
<td>18.50</td>
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</table>

**Panel C: All Households**

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>HI</th>
<th>MI</th>
<th>LI</th>
<th>HE</th>
<th>LE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Household Share, %</strong></td>
<td>100.00</td>
<td>44.39</td>
<td>46.34</td>
<td>9.26</td>
<td>55.46</td>
<td>44.54</td>
</tr>
<tr>
<td><strong>Default Rate per 1000 Households</strong></td>
<td>3.52</td>
<td>2.91(^a)</td>
<td>4.14(^a)</td>
<td>3.36(^a)</td>
<td>2.87(^a)</td>
<td>4.33(^a)</td>
</tr>
</tbody>
</table>
Table 2: Mortgage Shares and Foreclosure Rates at County Level

This table presents summary statistics for mortgage shares and foreclosure rates at the county level. The county GINI Coefficient in year 2000 and Rurality Index in year 2003, which reflect income inequality and distinguishes metropolitan from non-metropolitan counties by population and size respectively, are from Burkey, M. (2006) and the Economic Research Service of the U.S. Department of Agriculture. The average Household Income and Unemployment Rate between 2000 and 2007 by county are from the U.S. Census Bureau and Bureau of Labor Statistics respectively. The cumulative growth rates in GDP per Capita between 2000 and 2007 by county are from the Bureau of Economic Analysis. The House Price Appreciation between 2000 and 2007 by county is computed from the Federal Housing Financing Agency House Price Index of average price changes on repeat sales of single-family house prices whose mortgages are purchased or securitized by Fannie Mae or Freddie Mac. The cumulative growth rates in Population and Housing Units between 2000 and 2007 by county are from the U.S. Census Bureau.
<table>
<thead>
<tr>
<th>Indicator</th>
<th>County</th>
<th>Household Share %</th>
<th>Default Rate per 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>GINI Coefficient, 2000</td>
<td>Average</td>
<td>0.44</td>
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<tr>
<td></td>
<td>High: Above</td>
<td>0.46</td>
<td>61.47</td>
</tr>
<tr>
<td></td>
<td>Low: Below</td>
<td>0.40</td>
<td>38.53</td>
</tr>
<tr>
<td>Rurality Index, 2003</td>
<td>Average</td>
<td>1.65</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High Urban</td>
<td>1.43</td>
<td>93.57</td>
</tr>
<tr>
<td></td>
<td>Low Urban</td>
<td>4.94</td>
<td>6.43</td>
</tr>
<tr>
<td>Household Income 00-07,</td>
<td>Average</td>
<td>41.52</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High: Above</td>
<td>53.24</td>
<td>73.52</td>
</tr>
<tr>
<td></td>
<td>Low: Below</td>
<td>35.03</td>
<td>26.48</td>
</tr>
<tr>
<td>GDP per Capita Growth Rate 00-</td>
<td>Average</td>
<td>1.17</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High: Above</td>
<td>1.63</td>
<td>45.07</td>
</tr>
<tr>
<td></td>
<td>Low: Below</td>
<td>0.79</td>
<td>54.93</td>
</tr>
<tr>
<td>Unemployment Rate 00-07, %</td>
<td>Average</td>
<td>4.68</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High: Above</td>
<td>5.60</td>
<td>44.59</td>
</tr>
<tr>
<td></td>
<td>Low: Below</td>
<td>3.94</td>
<td>55.41</td>
</tr>
<tr>
<td>House Price Appreciation 00-07,</td>
<td>Average</td>
<td>5.35</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High: Above</td>
<td>8.12</td>
<td>58.29</td>
</tr>
<tr>
<td></td>
<td>Low: Below</td>
<td>4.15</td>
<td>41.71</td>
</tr>
<tr>
<td>Population Growth Rate 00-07,</td>
<td>Average</td>
<td>1.35</td>
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<tr>
<td></td>
<td>High: Above</td>
<td>2.56</td>
<td>48.30</td>
</tr>
<tr>
<td></td>
<td>Low: Below</td>
<td>0.23</td>
<td>51.70</td>
</tr>
<tr>
<td>Housing Unit Growth Rate 00-07,</td>
<td>Average</td>
<td>1.74</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High: Above</td>
<td>2.93</td>
<td>47.13</td>
</tr>
<tr>
<td></td>
<td>Low: Below</td>
<td>0.68</td>
<td>52.87</td>
</tr>
</tbody>
</table>
Table 3: Differences in Household Attributes and Property Characteristics of Mortgage Foreclosure

This table compares attributes and property characteristics across households classified by their mortgage foreclosure status and the income inequality of the counties in which they reside. Counties with above-median income inequality are categorized as High GINI, and below-median income inequality, as Low GINI. Households with annual incomes above $75,000 are classified as High Income (HI); with annual incomes between $30,000 and $75,000 as Middle Income (MI); and annual incomes below $30,000 as Low Income (LI). Households where the head of household completed at least vocational or technical school are classed as High Education (HE), and where the head of household completed only high school as Low Education (LE). Reported values are the differences the mean values between High and Low GINI counties across household groups by mortgage foreclosure status expressed in percentage terms. a,b,c denote statistical significance at the 1%, 5%, and 10% levels, respectively. See Appendix for variable definitions.
# High GINI - Low GINI

## Panel A: Households in Foreclosure

<table>
<thead>
<tr>
<th>Variable</th>
<th>All</th>
<th>HI</th>
<th>MI</th>
<th>LI</th>
<th>HE</th>
<th>LE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Household</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td>-0.06</td>
<td>0.10</td>
<td>-0.05</td>
<td>-0.06</td>
<td>0.02</td>
<td>-0.13</td>
</tr>
<tr>
<td>Education, years</td>
<td>0.11</td>
<td>0.22</td>
<td>0.05</td>
<td>-0.01</td>
<td>0.08</td>
<td>0.00</td>
</tr>
<tr>
<td>Net Worth</td>
<td>-0.03</td>
<td>0.17</td>
<td>-0.12</td>
<td>-0.23</td>
<td>0.06</td>
<td>-0.11</td>
</tr>
<tr>
<td>Single, %</td>
<td>3.64</td>
<td>1.15</td>
<td>4.61</td>
<td>4.65</td>
<td>3.58</td>
<td>3.70</td>
</tr>
<tr>
<td>Age, years</td>
<td>1.04</td>
<td>1.00</td>
<td>0.99</td>
<td>0.92</td>
<td>1.26</td>
<td>0.77</td>
</tr>
<tr>
<td>Number of residents</td>
<td>-0.10</td>
<td>-0.10</td>
<td>-0.10</td>
<td>-0.12</td>
<td>-0.10</td>
<td>-0.11</td>
</tr>
<tr>
<td>Length of residence, years</td>
<td>0.29</td>
<td>0.26</td>
<td>0.29</td>
<td>0.23</td>
<td>0.25</td>
<td>0.30</td>
</tr>
<tr>
<td><strong>Property</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchase to median purchase, %</td>
<td>-4.22</td>
<td>-7.80</td>
<td>-1.00</td>
<td>-2.65</td>
<td>-7.19</td>
<td>-1.77</td>
</tr>
<tr>
<td>Loan to purchase, %</td>
<td>5.81</td>
<td>-5.47</td>
<td>11.46</td>
<td>21.48</td>
<td>0.13</td>
<td>10.52</td>
</tr>
<tr>
<td>Loan to value, %</td>
<td>2.22</td>
<td>1.55</td>
<td>3.07</td>
<td>-0.08</td>
<td>1.46</td>
<td>2.87</td>
</tr>
<tr>
<td>Loan to income, %</td>
<td>77.89</td>
<td>33.62</td>
<td>62.35</td>
<td>165.05</td>
<td>56.49</td>
<td>95.83</td>
</tr>
<tr>
<td>Variable interest loans, %</td>
<td>6.13</td>
<td>4.99</td>
<td>7.55</td>
<td>2.37</td>
<td>4.46</td>
<td>6.09</td>
</tr>
</tbody>
</table>

## Panel B: Households not in Foreclosure

<table>
<thead>
<tr>
<th>Variable</th>
<th>All</th>
<th>HI</th>
<th>MI</th>
<th>LI</th>
<th>HE</th>
<th>LE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Household</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Income</td>
<td>-0.08</td>
<td>0.13</td>
<td>-0.08</td>
<td>-0.06</td>
<td>-0.01</td>
<td>-0.21</td>
</tr>
<tr>
<td>Education, years</td>
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<td>0.26</td>
<td>0.14</td>
<td>0.03</td>
<td>0.08</td>
<td>0.00</td>
</tr>
<tr>
<td>Net Worth</td>
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<td>-0.15</td>
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<td>Single, %</td>
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<td>2.80</td>
<td>3.32</td>
<td>2.76</td>
<td>2.52</td>
</tr>
<tr>
<td>Age, years</td>
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<td>1.51</td>
<td>0.91</td>
<td>-0.75</td>
<td>1.31</td>
<td>1.08</td>
</tr>
<tr>
<td>Property</td>
<td>Number of residents</td>
<td>Length of residence, years</td>
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</tr>
<tr>
<td>----------------------------------------------</td>
<td>---------------------</td>
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<tr>
<td></td>
<td>-0.05(^a)</td>
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<td>-0.06(^a)</td>
<td>0.47(^a)</td>
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<td>0.40(^a)</td>
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<tr>
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<td>0.02(^a)</td>
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<td>0.44(^a)</td>
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<tr>
<td>Purchase to median purchase, %</td>
<td>-0.86(^a)</td>
<td>-0.58(^a)</td>
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<td></td>
<td>0.24</td>
<td>-3.71(^a)</td>
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<td>-0.42(^a)</td>
<td>-1.67(^a)</td>
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<td>Loan to purchase, %</td>
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<td>3.36(^b)</td>
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<td>8.71(^a)</td>
<td>17.09(^a)</td>
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<tr>
<td></td>
<td>3.92(^b)</td>
<td>10.63(^a)</td>
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<td>Loan to value, %</td>
<td>0.10(^a)</td>
<td>-0.49(^a)</td>
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<tr>
<td></td>
<td>0.88(^a)</td>
<td>0.68(^a)</td>
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<td>-0.14(^a)</td>
<td>0.51(^a)</td>
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<tr>
<td>Loan to income, %</td>
<td>30.98(^a)</td>
<td>19.13(^a)</td>
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<tr>
<td></td>
<td>21.69(^a)</td>
<td>27.43(^a)</td>
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<tr>
<td></td>
<td>30.11(^a)</td>
<td>32.46(^a)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable interest loans, %</td>
<td>2.43(^a)</td>
<td>2.47(^a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.34(^a)</td>
<td>2.49(^a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.23(^a)</td>
<td>2.52(^a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4: Contagion in Household Mortgage Default

This table reports the mortgage shares and mortgage default rates of households in counties that exhibit high and low spatial contagion. The LISA statistic for each county is computed using two alternative proximity weight matrices: one based on adjacency, and the other, on centroid distance.

\[
I_i = \frac{(y_i - \bar{y}) \sum_j W_{ij} (y_j - \bar{y})}{\sum_i (y_i - \bar{y})^2 / N}
\]

where \( y \) is the vector of mortgage default rate deviations from the average across counties; \( \bar{y} \) is the mean of \( y \); \( W \) is a proximity weight matrix, and \( N \) is the total number of counties. Counties with LISA statistics that are statistically significant at the 5% are classified as high spatial contagion counties and low spatial contagion counties otherwise. The results are consistent across both weighting matrix structures. \(^{a,b,c}\) denote statistical significance at the 1%, 5%, and 10% levels.

<table>
<thead>
<tr>
<th></th>
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<th>High Spatial Contagion</th>
<th>Low Spatial Contagion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>HI</td>
<td>MI</td>
</tr>
<tr>
<td><strong>Adjacency</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household Share, %</td>
<td>27.05</td>
<td>49.41</td>
<td>42.58</td>
</tr>
<tr>
<td>Default Rate per 1000</td>
<td>7.10a</td>
<td>5.55a</td>
<td>8.84a</td>
</tr>
<tr>
<td><strong>Centroid Distance</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Household Share, %</td>
<td>30.53</td>
<td>48.09</td>
<td>43.18</td>
</tr>
<tr>
<td>Default Rate per 1000</td>
<td>6.71a</td>
<td>5.41a</td>
<td>8.24a</td>
</tr>
</tbody>
</table>
Table 5: First Stage Regressions of Household Leverage

Columns 1 to 3 report least squares regressions of household leverage, column 4 reports least squares regressions of household purchase decision, and Column 5, the logistic regression of interest loan type, against income, education, marital status, age, household size, net worth, and tenure of residency, controlling for contagion and the economic characteristics of counties to which the households belong. Column 5-8 report least squares regressions of household post-acquisition leverage again the same controls. High income-high education households are used as the reference group. a,b,c denote statistical significance at the 1%, 5%, and 10% levels.
## Loan to Income

<table>
<thead>
<tr>
<th>Variable</th>
<th>PostAcq-Lev to Inc</th>
<th>PostAcq-Lev to Value</th>
<th>PostAcq-Lev to Adj. Purchase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-277.63 *** 124.51 *** 74.75 *** -277.63 *** 124.51 ***</td>
<td>-231.65 *** 305.59 * -0.08</td>
<td>-3.39 *** 170.24 *** 0.32 ***</td>
</tr>
<tr>
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## F-statistic

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## R²

|   | 21.79 22.76 0.09 21.79 22.76 |
|---|---|---|---|
Table 6: Second Stage Logistic Regressions of Household Mortgage Default

Table reports logistic regressions of household mortgage default against predicted household leverage and interest loan type from first stage regressions of household leverage and interest loan type against income, education, marital status, age, household size, net worth, and tenure of residency, controlling for contagion and the economic characteristics of counties to which the households belong.  \(^{a,b,c}\) denote statistical significance at the 1%, 5%, and 10% levels.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Intercept</th>
<th>Loan to Income_MI</th>
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<th>Loan to Income_LE</th>
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<th>Variable Interest Loans 05after</th>
<th>Variable Interest Loans 05before</th>
<th>Value to Purchase</th>
<th>Contagion: Adjacency</th>
<th>Rurality Index</th>
<th>Household Income</th>
<th>House Price Appreciation 00-07</th>
<th>Population Growth Rate 00-07</th>
<th>Housing Unit Growth Rate 00-07</th>
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<th>Unemployment Rate 00-07</th>
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Panel A1: Foreclosure: Yes = 1 / No = 0

Wald Statistics

Pseudo $R^2$
## Panel A2: 

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<tr>
<td>Loan to Value_LE</td>
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<tr>
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<td>Housing Unit Growth Rate 00-07, %</td>
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## Panel B1: Foreclosure: Yes = 1 / No = 0

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*Note: *** denotes statistical significance at the 1% level.*
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<td>Loan to Purchase</td>
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### Panel C1:

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<td>Pur to Med Pur 00after</td>
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<td>Variable Interest Loans 05after</td>
</tr>
<tr>
<td>Variable Interest Loans 05before</td>
</tr>
<tr>
<td>Value to Purchase</td>
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<tr>
<td>Contagion: Adjacency</td>
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<tr>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
</tr>
<tr>
<td>Rurality Index</td>
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<tr>
<td>Household Income</td>
</tr>
<tr>
<td>House Price Appreciation 00-07, %</td>
</tr>
<tr>
<td>Population Growth Rate 00-07, %</td>
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<tr>
<td>Housing Unit Growth Rate 00-07, %</td>
</tr>
<tr>
<td>GDP per Capita Growth Rate 00-07, %</td>
</tr>
<tr>
<td>Unemployment Rate 00-07, %</td>
</tr>
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<td>Wald Statistics</td>
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<td>Pseudo R-squared</td>
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<td>Variable Interest Loans 05after</td>
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<td>Variable Interest Loans 05before</td>
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<td>House Price Appreciation 00-07, %</td>
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<td>Population Growth Rate 00-07, %</td>
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<td>Housing Unit Growth Rate 00-07, %</td>
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<td>GDP per Capita Growth Rate 00-07, %</td>
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Panel C3: Foreclosure: Yes = 1 / No = 0

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<td>PostAcq LTP_LI</td>
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<td>Pur to Med Pur 00after</td>
<td>0.580 ***</td>
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<td>-0.007 ***</td>
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<td>Housing Unit Growth Rate 00-07, %</td>
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<td>0.020 ***</td>
<td>0.022 ***</td>
<td>0.026 ***</td>
<td>0.032 ***</td>
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<td>-0.311 ***</td>
<td>-0.307 ***</td>
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IV. Geographic Concentration of Residential Foreclosures: Household Demographics and Spatial Contagion

Abstract: We use Spatial Statistics (Anselin, 1988, 1990) to analyze data of residential foreclosures at county level to account for the unusual concentration of foreclosures observed in the south Pacific, east North Central, and south Atlantic regions. We show that spatial correlation at county level plays an important role in explaining the large number of mortgage defaults that clustered in these regions. Refining our data with Acxiom Corporation’s household demographic data, we construct income-education indicators for each U.S. county and provide evidence on the relations between mortgage default and socio-economic composition of county populations.

A. Introduction

The residential foreclosure crisis that struck U.S. housing market since 2007 were unusual in at least two aspects. First, foreclosures were mostly concentrated in regions of the United States with vibrant economies prior to 2007 – specifically in California, Florida, Arizona and Nevada. Second, foreclosures were higher in counties largely populated by households with relatively high incomes and education levels than in counties populated by households with lower incomes and levels of education. It is therefore highly plausible that foreclosures were prompted by causes other than economic factors – regional recession and rising unemployment, in particular.

This paper attempts to explain this unusual concentration of foreclosures observed in the south Pacific, east North Central, and south Atlantic regions. We obtain foreclosure data from RealtyTrac and household and housing characteristics from Axiom Corporation to conduct our
analysis. Employing the Spatial Durbin Model (SDM) of Anselin (1990, 1995), we construct measures of spatial correlation across households that incorporate the adjacency effects of contiguous counties.

Foreclosure at the county level exhibit significant spillover. County default rates are spatially correlated with neighboring counties. Our results are robust to alternative definitions of adjacency, either measured by the distance between centroid points of pair-wise counties, or as a dummy variable that equals 1 when adjacent counties share the same boundary or corner points, and 0, otherwise.

In addition, we categorize the population in each county into six income-education groups and provide evidence on the relations between mortgage default and socio-economic composition of county populations. The six groups are generated by interacting three levels of income, namely, HI (above 75,000 in annual income), MI (between $30,000 and $74,999) and LI (below $29,999), and two levels of education, namely, HE (over 12 years’ of education) and LE (12 years or below). Unlike other research that analyze the pure effects of income and/or education averages for each U.S. county, which masks the distribution of each dimension, our data and methodology allow us to study each population group and introduce new evidence on the relations between mortgage defaults on the density of certain population groups.

Controlling for spatial correlation, county default rates were positively correlated with average household income in the county, as well as, with the percentage of middle-income, low education households that reside in the county. Household income was not the sole determinant of mortgage default, contrary to the thesis that home foreclosures were primarily the result of predatory lending to low income households. The number of foreclosures is greater in densely
populated counties with higher percentages of households that simply went too far in purchasing homes they could not afford. Households went into foreclosure when income was insufficient to cover interest payments and the refinancing option became unavailable when housing prices declined.

Research using similar spatial methodology include Leonard and Murdoch (2009) and Harding, et al. (2009). In Leonard and Murdoch (2009), the authors estimate that a foreclosure within 250 feet adversely affects housing price by about $1,666, after accounting for the spatial dependence of housing prices and in the errors of models and other known factors impacting sale price of a home. Similarly, Harding, Rosenblatt and Yao (2009) show that contagion from nearby foreclosure amounts to about 1% decline in local housing price per foreclosed property and diminishes quickly with the increased distance to the distressed property. Both papers focus on the effects of foreclosure on housing price changes, but not on the determinants of foreclosure itself.

The rest of this paper is organized as follows. Section B reviews the current literature on residential default models and introduces spatial correlation methods. Data descriptions are presented in the next section. Section D reports our empirical results. Section E concludes.

B. Residential Default Models

1. Frictionless Default Model

An extensive literature on mortgage default is summarized in Quercia and Stegman (1992). “Ruthless” or strategic default (Fabozzi, Ramsey, and Marz, 2000) is a real option whose value depends only on the prevailing riskfree rate of interest and volatility of home prices (Foster
and Van Order, 1984, 1985; Epperson et al., 1985). The decision to exit through default by exercising the implied American put option is solely dependent on the value of the home relative to the size of the outstanding mortgage, which will be the same across households who own identical properties. Because no transaction cost is assumed in the Frictionless Option Model (Vandell 1995, Archer et al. 1996), it is not surprising the model fails to find compelling empirical support.

Borrower traits impact mortgage default decisions. Vandell and Thibodeau (1985) point to transaction costs – damage to one’s credit rating, relocation costs, and psychological costs, associated with the household default decision. Riddiough (1991) finds that trigger events such as divorce, unemployment, or illness either considered in isolation or interacted with negative equity precipitate mortgage default. Moreover, as Vandell (1995) notes, the Frictionless Option Model neglects the role of the lender on mortgage default – namely that, bank capital and solvency considerations influence the willingness of the lender to renegotiate the original terms of the mortgage. Transactions costs and the possibility of prepayment through refinancing changes the threshold values at which households will exercise their put options to default, and thereby, the timing of strategic default (Kau, Keenan and Kim 1994). In a friction-adjustable mortgage default model, Kau and Slawson (2002) imbed the impact of transactions costs and heterogeneity in homeowners. Moreover, as Deng et al. (2000) find, the heterogeneity and subjective valuation of properties also affect household default decisions. Given the complexity of the household default decision, omitted variable bias is an important source of errors in mortgage default studies (Pavlov, 2001; An et al., 2004; Deng et al., 2005).

More importantly, as Can (1998) observes, “neighborhood” affects residential purchase
and household default decisions. Households with similar social, economic, and demographic attributes will cluster together. Using survey data to study household default propensities, Guiso et al. (2009) find that households will default only when the equity shortfall is severe. Social and moral norms constrain household default, but the social stigma from default wanes when the percentage of households in foreclosure rises. Further, Deng et al. (2005) note that households in affluent counties tend to refinance, and relocate into and out of communities, at a higher rate.

2. Spatial Default Model

Because homeowners with similar traits tend to cluster in neighborhoods, it is likely that many of the latent variables that influence household default are spatially correlated. High foreclosure rates in real estate “hot” spots such as California, Nevada, and Florida, strongly suggest that neighborhoods affect mortgage foreclosures.

In this paper, we introduce a Spatial Default Model (Anselin, 1988; Anselin, 1990) to account for the spatial dependencies of household defaults, which also takes into consideration, economic fundamentals and household demographics. The disturbance terms of spatially correlated events violate the identical and independence assumptions of ordinary-least-squares (OLS) regressions. Spatial models that explicitly recognize the geographic dependencies of events provide more realistic inference, better prediction, and more efficient parameter estimation (Pace, Barry and Sermans, 1998).

The spatial correlation of outcomes around a local neighborhood is computed as follows:
where $y_i, y_j$ refers to $y$ valued at locations $i$ and $j$. The $i, j$ pair has a spatial interpretation based on the underlying connectedness of the neighborhood. Because $y_i$ depends on neighboring outcomes, we can formulate this relationship in a spatial autoregressive process as in Lesage and Pace (2009).

$$y_i = \rho \sum_{j=1}^{n} W_{ij} y_j + \varepsilon_i$$

$$\varepsilon_i \sim N(0, \sigma^2) \quad i = 1, \ldots, n$$

where $W_{ij}$ is the element at the $i^{\text{th}}$ row and the $j^{\text{th}}$ column of the weight matrix $W$. The term, $\sum_{j=1}^{n} W_{ij} y_j$, which is the spatial lag, is simply a linear combination of values taken by neighboring observations. The weight matrix reflects pairwise proximities across locations.

More weight is typically given to close neighbors, and less weight, to distant neighbors. We construct the weight matrix in two ways. In the first, weights equal the inverse distance squared in miles between the centroid points across pairs of counties. In the second, weights are dummy variables based on the contiguity of two counties – equal to 1, if two counties share a boundary, and 0 otherwise.

Spatial models take into consideration the geographic spillover effects of mortgage default. Li (2011) uses sheriffs’ foreclosure sale data to examine the relationship between residential mortgage default and neighborhoods. She finds that residential foreclosure rates are positively correlated with neighborhood differences in economic and demographic
characteristics – the percentage of population that is black, the percentage of households where the head of household is female, median household income, and unemployment rate. Moreover, she finds that a high default rate in one region affects the default rate of a nearby region when their housing markets overlap. Specifically, high foreclosure rates and declining home values in region $i$ lead to declining home values in region $j$ that precipitates high foreclosure rates in that region. The interaction between default in a region and its neighboring region is captured by the spatial correlation coefficient.

Considering the spatial dependence of default and homeowner characteristics, we introduce the Spatial Durbin Model (Anselin, 1988). This model specified in (3) incorporates a spatial lag for dependent and independent variables.

$$y = \rho Wy + X\beta + WX\gamma + u$$
$$u \sim N(0, \sigma^2 I)$$

where $y$ is a vector of county default rates; spatially lagged default rates, $Wy$, are weighted default rates in surrounding counties; and $\rho$, is the coefficient of spatial correlation. $X$ is a matrix of explanatory variables, and $WX$, the corresponding matrix of spatially lagged explanatory variables. $u$ is a vector of errors.

Exploratory spatial data analysis commonly starts with Moran’s $I$ (Moran, 1950) and the Moran scatterplot (Anselin, 1996) to test whether the dependent variable is spatially correlated. Moran’s $I$ is defined in equation (4) as
\[ I = \frac{\sum_i \sum_j W_{ij} (y_i - \bar{y})(y_j - \bar{y})}{\sum_i (y_i - \bar{y})^2 / N} \]

where \( y \) is the variable of interest; \( \bar{y} \) is the mean of \( y \); \( W_{ij} \) is the weight matrix based on the proximity structure, and \( N \), the total number of observations. Moran’s \( I \) ranges from -1 (perfect negative) to +1 (perfect positive) spatial correlation. The null hypothesis that spatial correlation is absent is rejected when the \( p \)-value that \( I = 0 \) is small.

Moran’s \( I \) can be decomposed into Local Indicators of Spatial Association (LISA) that quantifies the degree to which a given episode impacts surrounding regions (Anselin, 1995). For each location, we compute a LISA index as:

\[ I_i = \frac{(y_i - \bar{y}) \sum_j W_{ij} (y_j - \bar{y})}{\sum_i (y_i - \bar{y})^2 / N} \]

The summation of LISA indices across locations is proportional to the Moran’s \( I \).

In the next section, we present our data and compute Moran’s \( I \) and LISA indices for our sample of U.S. residential mortgage defaults. We use these statistics to evaluate the spatial dependency of defaults. As will become evident, accounting for the geographic distribution of foreclosures provides important insights on mortgage default and implications for public policy.

C. Data and Variables

1. Mortgage Foreclosure Rates
Our mortgage default rates ($DR$) are calculated as the ratio of the total number of notices of default or sale issued to households divided by the total number of mortgaged properties in each county. Default and sale notices were obtained from Realty Trac, and the number of mortgaged properties, from the U.S. Census Bureau. A “notice of default” occurs when the borrower misses three or more monthly payments and the lender issues a notification of default. Should the borrower fail to modify the terms of the mortgage and reaffirm good standing, a “notice of sale” is then served on the borrower, which specifies the date and place of the public auction. There were a total of 217,088 mortgage foreclosures across 41 states and the District of Columbia in our sample over the third quarter of 2008 – a peak period for mortgage foreclosures.

Because the default rate, which ranges between 0 to 1, is not normally distributed, we take a logistic transform.

$$\text{Log } DF = \log \left( \frac{DR}{1-DR} \right)$$

Observe from the default heat map shown in Figure 1 that mortgage defaults are distributed unevenly across counties and highly clustered in certain regions of the U.S. We use Moran’s $I$ (Moran, 1950) and the Moran scatterplot (Anselin, 1996) discussed in Section II-B to formally test for spatial correlation in county default rates. Our computed Moran’s $I$, with a $p$-value less than 0.0001, confirms significant spatial correlation in mortgage foreclosures.

To visualize the spatial effect, we show the Moran scatter plot in Figure 2 and the interaction between default $y$ and lagged default $Wy$ in Figure 3. From both plots, it is readily
apparent that default is positively correlated to spatially lagged default. The red (dark) spots in the figures concentrate in most counties in California, counties in Arizona and Nevada adjacent to California, and some counties in Florida. Residential mortgage defaults and the spatial dependence of defaults were higher in these counties.

Figure 4 maps the important LISA counties where local spatial dependencies contribute to global spatial association. The map substantiates the regional contagion in mortgage defaults. Counties with significant LISA indices congregate in California, Arizona, Florida, northern New York, and West Virginia.

2. Household Demographics and Leverage

Two additional datasets, referred to as “Real Property” and “Consumer”, respectively, were used to compile household demographics. Both datasets were provided by the Acxiom Corporation in Little Rock, Arkansas. The “Real Property” dataset, covering 59.5 million housing units, presents information on the housing choice of consumers, with details on home purchase, loan information (loan value, interest rate type), and other features of the house (purchase price, and market value estimates). The “Consumer” database, covering 191 million households, contains household demographics (marital status, education, age, number of children) and household finance (net worth, and estimated income). These two datasets were merged based on the property address and the first and last name of the head of household – 44 million individual properties across 45 states and the District of Columbia. The merged

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28 Acxiom uses these databases to customize mailing lists or target advertising to specific consumer segments for its clients
29 Five of the least populated states are missing from the database: Maine, Vermont, New Hampshire, South Dakota, and Kansas.
datasets were further consolidated with a RealtyTrac foreclosure dataset containing 13 million households. In the resulting final dataset, there were 46,584 households in foreclosure, representing a nationwide default rate of 3.5 per 1,000 households.

To construct household profiles, we classified households into 6 income-education groups. Income has 3 levels – HI (at or above 75,000 in annual income), MI (between $30,000 and $74,999) and LI (at or below $29,999). Education has 2 levels – HE (over 12 years’ of education) and LE (12 years or below). The interaction generates 6 groups: High Income High Education (HIHE), High Income Low Education (HILE), Middle Income High Education (MIHE), Middle Income Low Education (MILE), Low Income High Education (LIHE), and Low Income Low Education (LILE). Households from Alaska and Hawaii were deleted because these states were not adjacent to any other state, as was North Dakota and Mississippi, which had missing values on requisite data. The resulting sample encompassed 875 counties across 41 states and the District of Columbia.

Using 5-digit county codes (FIPS), aggregate household profiles at the county level were then formed in one of two ways. First, in each county, we counted the number of households belonging to each income-education group and divided by the total number of households to arrive at a percentage. Second, we calculated a rank score for each income-education group by assigning to each household the sum of its income (1 through 9 from lowest to highest) and education (1 for low or 2 for high education) rank. In each county, the rank score for each income-education group is the sum total of rank scores across households in the income-education group divided by the number of households.

Similarly, we also aggregate other household characteristics at county level. AGE is the
median age of the head of the household. Household size, denoted as $HSIZE$, is the county median number of people residing in the same residence. $SING$ is the ratio of single to married household. $LENG$ is the average length of residence. Our household finance variables are $INCO$, the median household income of the county, and $NETW$, the median household networth.

Importantly, joint decisions on the amounts spent on home purchase and financed by debt, which determine household “indebtedness”, will impact the likelihood of mortgage default by households. We define loan-to-value ($LTV$) as the ratio between the initial mortgage loan at the time of house purchase over the estimated market value of the house. Similarly, loan-to-income ($LTI$) is the ratio of initial loan over a household’s estimated income. We set $Over-Leverage$ equal to 1 when a household spent more than the median home purchase in the same county-year, and incurred a larger loan (in terms of loan-to-income ratio) than the median in the income-education group to which the household belongs, and 0, otherwise. In our robustness checks, we also measure over-leverage by comparing to the income-education group median of loan-to-purchase or loan to value.

Our $Leverage$ measure at the county level, $LEV$, is the percentage of households that over-extended themselves in their home purchase and loan decisions weighted by the population of the county relative to the total population across counties. Weighting by population density is important because the likelihood of contagion in mortgage default will depend on the size of neighborhoods. When a county is sparsely populated, decisions of households will weakly influence their closest neighbors, but will strongly influence, in densely populated areas. Assigning a population density weight reflects our sense that overreaching behavior is more significant in high density areas.
3. Other Social and Economic Determinants of Default

During the housing boom, many of the subprime loans made were variable interest rate loans, especially in the hottest markets. In California, for example, about 60% of all loans in the year 2005 were interest-only or payment-option ARMs.\textsuperscript{30} These loans allowed borrowers to qualify for (bigger) homes than otherwise because lenders based loan decisions on the low initial monthly payments. We use the ratio of variable to fixed interest loans, $VAR$, to proxy for the credit risk embedded in mortgages in a given county. We expect this variable to be positively correlated with default risk.

Population growth proxies for population mobility and market demand, and housing unit growth, with the supply of residential properties. We obtain population and housing unit growth rates, denoted as $POPG$ and $HOUG$, respectively, between 2000 and 2008 from the U.S. Census Bureau and HMDA. The Census Bureau also provides the percentage of the white population in 2008. We calculate the ratio of white to non-white households, $WHIT$, to measure ethnic differences across counties, which we expect to be negatively correlated with default probability. Chan et al. (2010) find that mortgage default rates were higher in predominantly black communities regardless of the borrower’s own race, using a database from New York City.

Additionally, we control for housing market trends. On the one hand, home price appreciation provides an equity cushion for homeowners in delinquency. Homeowners can avoid foreclosure by prepaying loans through refinancing or property sale. On the other hand, stagnating or falling home prices provide fewer opportunities to exit the foreclosure process.

Home price appreciation by county should be negatively correlated with default rate. Quarterly house price indices are obtained from the Federal Housing Finance Agency.

We use four variables to evaluate the effect of home prices on mortgage defaults. The first variable is $LHPI$, the log transform of the House Price Index in 2000, which is the benchmark price level before the rise in home prices. All else equal, we expect higher initial home prices to be positively correlated with default rates because many of the defaults are from coastal areas with relatively high home values. The second variable is $DHPI_{0006}$, the annual price appreciation between 2000 and 2007, calculated by averaging the annual price changes. Counties with the highest appreciation during this period should have higher default rates in subsequent years because rising home prices either invite more keeping up with the Jones’s behavior or attract speculative investors and house ‘flippers’. The last variable, price volatility ($VOL$), quantifies the temporal dynamics of the housing market.

Next, we control for local economic conditions. Utilizing data from the Bureau of Labor Statistics, we calculate the average unemployment rate ($UNEM$) between 2005 and 2007 by county, and from the Bureau of Economic Analysis, real GDP per capita growth by state ($GDPG$). We also distinguish between rural and urban areas using the rurality index ($RURA$), which is computed by the Economic Research Service of U.S. Department of Agriculture.\textsuperscript{31} The variable takes values from 1 (urban) to 9 (rural) based on population and adjacency to metro areas.

Finally, we control for GINI coefficients measured in year 2000 to indicate the level of income distribution inequality in each county. Theoretically, GINI coefficients ranges from 0 to

\textsuperscript{31}http://www.ers.usda.gov/Briefing/Rurality/RuralUrbCon/
1, with 0 representing perfect equality. The mean and median for our sample are both 0.43, with an interquartile range of 0.41 to 0.45. Our data are taken from the U.S. Census.

For ease of reference, a summary of the key variables is included as Appendix 1.

D. Empirical Results

Summary statistics on state foreclosure rates and LISA indices are reported in Table 1. The Pearson correlation coefficients between foreclosure and LISA is 0.547 and significant at 1% level. California has the highest default rate, 6.621 per thousand households, in our sample. The mean spatial correlation is 2.199 across neighboring counties in California. Neighborhood effects are more significant in the top five default states than in all other states.

Table 2 shows the summary statistics for county level variables. The mean (median) county default rate is 2.74 (1.46) per thousand population. The mean (median) of LISA statistics is 0.38 (0.11). Middle income households make up the largest share of households in each county, followed by high income households. Low income households, on average, make up 13% of the households across counties. Approximately two-thirds of the households in high income groups are also highly educated, with a college degree or higher. In contrast, about two-thirds of the low income group also have low levels of education, with twelve or fewer school years.

The last column of Table 2 are the Pearson correlation coefficients between county default rates and all other variables. Default rate is significantly and positively correlated with LISA at 0.78 – county defaults were impacted by defaults in neighboring counties. Consistent with Table 2, default is also positively correlated with household income, net worth, education, and
proportion of single homeowners. Age is negatively correlated with default. Households with recently purchased homes, high loan to value, and variable interest rate mortgages, are more likely to default. Default is positively correlated with home price appreciation between 2000 and 2006, and negatively correlated, with home price appreciation between 2006 and 2008. Finally, default is more likely to occur in urban regions relative to rural regions, and in minority communities relative to less diverse communities.

Table 3 reports the distribution of household profiles and default shares across county default quintiles. The six household profiles are constructed by interacting income and education. Middle income households with low education (MILE) are more likely to default than other groups with default rate 4.72 per thousand households. For each county quintile, MILE is the group with highest default rate. If a household defaults, it is 32.41% likely to be a middle-income class with low education. For each income group, households with low education are more likely to default than those with high education. For top quintile, the default rate of MILE is almost twice of default rate of the peers for all counties. The default distribution of six profiles are consistent across county quintiles.

Table 4 compares the determinants of default between high and low cluster regions. The sample is divided based on the median of county LISAs. The mean default rate is 6.639 per thousand households in counties with high spatial correlation, and 1.64 per thousand households, at counties with low spatial correlation. The mean and median default rate across high and low cluster regions are significantly different at 0.1% level. There are more households with seniors as head of household, and the Gini index is relatively higher, in high spatially correlated counties. Further, the median ratio of variable loans to total debt is 0.227 in high spatially
correlated counties, almost double that in low spatially correlated counties. In 2000, there are no significant differences in housing prices across the two subsamples. After 2000, however, the change in housing prices were greater in high spatially correlated counties. Home prices appreciated 8.3% per year on average during 2001-2006 and depreciated 4.7% per year after subprime mortgage crisis in year 2007 in high spatially correlated areas. Contagion in default is more significant on variable interest rate mortgages and in regions that experienced significant appreciation in home prices.

Prior research that examine default at the county or zip code level, average out many aspects of geographic diversity (e.g., Mian and Sufi, 2009, and others). Our analysis, which accounts for the spillover effects, offers a distinct advantage in predicting default after controlling the spatial contagions of mortgage default.

County data allows us to categorize and disentangle the factors of default into pure and spatial effects which provide insights on the geographic clustering of defaults. Pure effects capture homeowner and property characteristics, and spatial effects, the spillover effects from adjacency. Again, adjacency in measured in two different ways – the first, as the distance between centroid points of pair-wise counties, and the second, as a dummy variable that equals 1 when adjacent counties share the same boundary or corner points, and 0, otherwise.

We use Spatial Durbin Model (SDM) of Anselin(1988) to isolate factors that impact areas with high spatial correlation in default rates. As shown in Figure 2, default is not evenly distributed across the country. Counties in California, Florida, and Arizona experienced much higher likelihoods of default. Non-spatial default models do not account for geographic imbalances.
Table 5 presents the linear regressions of LISA on county level economic and demographic variables. LISA is calculated from equation (5) using a centeroid distance weight matrix (left panel) and adjacency matrix (right panel). Household income and education averages across counties are not significantly related to LISA.

Table 5 shows, however, that higher percentages of LILE and MIHE groups in the county are associated with spatial contagion. Overreaching by MILE households also contribute to contagion. The cluster of household defaults within county is stronger as the rank score of HILE, LILE, and MIHE groups increase. The “hot” spots of defaults are also driven by younger households. In addition, LISA is significantly positively correlated with ratio of variable to fixed interest loans, GDP growth rate, and ratio of white to non-white population.

Table 6 uses the Spatial Durbin Model (SDM) of Anselin (1988) to predict county level foreclosure. The weight matrix in the left panel is based centeroid distance, and adjacency, in the right panel. In both models, the spatial autocorrelation coefficient is positive and significantly different from zero. County default rates correlate positively with neighborhood proximity.

Regression coefficients, adjusted for the latent spatial influence on household default, reveal that affluent counties, with higher average household income, experience higher levels of default compared to poorer counties. A robustness check eliminating counties in the 90th and higher income percentile confirms the positive impact of household income on default. Counties with higher average education also had higher, but statistically insignificant, default rates. In addition, consistent with prior literature, average default rates are lower in counties with a higher proportion of senior households, and higher, in counties with relatively larger households,
more singles as head of household, and higher incidence of variable interest loans.

Regression coefficients of the percentage of households in the income-education groups confirm the confluence of income and education in describing foreclosure suggested by the above results. Default is lowest for the baseline HIHE group as indicated by high and statistically significant negative intercepts. Default is also lower when the percentage of the LIHE group in the county is higher. Further, the positive and significant leverage coefficients confirm that county defaults are more severe as the percentage of overreaching households increases. Counties with a larger percentage of MILE households who overbought and overborrowed have higher foreclosure rates.

An advantage of the SDM model is that it can distinguish between the direct impact of an explanatory variable on the default rate in the county itself, and the indirect impact from all other regions. In Panel B and C of Table 6, we decomposed effects of each explanatory variable on mortgage defaults into direct and indirect effects. The total impact of income on default rate is 0.25, of which 88% of the effect is from the county itself and 12% are spillover effects from neighboring counties. Home price appreciation between 2000 and 2007 significantly increases the likelihood of default. The spillover effect from home price appreciation accounts for more than one half of total default risk. Although state GDP growth decreases mortgage default risk, the overall impact will diminish when GDP growth in nearby states is low. Moreover, a county income inequality significantly increases the default rate. The effect of income inequality on default rates spills over to the surrounding counties. The overall effect of GINI on default rate is 10.8, of which 68% of the effect is from the neighbor counties. This implies that an uneven development of regions has an adverse effect on the default risk of all regions.
In summary, strong spatial correlations in foreclosures at the county level explain clusters of real-estate “hot” markets. In addition, the results lend support to the overreaching hypothesis. Foreclosures are higher in counties with higher average incomes and higher percentage of households who overbought and overborrowed – MILE households, in particular.

E. Conclusion

We utilize foreclosure and household data to construct county-level measures of mortgage default and population compositions at U.S. counties and apply spatial statistics to examine the relations between aggregate default and socio-economic characters of household groups in each county. We find that spatial correlation plays a significant role in mortgage defaults. Defaults cluster on the east and west coasts where incomes and home prices are higher. In these regions, borrowers relied heavily on adjustable rate loans presumably to make monthly payments manageable. Wall Street banks were complicit in devising creative financing products to enable households to purchase homes. Once home prices stopped rising, the credit cycle collapsed, resulting in a wave of foreclosures.
References


Figure 1: Heat Map of Mortgage Default across Counties
Figure 2: Moran Scatterplot of Mortgage Default
Figure 3: Counties with Influence

Figure 4: Counties with Significant Spatial Correlation
Table 1: Summary Statistics on Mortgage Default Rates and Spatial Contagion

Table presents household mortgage default and spatial contagion at the county level across 41 states and the District of Columbia. The spatial impact of a certain county’s mortgage foreclosure on its neighboring counties is evaluated by Local Indicator of Spatial Association (LISA) indices which are calculated as follows:

\[ I_i = \frac{(y_i - \bar{y}) \sum_j W_{ij} (y_j - \bar{y})}{\sum (y_j - \bar{y})^2 / N} \]

where \( y_i \) is the default rate of the \( i^{th} \) county; \( \bar{y} \) is the mean of \( y \); \( W \) is the weight matrix based on the proximity structure, and \( N \) is the total number of counties.

<table>
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<th>County</th>
<th>Default Rate</th>
<th>Mean</th>
<th>Median</th>
<th>Std</th>
<th>Q1</th>
<th>Q3</th>
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<td>-0.01</td>
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<td><strong>Total</strong></td>
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<td><strong>2.46</strong></td>
<td><strong>0.36</strong></td>
<td><strong>0.13</strong></td>
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### Table 2: Summary Statistics on Household Demographics and Macroeconomic Conditions

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<th></th>
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<th>Q1</th>
<th>Q3</th>
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<td>1.94</td>
<td>12.00</td>
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<td>0.17 (000)</td>
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<tr>
<td>HIHE, %</td>
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<td>13.50</td>
<td>30.76</td>
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<td>HILE, %</td>
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<td>11.12</td>
<td>5.20</td>
<td>7.71</td>
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<tr>
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<td>4.56</td>
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</tr>
<tr>
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<td>29.56</td>
<td>8.34</td>
<td>23.20</td>
<td>34.59</td>
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</tr>
<tr>
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<td>2.07</td>
<td>2.53</td>
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</tr>
<tr>
<td>LILE, %</td>
<td>8.71</td>
<td>7.47</td>
<td>5.54</td>
<td>4.33</td>
<td>11.86</td>
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<td>726.62</td>
<td>16.44</td>
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</tr>
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<td>2.09</td>
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<td>1.83</td>
<td>2.31</td>
<td>-0.13 (000)</td>
</tr>
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<td>1.50</td>
<td>2.16</td>
<td>-0.19 (000)</td>
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<td>0.11</td>
<td>0.14</td>
<td>0.31</td>
<td>-0.27 (000)</td>
</tr>
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<td>0.18</td>
<td>0.14</td>
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<td>-0.28 (000)</td>
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<td>0.66</td>
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<td>7.00</td>
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<td>3.00</td>
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<td>LTV</td>
<td>VAR</td>
<td>LHPI2000</td>
<td>DHPI0007</td>
<td>POPG</td>
</tr>
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<td>-------</td>
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<td>----------</td>
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</tr>
<tr>
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<td>7.60</td>
<td>62.63</td>
<td>0.16</td>
<td>4.85</td>
<td>0.05</td>
<td>11.31</td>
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<tr>
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<tr>
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<td>2.72</td>
<td>14.92</td>
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<td>0.03</td>
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<td></td>
<td>5.85</td>
<td>53.00</td>
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<td>0.08</td>
<td>16.30</td>
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<td>0.22</td>
<td>0.45</td>
<td>0.17</td>
<td>0.25</td>
<td>0.22</td>
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<tr>
<td></td>
<td>(.001)</td>
<td>(000)</td>
<td>(000)</td>
<td>(000)</td>
<td>(000)</td>
<td>(000)</td>
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Table 3: Distribution of household profiles and default shares

Counties are grouped into quintiles by default rates. For each quintile, the table reports the distribution of household profiles and default shares. The default rates for each household profile are also calculated across county quintiles.

<table>
<thead>
<tr>
<th>County Default Rate</th>
<th># of obs.</th>
<th>HIHE</th>
<th>HILE</th>
<th>MIHE</th>
<th>MILE</th>
<th>LIHE</th>
<th>LILE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong> share of sample</td>
<td>29.99%</td>
<td>14.46%</td>
<td>22.28%</td>
<td>24.02%</td>
<td>3.23%</td>
<td>6.03%</td>
<td></td>
</tr>
<tr>
<td>share of defaults</td>
<td>20.14%</td>
<td>16.55%</td>
<td>22.06%</td>
<td>32.41%</td>
<td>3.04%</td>
<td>5.81%</td>
<td></td>
</tr>
<tr>
<td>default rate per 1000 pop</td>
<td>13,320,198</td>
<td>2.35</td>
<td>4.00</td>
<td>3.46</td>
<td>4.72</td>
<td>3.30</td>
<td>3.37</td>
</tr>
<tr>
<td><strong>Top 20%</strong> share of sample</td>
<td>32.16%</td>
<td>15.87%</td>
<td>21.48%</td>
<td>22.53%</td>
<td>2.93%</td>
<td>5.03%</td>
<td></td>
</tr>
<tr>
<td>share of defaults</td>
<td>20.48%</td>
<td>16.90%</td>
<td>21.83%</td>
<td>32.11%</td>
<td>3.01%</td>
<td>5.66%</td>
<td></td>
</tr>
<tr>
<td>default rate per 1000 pop</td>
<td>5,419,150</td>
<td>4.08</td>
<td>6.83</td>
<td>6.52</td>
<td>9.14</td>
<td>6.59</td>
<td>7.22</td>
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<tr>
<td><strong>4/5</strong> share of sample</td>
<td>32.74%</td>
<td>15.13%</td>
<td>21.18%</td>
<td>22.85%</td>
<td>2.81%</td>
<td>5.28%</td>
<td></td>
</tr>
<tr>
<td>share of defaults</td>
<td>20.19%</td>
<td>16.09%</td>
<td>22.35%</td>
<td>32.50%</td>
<td>2.79%</td>
<td>6.08%</td>
<td></td>
</tr>
<tr>
<td>default rate per 1000 pop</td>
<td>3,390,158</td>
<td>1.54</td>
<td>2.66</td>
<td>2.64</td>
<td>3.56</td>
<td>2.49</td>
<td>2.88</td>
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<tr>
<td><strong>3/5</strong> share of sample</td>
<td>29.76%</td>
<td>14.15%</td>
<td>22.54%</td>
<td>23.96%</td>
<td>3.30%</td>
<td>6.29%</td>
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<td>17.77%</td>
<td>14.57%</td>
<td>23.71%</td>
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<td>6.58%</td>
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<tr>
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<td>2,013,833</td>
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<td>1.37</td>
<td>1.81</td>
<td>1.63</td>
<td>1.37</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-----------</td>
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<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>2/5 share of sample</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td>share of defaults</td>
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<td>10.67%</td>
<td>25.42%</td>
<td>28.62%</td>
<td>4.26%</td>
<td>8.50%</td>
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<td>default rate per 1000 pop</td>
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<td>0.24</td>
<td>0.55</td>
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<td>0.75</td>
<td>0.45</td>
<td>0.41</td>
</tr>
<tr>
<td>Bottom 20% share of sample</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>share of defaults</td>
<td>21.06%</td>
<td>10.87%</td>
<td>25.68%</td>
<td>29.35%</td>
<td>4.29%</td>
<td>8.75%</td>
<td></td>
</tr>
<tr>
<td>default rate per 1000 pop</td>
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<td>0.08</td>
<td>0.06</td>
<td>0.15</td>
<td>0.32</td>
<td>0.02</td>
<td>0.05</td>
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Table 4: Comparisons Across High and Low Spatial Correlation Counties

The full sample is partitioned into two subsamples according to national median of Local Indicator of Spatial Association (LISA). The p-values of T-test and Wilcoxon Rank test are reported in the parentheses. Statistical significance at 1%, 5%, and 10% are denoted as ***, **, and *, respectively.

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<th>Low Spatial Correlation</th>
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<tr>
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</tr>
<tr>
<td>LILE, RANK</td>
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</tr>
<tr>
<td>NETW</td>
<td>6.71</td>
</tr>
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<td>AGE</td>
<td>53.69</td>
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<tr>
<td>HSIZE</td>
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<td>Mean</td>
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<td>----------</td>
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<tr>
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<tr>
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<td>VAR</td>
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<td>LHPI2000</td>
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<tr>
<td>DHPI0007</td>
<td>0.08 (0.000)</td>
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<tr>
<td>POPG</td>
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<td>HOUG</td>
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<td>GDPG</td>
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<td>WHIT</td>
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<tr>
<td>RURA</td>
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<tr>
<td>GINI</td>
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# of Obs. 143 732
Table 5: Impact of Household Demographics and Macroeconomic Conditions on Spatial Correlations

The dependent variable is the spatial correlation, LISA statistics. On the left panel, the weight matrix is constructed by the inverse of distance squared between each pair of centroid points. On the right panel, the weight takes the binary value. If two counties share the common boundary, weight takes value one, and zero otherwise. Statistical significance at 1%, 5%, and 10% are denoted as ***, **, and *, respectively.

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<tr>
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<th>Proximity_Neighborhood</th>
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<td>HILE, %</td>
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<td>MIHE, %</td>
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</tr>
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<tr>
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<td>LILE, %</td>
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<td>MIHE, RANK</td>
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<tr>
<td>MILE, RANK</td>
<td></td>
</tr>
<tr>
<td>LIHE, RANK</td>
<td></td>
</tr>
<tr>
<td>LILE, RANK</td>
<td></td>
</tr>
<tr>
<td>LEV</td>
<td></td>
</tr>
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<td></td>
<td>HILE, RANK*LEV</td>
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<td>----------</td>
<td>----------------</td>
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<tr>
<td></td>
<td>0.00 (0.14)</td>
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<td></td>
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<td>Variable</td>
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<td>GDPG</td>
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<td>UNEM</td>
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<tr>
<td>RURA</td>
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<tr>
<td>GINI</td>
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<tr>
<td>Intercept</td>
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<td>Adj. R-square</td>
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</tr>
<tr>
<td># of obs.</td>
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Table 6: Mortgage Default Rates and Spatial Contagion

The dependent variable is log transformation of default rate (Log DF). Spatial Durbin Model (SDM) adds lagged dependent variable and lagged independent variable to traditional OLS model. In the left panel, the weight matrix is constructed by the inverse of distance squared between each pair of centroid points. In the right panel, the weight takes the binary value. If two counties share the common boundary, weight takes value one, zero otherwise. The direct impacts and indirect impacts from Spatial Durbin Model. Direct impact is calculated by averaging all diagonal values in matrix $S_r(W)$ for the $r^{th}$ explanatory variable. Indirect impact is the average of all off-diagonal values in $S_r(W)$. In SDM model, $S_r(W) = (I - \rho W)^{-1}(I\beta + W\gamma_r)$.

| Panel A: | Proximity_Distance | | Proximity_Neighborhood |
|---|---|---|---|---|
| | Mod1 | Mod2 | Mod3 | Mod4 | Mod5 | Mod6 |
| RHO | 0.76 (0.00) | 0.65 (0.00) | 0.64 (0.00) | 0.46 (0.00) | 0.42 (0.00) | 0.41 (0.00) |
| INC | 0.22 (0.01) | 0.27 (0.01) | 0.28 (0.00) | 0.31 (0.00) | 0.28 (0.00) | 0.31 (0.00) |
| EDU | 0.03 (0.27) | 0.07 (0.05) | 0.01 (0.68) | 0.05 (0.16) | 3.58 (0.15) | 3.24 (0.08) |
| HILE, % | 2.42 (0.33) | 2.86 (0.11) | 1.79 (0.18) | 2.41 (0.08) | 3.24 (0.08) | 2.41 (0.08) |
| MIHE, % | -9.82 (0.06) | -8.36 (0.12) | -9.82 (0.06) | -8.36 (0.12) | 3.34 (0.22) | 2.59 (0.37) |
| LIHE, % | -9.82 (0.06) | -8.36 (0.12) | -9.82 (0.06) | -8.36 (0.12) | 3.34 (0.22) | 2.59 (0.37) |
| LILE, % | 0.30 (0.34) | 0.48 (0.14) | 0.42 (0.05) | 0.42 (0.05) | 0.42 (0.05) | 0.42 (0.05) |
| HILE, RANK | 0.30 (0.34) | 0.48 (0.14) | 0.42 (0.05) | 0.42 (0.05) | 0.42 (0.05) | 0.42 (0.05) |
| MIHE, RANK | 0.32 (0.14) |


<table>
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<tr>
<th>Variable</th>
<th>Estimate 1</th>
<th>Std. Error 1</th>
<th>Estimate 2</th>
<th>Std. Error 2</th>
<th>Estimate 3</th>
<th>Std. Error 3</th>
<th>Estimate 4</th>
<th>Std. Error 4</th>
<th>Estimate 5</th>
<th>Std. Error 5</th>
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<th>Std. Error 6</th>
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<td>0.08</td>
<td>0.69</td>
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<tr>
<td>LIHE, RANK</td>
<td>-2.08</td>
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<td>-1.92</td>
<td>0.06</td>
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<td></td>
</tr>
<tr>
<td>LILE, RANK</td>
<td>0.39</td>
<td>0.64</td>
<td>0.31</td>
<td>0.72</td>
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</tr>
<tr>
<td>HILE, RANK*LEV</td>
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## Appendix 1: Variable Description

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<td>GINI index as of 2000</td>
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Appendix 2

Household income is expressed as a value from 1 to 9 as follows.

1 = less than $15,000;
2 = $15,000 - $19,999;
3 = $20,000 - $29,999;
4 = $30,000 - $39,999;
5 = $40,000 - $49,999;
6 = $50,000 - $74,999;
7 = $75,000 - $99,999;
8 = $100,000 - $124,999;
9 = greater than $124,999.

Net worth ranges from 1 to 11 as follows.

1=less than or equal to $0;
2=$1-$4,999;
3=$5,000-$9,999;
4=$10,000-$24,999;
5=$25,000-$49,999;
6=$50,000-$99,999;
7=$100,000-$249,999;
8=$250,000-$499,999;
9=$500,000-$999,999;
10=$1,000,000-$1,999,999;
11=$2,000,000+.
V. Conclusion

In the first essay, we explain why a robust link between independent directors on boards and firm value. Boards dominated by powerful independent directors increase shareholder’s valuations of those companies. Sudden director death event study regressions show causation to flow from powerful independent directors to shareholder valuations. These results validate measuring not just directors’ status as independent, but also their power – their ability to access information, draw on external resources, and mobilize support to question and, if necessary, defy CEOs bent on strategies that risk destroying shareholder wealth and exposing directors to lawsuits.

In the second essay, we examine Rajan (2010) credit substitution for income hypothesis that income inequality is a deep cause of the recent U.S. housing crisis because households with stagnant incomes use leverage to maintain consumption. Using nationwide databases on household profiles and foreclosures as of the 3rd quarter of 2008 we find evidence consistent with this thesis. Low and middle income households have relatively high leverage, especially in counties with high income inequality. Moreover, these households are more likely to default.

In the last essay, we utilize foreclosure and household data to construct county-level measures of mortgage default and population compositions at U.S. counties and apply spatial statistics to examine the relations between aggregate default and socio-economic characters of household groups in each county. We find that spatial correlation plays a significant role in mortgage defaults. Defaults cluster on the east and west coasts where incomes and home prices are higher. In these regions, borrowers relied heavily on adjustable rate loans presumably to make monthly payments manageable.