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ECONOMIC SHOCKS, COMPETITION AND MERGER ACTIVITY

MARCIN W. KROLIKOWSKI

(Corresponding Author). Assistant Professor of Finance.
School of Business
Providence College

KEVIN OKOEGUALE

Finance School of Economics and Business Administration
Saint Mary's College of California

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SUMMARY: I. INTRODUCTION. II. DATA. III. HYPOTHESIS DEVELOPMENT & EMPIRICAL APPROACH. 1. HYPOTHESES DEVELOPMENT. IV. EMPIRICAL APPROACH. V. ENDOGENEITY. VI. EMPIRICAL ANALYSIS. 1. UNIVARIATE ANALYSIS: DEREGULATED INDUSTRIES. 2. UNIVARIATE ANALYSES: "HIGH-TECH" INDUSTRIES. VII. MULTIVARIATE TESTS: FULL SAMPLE. VIII. MULTIVARIATE TESTS: DEREGULATED AND HIGH-TECH INDUSTRIES. IX. CONCLUSION. X. ACKNOWLEDGEMENTS. XI. REFERENCES.

Abstract

This study seeks to understand "how" economic shocks drive industry merger activity. We test whether economic shocks from deregulation and technological change drive industry merger activity by increasing industry competition, controlling for the effect of valuations. We find that these shocks drive merger activity through three channels related to industry competition; deregulation drives merger activity by increasing entry and cash flow volatility; technological change drives merger activity by increasing entry and inter-firm dispersion in the quality of production technology. These findings underscore the role of the competitive mechanism in how managers reallocate assets via mergers and support the view that the industry-level clustering of merger activity is an efficiency-driven restructuring response to increased competition.

Keywords

Mergers; Deregulation; Technological Change; Competition; Efficiency

JEL Classification: G34; G38

I. INTRODUCTION

In 2000 the aggregate value of mergers between public U.S. targets and public acquirers was over $940 billion based on data from Security Data Company's (SDC) M&A database. Six industries consisting of deregulated and high-tech industries –petroleum and natural gas, utilities, banking, communication, computer software, and electronic equipment– collectively accounted for more than two-thirds of the total activity in 2000. The evidence from existing merger research shows that merger activity, as in 2000, tends to cluster within a few industries during periods of high aggregate merger activity. But it isn't clear what mechanism, and whether it is efficient, is responsible for this industry-level clustering of merger activity.

The merger literature provides a number of alternative theories on the drivers of merger activity. Some theories are clearly linked to efficiency and others are not. For example, the economic shocks theory considers mergers as an efficiency-driven response to changes to industry structure brought about by economic, regulatory or technological shocks. In contrast, the misvaluation theory considers the primary driver of mergers to be stock market misvaluations, although it is plausible that a merger driven by misvaluation could end up providing some efficiency benefits if synergies exist. Similarly, mergers based on hubris and collusion theories, where the primary drivers are overconfidence and hubris, respectively, could also provide efficiency benefits if synergies exist. Therefore, an attempt to determine whether mergers are motivated by efficiency by simply testing for efficiency-improvements following mergers would likely be unsuccessful.

Harford (2005) asserts that once an economic, regulatory or technological shock occurs, managers simultaneously react and then compete for the best or most efficient combination of assets. But "how" these shocks efficiently drive merger activity is yet to be adequately studied or understood. This study takes a new approach to testing whether mergers are efficiency-driven, by investigating specifically the role of the competitive mechanism in "how" economic shocks from deregulation and technological change drive merger activity, controlling for the effect of valuations. A main virtue of competition emphasized in the economics literature is its role as a mechanism that stimulates internal efficiency (Ros, 1999). Using a sample of 6,943 M&A transactions involving public U.S. targets and public acquirers in 48 industries and for the period from 1980 to 2009, we show empirically that economic shocks from deregulation and technological change drive merger activity by increasing industry competition. This supports the view that the industry-level clustering of merger activity is an efficiency-driven restructuring response to increased competition.

Prior research provides strong empirical evidence linking the industry-level clustering of merger activity in the 1980s and 1990s to changes to industry structure brought about by economic shocks from deregulation (Mitchell and Mulherin, 1996; Mulherin and Boone, 2000; Andrade et al., 2001). Jovanovich and Rousseau (2002) use a Q-theory model of mergers to show that the high merger activity levels of the 1980s and 1990s were a response to profitable reallocation opportunities attributable to economic shocks from technological change. However, there still exists a gap in our understanding of "how" economic shocks from deregulation and technological change drive merger activity, providing an avenue for investigating the effect of competition on merger activity. While the economic literature contains well-established and testable hypotheses on the effects of competition on efficiency, the theoretical effects of competition on mergers is less clear.

We begin our investigation by documenting the patterns of M&A activity over the 30-year sample period and confirm that merger activity in the 1980s and 1990s clusters at the industry-level, with deregulation and technological change playing important roles. Deregulated industries account for 31% of the total value of M&A activity in the 1980s and 51% in the 1990s. The industries impacted by major deregulation events in the 1990s – petroleum and natural gas, utilities, communication, and banking – also account for about 36% of the total value of M&A activity in the 2000s. Eight industries classified as "high-tech" by the OECD (Organization for Economic Co-operation and Development) based on R&D intensity, account for 18%, 38% and 39% of the total value of M&A activity in the 1980s, 1990s and 2000s, respectively. This study extends the analysis in prior research by introducing evidence from the 2000s and from "high-tech" industries, as evidence from Winston (1993) indicates that deregulated industries account for an increasingly less significant percentage of the U.S. economy post the 1970s.

We hypothesize that economic shocks from deregulation and technological change drive merger activity through three channels related to industry competition: entry, cash flow volatility and inter-firm dispersion in the quality of production technology. Deregulation and technological change increase competition by removing or reducing barriers to entry. An increase in entry is expected to increase the feasible set of merger possibilities. Cash flow volatility is expected to increase as competition increases with entry; higher cash flow volatility or lower correlation between firms' cash flows is expected to increase the probability of exit via bankruptcy, with mergers providing an alternative means of exit. An increase in inter-firm dispersion in the quality of production technology is expected to result from technological change because firms adapt to new technologies at different rates, and is expected to increase potential merger synergies.

We use the Q-theory model of mergers (Jovanovich and Rousseau, 2002) to illustrate how economic shocks from deregulation and technological change would lead to an increase in inter-firm dispersion in Tobin's Q and in merger activity by increasing competition, consistent with the stylized fact that high market-to-book firms (M/B – proxy for Tobin's Q) buy lower M/B firms. Deregulation and the arrival of new technology allow the set of input-output combinations to expand (Jovanovich and Rousseau, 2001), given that, regulatory constraints on firms' operating activities and risk-taking behavior artificially restrict the size and scope of firms' activities in the presence of significant economies of scale and scope. Economic theory suggests that as entry increases following deregulation, in the presence of significant economies of scale and scope, firms will be operating at higher per-unit costs. So, to the extent that deregulation permits mergers, one expects that the increase in entry would be accompanied by an increase in merger activity that takes advantage of available economies of scale and scope to reduce per-unit costs. Mergers move assets to more valued uses (Maksimovic and Phillips, 2001).

The univariate evidence shows that the increases in industry M&A activity, following major deregulation events during the 1990s, are associated with increases in industry competition. Industry competition, measured by either the level of entry (the number of firms or the level of industry concentration), increased after the deregulation events in the petroleum and natural gas, communication and banking industries. Periods of high cash flow volatility are associated with the increases in competition following deregulation in the petroleum and natural gas, utilities and communication industries. We also find that the high levels of M&A activity observed in the late 1990s and early 2000s in "high-tech" industries were preceded by high levels of competition and high rates of R&D investment, which contributed to the excess capacity associated with the Nasdaq stock market crash of 2000 and the U.S. recession of 2001. For the "high-tech" industries, the correlation between the rate of R&D investment and the measures of industry competition is highly positive.

The main result from the multivariate regressions, using the full sample panel data, is that industry M&A activity is positively associated with the level of entry and cash flow volatility. The result is robust to controlling for the effect of potential stock market misvaluation and variation in the investment opportunity set. This evidence underscores the role of competition in how managers reallocate assets via mergers. In order to draw clearer inferences about the channels through which economic shocks from deregulation and technological change drive merger activity, we run separate sub-sample regressions for deregulated and "high-tech" industries. We examine whether the channels differ in their importance to deregulation and technological change.

The deregulated industries in the sample – petroleum and natural gas, utilities, communication, banking and transportation – are industries impacted by major deregulation events since the late 1970s. As noted earlier, the "high-tech" industries in the sample – medical equipment, pharmaceutical, aircraft, computer hardware, computer software, electronic equipment, and measuring & control – are industries classified as "high-tech" by the OECD based on R&D intensity. Although the communication industry qualifies as both a deregulated and a "high-tech" industry it is treated as a deregulated industry for the purpose of this analysis.

For the deregulated industries, we find that industry M&A activity is positively associated with level of entry and cash flow volatility, but we do not find evidence of an association between industry M&A activity and inter-firm dispersion in the quality of production technology. For "high-tech" industries, we find that industry M&A activity is positively associated with the level of entry and inter-firm dispersion in the quality of production technology. These findings imply that while the entry channel is important to both deregulation and technological change, the other two channels differ in their importance to deregulation and technological change; deregulation drives industry merger activity by increasing entry and cash flow volatility; technological change drives merger activity by increasing entry and inter-firm dispersion in the quality of production technology.

Overall, the evidence shows that economic shocks from deregulation and technological change drive merger activity by increasing industry competition – an inference that could be extended to other sources of economic shocks such as industry overcapacity, financing innovations, globalization, international trade, demand shocks and input costs shocks that also have the potential to induce a more competitive environment. For example, Jensen (1993) attributes a substantial portion of the exits via M&A in the 1980s and

1990s to excess capacity driven largely by the ten-fold increase in crude oil prices between 1973 and 1979.

Ahern and Harford (2014) examine the role of product market relationships in "how" economic shocks lead to merger waves and show that vertical links or customer-supplier relations strongly predict inter-industry merger waves. Garfinkel and Hankins (2010) provide evidence suggesting that risk management is one of the underlying economic reasons for the link between vertical integration and merger waves. Garfinkel and Hankins (2010) show that merger waves are more likely to start following periods when many firms in an industry experience increasingly volatile cash flows. The roles of vertical industry links and risk management in "how" merger waves propagate are supportive of the role of competition in "how" economic shocks drive industry merger activity.

The remainder of this paper proceeds as follows. Section 2 describes the M&A data and the variables employed in the study. Section 3 develops the hypotheses and the empirical testing approach. Section 4 presents the empirical results, first from the univariate analysis of the impact of deregulation and technological change on industry competition, and second from the multivariate tests. Following the discussion of the empirical results, Section 5 concludes the paper.

II. DATA

We extract all mergers and acquisitions recorded in Thompson Financial's Securities Data Company (SDC) M&A Database and satisfying the following criteria: 1) the transaction announcement date is between January 1, 1980 and December 31, 2009; 2) the transaction involves a U.S. public target and a public acquirer, which excludes leveraged buyouts (LBOs) and management buyouts (MBOs); 3) the transaction value is equal to or greater than $1 million; 4) the transaction deal status is "completed"; 5) the percentage of the target owned by the acquirer is greater than 50% after the transaction (more than 95% of the targets in the sample are 100% owned by the acquirer after the transaction) and is equal to or less than 50% before the transaction.

The transactions are assigned to 48 industry groups (by acquirer's industry) based on the Fama-French grouping scheme, using SDC recorded Standard Industry Classification (SIC) codes. The result is a sample of 6,943 M&A transactions assigned to their respective industry-years. We exclude transactions involving private firms to avoid data availability problems and because this study focuses on the merger decisions of managers of public firms that may be influenced by potential stock market misvaluations (Rhodes-Kropf et al., 2005). Misvaluations are attributed to either an inefficient stock market (Shleifer and Vishny, 2003) or asymmetric information between managers and investors (Rhodes-Kropf and Viswanathan, 2004).

In Table 1, we present summary descriptive statistics for the sample of 1440 industry-year observations – a panel data set of 48 industries from 1980 to 2009 – as well as statistics for sub-samples by decade. This is in keeping with a decade-by-decade approach that prior studies employ (see Mulherin and Boone, 2000; Andrade et al., 2001; Schleifer et al., 2003; Andrade et al, 2004; and Dong et al., 2006). We adjust all dollar values to 2009 dollars using the Consumer Price Index (CPI). The relatively low levels of M&A activity recorded for the 1980s is influenced by the fact that the SDC M&A data coverage in the 1980s is less complete than the data coverage since the 1990s (Netter et al. 2011). The range between the minimum and maximum industry-year observations relative to the mean for the full sample period, as well as in each decade, indicates clustering of mergers at the industry-level.

Table 1: Summary Descriptive Statistics of M&A Sample, 1980 – 2009

This table presents summary descriptive statistics of the SDC M&A sample from 1980 to 2009, involving public acquirers and public U.S. targets. Statistics for the full sample and for sub-samples by decade are reported, by count and by value ($ billions in 2009 dollars) of the deals.

	Total	1980s	1990s	2000s
Panel A: Count				
Sum	6,943.00	1,395.00	3,163.00	2,385.00
Mean	4.82	2.91	6.59	4.97
Median	2.00	1.00	2.00	2.00
Max	*146.00	51.00	*146.00	89.00
Min	0.00	0.00	0.00	0.00
Panel B: Value ($ billions)				
Sum	$9,096.91	$866.57	$4,031.27	$4,199.07
Mean	$6.32	$1.81	$8.40	$8.75
Median	$0.54	$0.26	$0.74	$1.09
Max	**$397.89	$36.90	**$397.89	$333.16
Min	$0.00	$0.00	$0.00	$0.00

** Maximum industry-year observation (count) occurred in Banking in 1997.*

*** Maximum industry-year observation (value) occurred in Communications in 1999.*

Table 2 ranks the top 10 most active industries by value of M&A deals as a percentage of the total value of M&A deals in each decade. Although the composition of the most active industries changes from one decade to the next, some industries (e.g. deregulated industries like banking and communication) consistently show up in the rankings. In each decade the top 10 industries account for greater than 50% of the total activity. This is consistent with the evidence in Mitchell and Mulherin (1996), who document clustering at the industry-level (deals assigned by target's industry) during the 1980s, and Andrade and Stafford (2004), who document clustering at the industry-level (deals assigned by acquirer's industry) for the period from 1970 to 1994. Harford (2005) also documents industry-level clustering for the period from 1981 to 2000. For the 1980s sample, the top 10 active industries account for 59% of the total value of M&A activity. For the 1990s and 2000s samples, the top 10 active industries account for 77% and 74%, respectively.

Table 2: Top 10 Industries by M&A Deal Value (% of Total) by Decade

This table presents a ranking of the top 10 industries in each decade by value of M&A deals. The ranking is based on total value of M&A deals recorded for each industry in each decade as a percentage of the total M&A deals recorded in the respective decade.

Rank	1980s	1990s	2000s
1.	Banking (12%)*	Communication (24%)***	Banking (17%)*
2.	Petroleum & Nat. Gas (8%)*	Banking (15%)*	Computer Software (11%)**
3.	Pharmaceuticals (8%)**	Insurance (7%)	Pharmaceuticals (9%)**
4.	Chemicals (7%)	Petroleum & Nat. Gas (6%)*	Petroleum & Nat. Gas (8%)*
5.	Printing & Publishing (4%)	Pharmaceuticals (5%)**	Communications (8%)***
6.	Communication (4%)***	Utilities (5%)*	Insurance (5%)
7.	Retail (4%)	Trading (5%)	Electronic Equipment (5%)**
8.	Consumer Goods (4%)	Chemicals (4%)	Trading (5%)
9.	Steel Works (4%)	Retail (3%)	Computer Hardware (3%)**
10.	Utilities (4%)*	Computer Software (3%)**	Utilities (3%)*

** Deregulated industry.*

*** High-tech industry.*

**** Communication classifies as both a deregulated and high-tech industry.*

Deregulated industries are marked with a single asterisk in Table 2 and account for a substantial amount of the M&A transactions across the decades. The industries that have undergone major regulatory reforms in recent decades include transportation (1978 & 1980), petroleum & natural gas (1978, 1981, 1989 & 1992), banking (1982, 1991, 1994 & 1999), communication (1982 & 1996), and utilities (1978, 1992 & 1996). Viscusi et al. (2005) provides a comprehensive list of the deregulation events. In the 1980s and 1990s, deregulated industries account for 31% and 51% of the total value of M&A activity, respectively. In the 2000s, after the major deregulation events of the 1990s, banking, communication, petroleum & natural gas, and utilities collectively account for about 36% of the total value of M&A activity. The fact that industries deregulated in the 1990s also become very active in the 2000s begs for explanations that extend beyond the neighborhood of a deregulation event.

Eight industries classified as "high-tech" by the OECD (Organization for Economic Co-operation and Development), based on R&D intensity, account for 18%, 38% and 39% of the total value of M&A activity in the 1980s, 1990s and 2000s, respectively. The "high-tech" industries in Table 2 are marked with double asterisks. The communication industry classifies as both a deregulated industry and a "high-tech" industry and is marked with triple asterisks. The "high-tech" industries make up 5 of the top 10 industries in the 2000s, more than in the previous decades.

We construct the proxy variables for the empirical tests by matching stock price data from the CRSP monthly stock file to accounting data from the CRSP/Compustat Merged Fundamentals Annual file. We extract relevant financial information for firm-year observations from 1976 to 2009, resulting in a sample of 191,261 firm-year observations. The firm-year observations are assigned to the Fama-French 48 industries based on SIC codes and required to have values for market equity, book equity and book assets.

The level of entry, ENTRY, in an industry each year is the number of new CRSP listed firms (with CRSP Share Codes 10 & 11) and serves as a proxy for industry competition. An alternative proxy for industry competition is the Herfindahl-Hirschman index of industry concentration, HH INDEX, computed as the sum of the squared market shares (sales over total industry sales) of firms in an industry in a given year. We also use the number of CRSP listed firms (CRSP Share Codes 10 & 11) in an industry, after adjusting for firms with dual class shares, as an additional proxy for industry competition. Due to data availability, these measures of industry competition are imperfect, as they do not incorporate data for private firms. This particular problem is, however, mitigated by the fact that publicly traded firms typically account for the vast majority of the market capitalization of an industry. In addition, a new CRSP listing often takes the form of an initial public offering (IPO) that gives the issuer access to the equity markets and new capital for investments. Lowry (2003) shows that private firms' demand for capital and investors' sentiments are important determinants of IPO volume.

We measure industry cash flow volatility using the shocks to firms' cash flows. We compute the cash flow shocks using quarterly cash flow data from the CRSP/Compustat Merged Fundamentals Quarterly file. The firms' quarterly cash flows are scaled by the number of commons shares outstanding and are then winsorized at the 1st and 99th percentiles. The quarterly cash flow shocks are then estimated from pooled cross-sectional and time-series industry-level regressions (see Irvine and Pontiff, 2009) that control for the seasonal variation and documented persistence in cash flow:

$$C_{ijt} - C_{ijt-4} = \varphi_1 + \beta_1(C_{ijt-1} - C_{ijt-5}) + \beta_2(C_{ijt-2} - C_{ijt-6}) + \beta_3(C_{ijt-3} - C_{ijt-7}) + \mu_{ijt} \quad (1)$$

Cijt is the quarter t cash flow for firm i belonging to industry j. Cijt – Cijt-4 is the difference between current quarter t cash flow and cash flow from four quarters ago (same quarter of the preceding year). The residuals, µijt, from equation (1), deflated by quarter-end share price, are the quarterly cash flow shocks. The quarterly cash flow shocks are deflated by end of quarter share price. The cross-sectional standard deviation of firms' quarterly cash flow shocks, DISP CFLOW SHOCKS, measures industry cash flow volatility. Higher industry cash flow volatility implies lower correlation between firms' cash flows.

The proxies for inter-firm dispersion in the quality of production technology are the cross-sectional standard deviation of return on sales, DISP ROS, and the cross-sectional standard deviation of return on assets, DISP ROA. Return on sales, ROS, is cash flow/sales and return on assets, ROA, is cash flow/book assets. The measure used for cash flow is operating income before depreciation. We exclude observations with ROS or ROA larger than 1 or smaller than –1 before computing the standard deviations. We also use the inter-firm dispersion in the rate of R&D investment, DISP R&D/ASSETS, computed as the cross-sectional standard deviation of R&D scaled by book assets, as a proxy for inter-firm dispersion in the quality of production technology. This proxy is particularly suited for "high-tech" industries, which are R&D intensive industries.

Table 3a and Table 3b present summary statistics and correlation coefficients, respectively, for the proxy variables based on the industry-year observations – 48 industries over the 1980 to 2009 sample period. Table 4 presents the averages of industry-year M&A activity, by count and by value ($ billions and in 2009 dollars), and some descriptive variables for all 48 industries. The data indicates that deregulated industries exhibit relatively high ENTRY and low M/B over the sample period. "High-tech" industries exhibit relatively high R&D/ASSETS and high M/B.

Table 3a: Summary Statistics of Industry-year Variables

This table presents summary statistics for the proxy variables employed in the study based on industry-year data. The industry-year data is computed from firm-year observations. ENTRY is the count of new CRSP listed firms (share code 10 & 11). Number of Firms is the count of CRSP listed firms (share code 10 & 11). HH INDEX is Herfindahl-Hirschman index of industry concentration, the sum of the squared market shares (sales over total industry sales) of firms in an industry in a given year based on data from CRSP/Compustat merged file. DISP CFLOW SHOCKS is the cross sectional standard deviation of firms' quarterly cash flow shocks, winsorized and scaled by quarter-end share price. DISP ROS is the cross-sectional standard deviation of the return on sales (cash flow/sales). DISP ROA is the cross-sectional standard deviation of the return on assets (cash flow/assets). To compute DISP ROS and DISP ROA I exclude firm-year observations where ROS or ROA is greater than 1 or less than –1, in order to remove the influence of extreme values. AVG R&D/ASSETS is the median R&D scaled by assets. DISP R&D/ASSETS is the cross sectional standard deviation of R&D scaled by assets. M/B is the mean market-to-book equity ratio (in natural logs) for each industry-year.

	Mean	Median	Max	Min	Std. Dev.	Obs.
ENTRY	10.00	4.00	167.00	0.00	16.51	1440
Number of Firms	117.71	80.00	873.00	4.00	121.34	1440
HH INDEX	0.14	0.09	0.97	0.01	0.15	1440
DISP CFLOW SHOCK	0.14	0.09	2.84	0.00	0.21	1440
DISP ROS	0.17	0.15	0.45	0.02	0.08	1440
DISP ROA	0.12	0.12	0.37	0.01	0.05	1440
AVG R&D/ASSETS	0.01	0.00	0.13	0.00	0.03	1440
DISP R&D/ASSETS	0.03	0.02	0.24	0.00	0.03	1440
M/B (log)	0.41	0.41	1.73	– 1.10	0.43	1440

Table 3b: Correlation Coefficients of Industry-year Variables

This table presents correlation coefficients for the proxy variables employed in the study based on industry-year observations. The industry-year data is computed from firm-year observations. ENTRY is the count of new CRSP listed firms (share code 10 & 11). HH INDEX is Herfindahl-

Hirschman index of industry concentration, the sum of the squared market shares (sales over total industry sales) of firms in an industry in a given year based on data from CRSP/Compustat merged file. DISP CFLOW SHOCKS is the cross sectional standard deviation of firms' quarterly cash flow shocks, winsorized and scaled by quarter-end share price. DISP ROS is the cross-sectional standard deviation of the return on sales (cash flow/sales). DISP ROA is the cross-sectional standard deviation of the return on assets (cash flow/assets). To compute DISP ROS and DISP ROA I exclude firm-year observations where ROS or ROA is greater than 1 or less than –1, in order to remove the influence of extreme values. AVG R&D/ASSETS is the median R&D scaled by assets. DISP R&D/ASSETS is the cross sectional standard deviation of R&D scaled by assets. M/B is the mean market-to-book equity ratio (in natural logs) for each industry-year.

	ENTRY	HH INDEX	DISP CFLOW SHOCK	DISP ROS	DISP ROA	AVG R&D/ ASSETS	DISP R&D/ ASSETS	M/B (log)
ENTRY	1.00							
HH INDEX	– 0.21	1.00						
DISP CFLOW SHOCK	0.00	0.00	1.00					
DISP ROS	0.25	– 0.08	0.10	1.00				
DISP ROA	0.12	0.02	0.05	0.52	1.00			
AVG R&D/ASSETS	0.21	– 0.08	– 0.05	0.20	0.41	1.00		
DISP R&D/ASSETS	0.21	– 0.08	– 0.06	0.22	0.49	0.82	1.00	
M/B (log)	0.29	0.01	– 0.15	0.28	0.42	0.42	0.44	1.00

Table 4: Averages of Industry-year M&A Activity and Descriptive Variables, 1980 – 2009

This table presents the averages (means) of industry-year M&A activity, by count and by value ($ billion in 2009 dollars), and descriptive variables. ENTRY is the count of new CRSP listed firms (share code 10 & 11). Number of Firms is the average count of CRSP listed firms (share code 10 & 11). HH INDEX is the average Herfindahl-Hirschman index of industry concentration computed from the sum of the squared market shares (sales over total industry sales) of firms for each industry-year. ROS is the average return on sales (cash flow/sales) computed from the median return on sales for each industry-year using Compustat data. R&D/ASSETS is the average R&D scaled by book assets computed from the median R&D scaled by assets for each industry-year using Compustat data. Missing firm-level R&D observations are replaced with zero. M/B is the average market-to-book equity ratio computed from the mean market-to-book equity ratio (in natural logs) for each industry-year.

	Industry	M&A (count)	M&A (Value)	ENTRY	Number of Firms	HH INDEX	ROS	R&D/ ASSETS	M/B (log)
1	Agriculture	0.33	0.08	1.77	16.40	0.42	0.05	0.00	0.27
2	Food Products	2.57	2.93	4.93	81.67	0.06	0.08	0.00	0.49
3	Candy and Soda	0.53	1.88	0.50	11.70	0.18	0.14	0.00	0.40
4	Beer and Liquor	0.43	2.33	1.13	15.77	0.22	0.14	0.00	–0.15
5	Tobacco Products	0.23	1.66	0.40	5.70	0.34	0.17	0.00	0.17
6	Recreation	1.50	1.67	3.97	48.90	0.34	0.09	0.02	0.24
7	Entertainment	2.53	3.76	10.10	82.00	0.19	0.18	0.00	0.68
8	Printing and Publishing	1.80	3.39	3.53	53.07	0.08	0.16	0.00	0.53
9	Consumer Goods	3.30	4.43	5.03	94.13	0.09	0.10	0.01	0.34
10	Apparel	1.17	0.67	3.53	68.53	0.06	0.08	0.00	0.14
11	Healthcare	4.47	3.95	14.40	117.47	0.09	0.11	0.00	0.83
12	Medical Equipment	5.43	3.79	16.93	167.77	0.11	0.11	0.05	1.07
13	Pharmaceutical Products	10.07	21.27	21.60	229.43	0.06	0.11	0.07	1.21
14	Chemicals	3.37	8.50	5.53	92.10	0.08	0.13	0.02	0.46
15	Rubber and Plastic Products	0.93	0.47	3.40	52.40	0.14	0.10	0.00	0.46
16	Textiles	0.77	0.20	1.97	38.57	0.11	0.10	0.00	–0.08
17	Construction Materials	2.43	1.62	4.67	117.07	0.05	0.11	0.00	0.20
18	Construction	1.77	1.42	4.90	65.90	0.05	0.07	0.00	0.16
19	Steel Works Etc.	2.80	3.54	3.70	74.57	0.06	0.10	0.00	–0.07
20	Fabricated Products	0.23	0.07	1.03	22.73	0.14	0.10	0.00	0.40
21	Machinery	5.40	4.71	9.23	183.30	0.05	0.10	0.02	0.44
22	Electrical Equipment	1.53	1.80	10.67	112.23	0.14	0.09	0.05	0.63
23	Automobiles and Trucks	2.17	3.71	3.90	76.57	0.13	0.09	0.01	0.03
24	Aircraft	1.37	2.87	1.37	26.30	0.22	0.12	0.01	0.34
25	Ship Building and Rail Equipment	0.20	0.05	0.60	8.03	0.52	0.08	0.00	0.63
26	Defense	0.43	0.99	0.60	10.23	0.46	0.12	0.02	0.70

	Industry	M&A (count)	M&A (Value)	ENTRY	Number of Firms	HH INDEX	ROS	R&D/ ASSETS	M/B (log)
27	Precious Metals	1.17	0.84	2.87	31.40	0.16	0.19	0.00	0.47
28	Non-Metal and Metal Mining	0.83	1.91	1.70	21.47	0.16	0.19	0.00	0.12
29	Coal	0.07	0.05	0.70	9.00	0.55	0.12	0.00	0.31
30	Petroleum and Natural Gas	8.30	21.17	21.87	250.67	0.06	0.26	0.00	0.48
31	Utilities	5.13	11.60	3.47	172.37	0.02	0.25	0.00	0.19
32	Communication	9.67	44.36	18.87	142.63	0.10	0.24	0.00	0.45
33	Personal Services	1.27	0.30	7.00	64.77	0.12	0.13	0.00	0.71
34	Business Services	8.27	4.25	31.43	290.93	0.34	0.11	0.00	0.77
35	Computer Hardware	5.60	6.44	14.00	145.83	0.14	0.09	0.09	0.78
36	Computer Software	16.93	19.69	40.30	283.90	0.10	0.09	0.09	1.01
37	Electronic Equipment	10.17	10.11	20.40	284.97	0.05	0.10	0.06	0.62
38	Measuring and Control Equipment	3.60	1.56	7.93	120.90	0.10	0.10	0.07	0.66
39	Business Supplies	1.80	3.64	2.70	60.13	0.06	0.12	0.00	0.29
40	Shipping Containers	0.40	0.21	1.13	19.17	0.13	0.11	0.00	– 0.24
41	Transportation	3.43	2.70	9.57	118.63	0.04	0.13	0.00	0.23
42	Wholesale	4.47	3.59	19.50	233.40	0.04	0.05	0.00	0.37
43	Retail	6.77	8.00	22.53	281.70	0.04	0.06	0.00	0.38
44	Restaurants, Hotels, Motels	3.40	2.64	11.30	124.43	0.06	0.11	0.00	0.54
45	Banking	58.73	47.05	57.97	566.13	0.03	0.26	0.00	0.07
46	Insurance	7.70	17.02	10.53	177.87	0.05	0.12	0.00	0.19
47	Real Estate	1.13	1.30	4.70	57.30	0.14	0.16	0.00	0.26
48	Trading	14.83	13.03	29.90	319.90	0.06	0.28	0.00	0.32

III. HYPOTHESIS DEVELOPMENT & EMPIRICAL APPROACH

1. HYPOTHESES DEVELOPMENT

Deregulation and the arrival of new technology allow the set of input-output combinations to expand (Jovanovich and Rousseau, 2001). Deregulation stimulates a more competitive environment and enables economies of scale and scope, by reducing or removing certain regulatory constraints on firms' operating activities and risk-taking behavior. New technology provides new sources of competitive advantage either through new products or new production processes.

A main virtue of competition emphasized in the economics literature is its role as a mechanism that stimulates internal efficiency (Ros, 1999), consistent with the notion that competition will force managers to reallocate resources to better uses. But, while the economics literature contains well-established and testable hypotheses on the effects of competition on efficiency, the theoretical effects of competition on mergers is less clear.

Deregulation and technological change are part of a number of forces impacting U.S. businesses since the 1970s. These forces, beginning with the ten-fold increase in crude oil prices between 1973 and 1979, led to excess capacity and exit in the 1980s and the 1990s (Jensen, 1993). Financing innovations in high-yield bonds in the mid-1970s opened the public markets to small and risky firms. Advancements in communication and transportation technologies, along with the globalization of trade through international agreements, have engendered a truly global economy. The increase in international trade contributed to the lessening of the government's antitrust stance; the growth of multinational firms and foreign competition allowed more mergers to occur without creating monopoly power. These change forces created more competition, leading to deregulation, which increased competition further (Weston, 2001).

Federal regulatory agencies and the U.S. Congress began liberalizing pricing, entry, and exit in the transportation, financial, energy, and communications industries in the mid-1970s. The regulatory reforms spurred more competition, restructuring, new market opportunities, technological innovations and cost reductions in these industries. Deregulation forced firms to eliminate production inefficiencies that existed under previous regulatory structures (Winston, 1998). For example, entry barriers prevented airlines and motor carriers from developing their networks optimally, exit barriers prevented railroads from shedding excess capacity, and price regulations prevented natural gas pipelines from efficiently marketing their capacity during peak and off peak periods. The removal of such entry and exit barriers decreased market power and provided firms with greater incentives to seek out efficiencies.

Winston (1998) finds that substantial efficiency improvements and merger activity have generally occurred following an industry's deregulation due to increased competition. In the trucking and banking industries for instance, many weaker firms that were unable to compete effectively and efficiently in a deregulated environment sought a merger partner. Incumbent firms in the airline, banking and railroad industries used mergers to enter new markets after deregulation. Following deregulation, the net result of entry, exit, and mergers has generally been that competition in actual markets become more intense (Winston, 1998). We propose that deregulation and technological change drive merger activity through three channels related to industry competition.

First, the removal of entry barriers increases the feasible set of merger possibilities. Prior to the wave of deregulations in the late 1970s, merger possibilities were limited because mergers were either explicitly prohibited by law (e.g., in banking with the 1933 Securities Act) or because entry was constrained by regulations. Partly in response to the energy crisis of the 1970s and innovations in production technologies, entry barriers were removed in utilities, natural gas, airlines and trucking. Deregulation of entry continued into the 1980s and 1990s, impacting other industries such as banking and communication. Regulatory constraints on firms' operating activities and risk-taking behavior artificially restrict the number of firms in an industry, as well as the size and scope of firms' activities. The removal of entry barriers helps eliminate the monopolistic incentives to restrict output (Fink, Mattoo and Rathindran, 2002). For example, the passage of the Garn-St Germain Act of 1982 allowed banks to enter into new markets and threaten incumbents (Stiroh and Strahan, 2003).

Economic theory suggests that as entry increases following deregulation, in the presence of significant economies of scale and scope, firms will be operating at higher per-unit costs. To the extent that mergers are permitted, one expects that the increase in entry would be accompanied by an increase in merger activity that takes advantage of available economies of scale and scope to reduce per-unit costs.

Second, cash flow volatility, uncertainty and the probability of exit are expected to rise as competition increases with entry. Peltzman's (1976) regulatory buffering effect model predicts that firms will face a more risky profit stream in a deregulated environment than in a regulated one. For example, the passage of the Motor Carrier Act of 1980 increased entry and price competition in the trucking industry (Zingales, 1998). The intense price competition resulted in exit via bankruptcy or liquidation of less efficient and more leveraged firms – 4,589 trucking companies shut down between 1980 and 1985.

A number of studies link the well-documented upward trend in idiosyncratic stock return risk over the past 40 years to increased competition, attributed in part to deregulation. The increase in competition following deregulation is shown to have contributed to increased cash flow volatility or decreased correlation between firms' cash flows (see Gaspar and Massa, 2006; Irvine and Pontiff, 2009). As competition increases, a firm's success comes increasingly at the expense of other firms, causing correlation between firms' cash flows to decrease. This contributes to higher cash flow volatility that in turn increases the probability of exit via bankruptcy or liquidation for marginally performing firms. Mergers provide an alternative means to exit.

Third, technological change increases the heterogeneity in the quality of firms' production technologies. Innovation in production technology undermines the natural monopoly features of certain industries by providing new sources of competitive advantage either through new products or new production processes. Technological change is often associated with new entry particularly in environments with high R&D intensities, such as in "high-tech" industries. Rapidly changing technology causes production processes to change frequently, making operating costs and demand less predictable (Gort, 1969). Firms that are not able to quickly adapt become takeover targets for those firms that can most efficiently operate the new technology (Jovanovich and Rousseau, 2001).

Deregulation, where it is spurred by technological change, will facilitate the arrival and expansion of new production technologies. For example, the deregulatory events leading up to the 1984 removal of the regulated monopoly status of long-distance phone service in the U.S. evolved contemporaneously with the development of microwave and fiber-optic technology by firms such as MCI and Sprint, making these firms viable competitors to AT&T's wireline network (Weston et al., 2004). The 1996 Telecommunications Act also facilitated entry and expansion of new communication technologies such as cable, cellular, internet etc. that offered alternatives to the services provided by local telephone companies (Okoeguale, 2013). Such arrival of new technology is expected to increase the heterogeneity in the quality of firms' production technologies because firms adapt to new technology at different rates, and thus contribute to potential merger synergies.

We use the Q theory model of mergers (Jovanovic and Rousseau, 2002) to illustrate how economic shocks from deregulation and technological change can drive industry merger activity by increasing industry competition. The Q theory model of mergers (Jovanovic and Rousseau, 2002) shows how resources flow to better uses and better managers through mergers. In the Q theory model, firm i employs production technology zi to produce output using capital stock Ki:

outputi = ziKi (2)

An acquirer with output zAKA bids for a target with output zTKT. There are gains to a merger when the target's zT is low, i.e. productivity of its technology is low, and the acquirer's zA is high. The output of the combined firm would be zA(KA + KT), which is higher than the sum of the two firms' pre-merger outputs by the amount (zA – zT)KT. The value of K inside firm i takes the form Qi(zi)Ki, where Qi is a function of the quality of firm i's production technology and is the ratio of market value to the replacement cost of capital. The merger creates value or synergies because QA(zA)KT > QT(zT)KT, i.e. the target's capital has a greater value inside the acquirer's firm. If all firms had the same z no M&A would take place. M&A should therefore rise, predicts the Q theory model of mergers, when the inter-firm dispersion in Q(z) is high.

We hypothesize that an increase in entry, following deregulation or technological change, increases merger activity in the presence of significant economies of scale and scope by increasing the number of potential merger combinations where QA(zA)KT < QT(zT)KT. We summarize this hypothesis as follows:

H1: *Industry merger activity is positively associated with entry.*

As cash flow volatility increases with entry or competition, marginally performing firms will face a higher probability of exit via bankruptcy or liquidation. This is expected to be reflected in market valuations in the form of lower Qi for marginally performing firms, and thus dispersion in Q(z) should rise.

H2: *Industry merger activity is positively associated with cash flow volatility.*

Some firms will make more efficient use of new technology than others because firms adapt to new technology at different rates. We hypothesize that the expansion of new production technology, by increasing the heterogeneity in the quality of firms' production technologies, increases dispersion in Q(z) and should lead to increased merger activity.

H3: *Industry merger activity is positively associated with inter-firm dispersion in the quality of production technology.*

In general, these three hypotheses relate industry merger activity to changes to the competitive structure of an industry brought about by deregulation and technological change, and will enable important inferences to be made about how economic shocks from deregulation and technological change drive merger activity and whether merger activity is motivated by efficiency.

IV. EMPIRICAL APPROACH

$$M\&A_{jt} = b_0 + b_1 Entry_{jt} + b_2 Cash\ Flow\ Volatility_{jt} + b_3 Disp\ in\ Technology_{jt} + \varepsilon_{jt} \quad (3)$$

Regression equation (3) relates industry-year M&A data to proxy variables for entry, cash flow volatility and inter-firm dispersion in the quality of production technology. The dependent variable, M&Ajt, is M&A activity measured by value ($ billions in 2009 dollars) or by count of deals for industry j at year t. Measuring M&A activity by value controls for size differences in M&A deals.

H1, H2, and H3 predict that the regression coefficients b_1, b_2, and b_3, respectively, are positive. We test H1 using the number of new CRSP listed firms, ENTRY, as a proxy for the level of entry. We test H2 using the cross-sectional standard deviation of firms' quarterly cash flow shocks, DISP CFLOW SHOCKS, as a proxy for cash flow volatility. We test H3 using the cross-sectional standard deviation of return on sales, DISP ROS, as a proxy for inter-firm dispersion in the quality of production technology. The cross-sectional standard deviation of return on assets, DISP ROA, and the cross-sectional standard deviation of R&D scaled by book assets, DISP R&D/ASSETS, both serve as alternative proxies for inter-firm dispersion in the quality of production technology.

ROS or cash flow/sales is a proxy for production efficiency (Zingales, 1998). ROA or cash flow/assets serves as an alternative proxy for robustness check. ROS simply captures the relationship between operating revenues and operating costs, and thus is a convenient measure of the efficiency or quality of production technology across a wide range of industries. However, given inherent inter-industry differences in product characteristics that impact revenue and cost structures, these measures are potentially noisy proxies for the quality of production technology. The rate of R&D investment, R&D/ASSETS, is introduced as an additional proxy for the quality of production technology. The rate of R&D investment, particularly in R&D intensive industries, is expected to reflect the rate at which firms within an industry adapt to new technology.

V. ENDOGENEITY

Before conducting the empirical analysis we address potential endogeneity concerns associated with the hypothesis that industry merger activity is positively associated with industry competition. A particular concern is whether systematic factors underlie a potential relation between industry merger activity and industry competition. For example, if an industry/economy experiences structural demand/supply changes that increases investment or growth opportunities and makes regulation less desirable, the industry may experience a rise in entry and merger activity following deregulation as a result of the increase in investment or growth opportunities. Ovtchinnikov (2013) shows that deregulation is endogenous with respect to industry performance.

The Q-theory model predicts that merger activity should rise with investment opportunities, captured in Q(z); Andrade and Stafford (2004) find that merger and non-merger investments are positively related to an acquirer's growth prospects. We include industry M/B ratio in the regressions to control for potential endogeneity resulting from variation in investment opportunities (see Smith and Watts, 1992). The inclusion of M/B in the regressions also helps to control for the effects of variations in business conditions, capital liquidity, and potential stock market misvaluations, given evidence from prior studies that misvaluation plays a role in merger activity (see Rhodes-Kropf et al., 2005).

Prior to the 1970s, which featured significant industry shocks from changes in production technologies, energy cost shocks, globalization and international trade, regulated industries (airline, petroleum and natural gas, railroads, telecommunications, trucking and utilities) were considered natural monopolies with significant economies of scale, and these industries attracted substantial capital investments into specific long-lived assets. To the extent that these later deregulated industries possess characteristics that are fundamentally different from those of their unregulated counterparts such as R&D intensive "high-tech" industries, an observed relation between industry merger activity and industry competition may be endogenous to industry characteristics. Thus, we include industry-specific fixed effects in the regressions to control for relative differences in industry characteristics such as asset-specificity and degree of economies of scale.

There is also the potential effect of broad technological changes, including advances in information and transportation technologies, and market-wide/macroeconomic factors that may affect merger activity in all industries and may contribute to making regulation less desirable. To control for these factors, we include year-fixed effects in the regressions.

$$M\&A_{jt} = b_0 + b_1 ENTRY_{jt} + b_2 DISP\ CFLOW\ SHOCKS_{jt} + b_3 DISP\ ROS_{jt} + b_4 M/B_{jt} + \alpha_t + \lambda_j + \varepsilon_{jt} \quad (4)$$

With these above-mentioned controls included in the regression model, the three variables of interest would essentially test for the effect of changes to industry competition on industry merger activity, holding valuations constant. This test would enable inferences about how economic shocks from deregulation and technological change drive merger activity. However, there is an important limitation to this multi-industry study. Although multi-industry studies would enable us to draw macro-level inferences, there is the problem that there may be different things occurring in different industries at the same time that would inhibit the application of such broad-based inferences. Single industry studies would avoid this potential problem but restrict inferences to specific industries.

VI. EMPIRICAL ANALYSIS

1. UNIVARIATE ANALYSIS: DEREGULATED INDUSTRIES

Deregulation is a relatively well-specified event and thus provides a natural setting for examining whether changes to industry M&A activity are associated with changes to industry competition. We begin by examining the time-series patterns of M&A activity and proxies for industry competition for the deregulated industries. For brevity we focus my analysis on major deregulation events that occurred during the 1990s.

In the petroleum and natural gas industry, the FERC (Federal Energy Regulation Commission) order 636 of 1992 required interstate pipeline companies to unbundle or separate their sales and transportation services. The purpose of the unbundling provision was to ensure that the gas of other suppliers could receive the same quality of transportation services previously enjoyed by the gas sale of a pipeline company. Unbundling increased competition among gas sellers and diminished the market power of pipeline companies[1]. This resulted in a reallocation of market shares across firms in the industry.

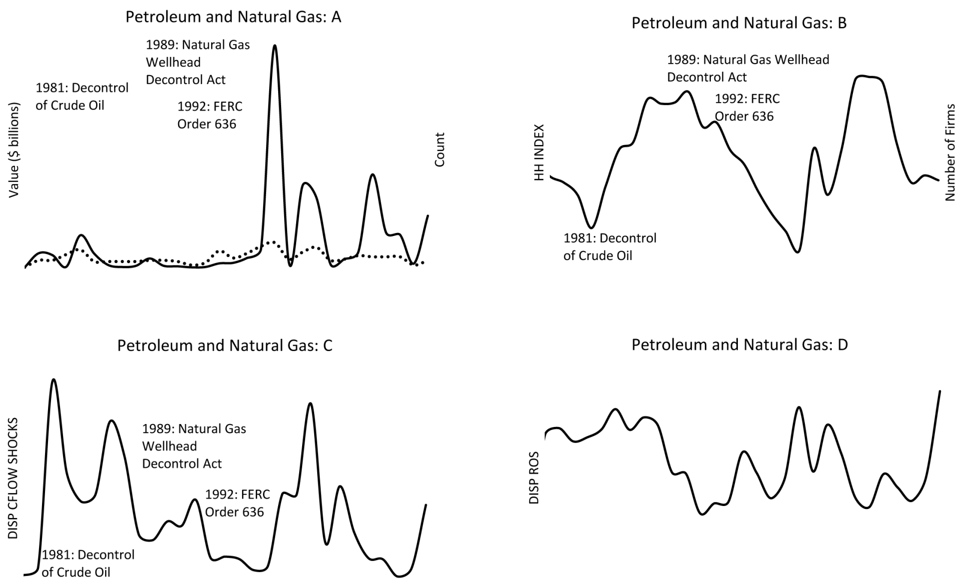
Figure 1a shows that FERC order 636 of 1992 was followed by an increase in M&A activity (panel A) and a steady decrease in the Herfindahl-Hirschman index of industry concentration (panel B), indicating an increase in industry competition even though there wasn’t much of a change in entry or the number of firms. Cash flow volatility rose temporarily in 1992 and then declined. Cash flow volatility rose again in 1998 and was accompanied by a sharp rise in M&A activity.

Figure 1a: Petroleum and Natural Gas Industry M&A Activity and Proxy Variables, 1980 – 2009

Panel A plots the time-series of M&A activity by value (solid line) and by count (dashed line). Major deregulation events during the sample period are identified. Panel B plots the time-series of HH INDEX (solid line), the Herfindahl-Hirschman index of industry concentration, and the Number of Firms (dashed line) listed on CRSP. Panel C plots the time-series of DISP CFLOW SHOCKS, the cross sectional standard deviation of firms’ quarterly

1. U.S. Energy Information Administration

cash flow shocks, winsorized and scaled by quarter-end share price. Panel D plots the time-series of DISP ROS, the cross-sectional standard deviation of the return on sales (cash flow/sales).

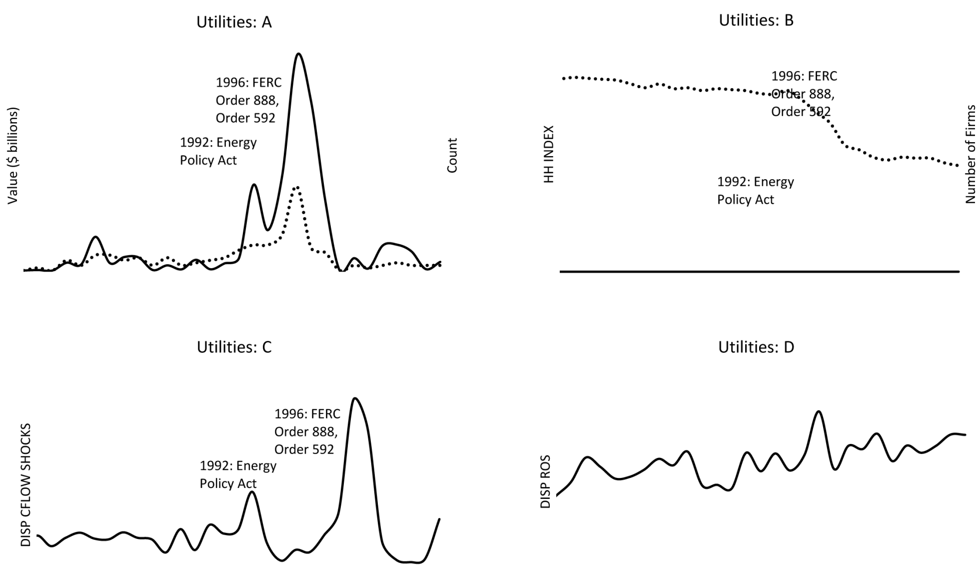


In the utilities industry, the Energy Policy Act of 1992 amended the Public Utility Holding Company Act of 1935 to help small utility companies stay competitive with larger utilities. It also amended the Public Utility Regulatory Policies Act of 1978 and broadened the range of resource choices for utility companies. Following the deregulation, many utility firms chose to expand via mergers (Becher, Mulherin and Walking, 2012). Subsequent to the Energy Policy Act of 1992, the FERC also adopted a more liberal attitude towards mergers in the utility industry (Joskow, 2000). The FERC began to allow horizontal mergers across a broader geographic scope and vertical mergers between electric utilities and natural gas utilities.

Figure 1b shows that the Energy Policy Act of 1992 was followed by an increase in M&A activity (panel A) and a slight decrease in the Herfindahl-Hirschman index of industry concentration, coupled with a decrease in the number of public traded firms (panel B). Cash flow volatility rose temporarily in 1992, increased further in 1995 and then declined rapidly in 1996 (panel C). FERC order 888 of 1996 mandated the unbundling of electric utility services. This was followed by a dramatic rise in M&A activity and an increase in the Herfindahl-Hirschman index of industry concentration, coupled with a decrease in the number of public traded firms. In 1996 the FERC announced a new merger policy (order 592) designed not to impede the development of vibrant and competitive generation markets. The 1992 and 1996 deregulations enabled mergers and a more competitive utilities industry (higher cash flow volatility) without dramatically increasing entry.

Figure 1b: Utilities Industry M&A Activity and Proxy Variables, 1980 – 2009

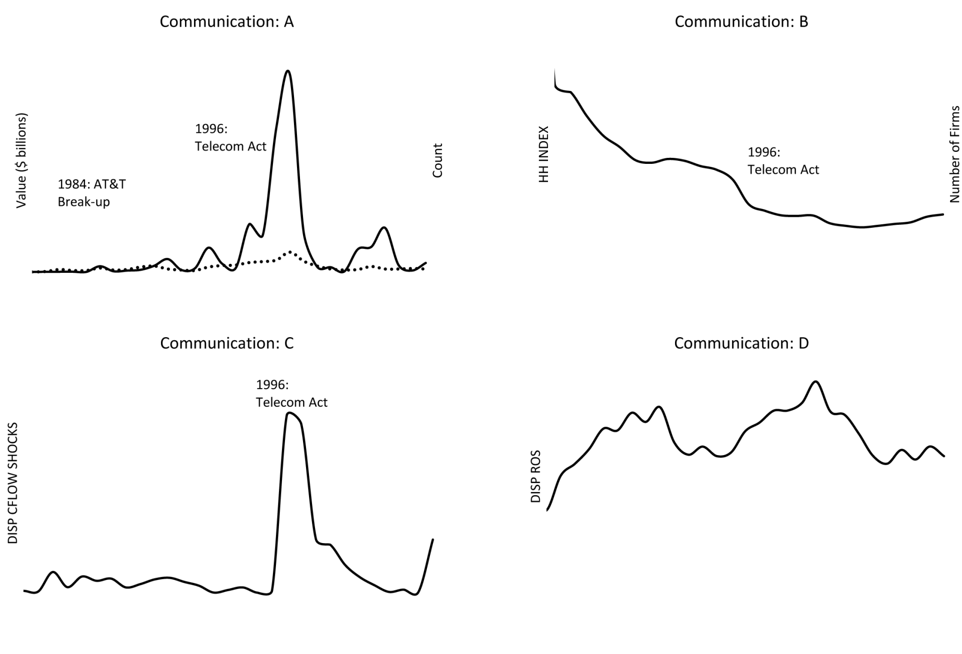
Panel A plots the time-series of M&A activity by value (solid line) and by count (dashed line). Major deregulation events during the sample period are identified. Panel B plots the time-series of HH INDEX (solid line), the Herfindahl-Hirschman index of industry concentration, and the Number of Firms (dashed line) listed on CRSP. Panel C plots the time-series of DISP CFLOW SHOCKS, the cross sectional standard deviation of firms' quarterly cash flow shocks, winsorized and scaled by quarter-end share price. Panel D plots the time-series of DISP ROS, the cross-sectional standard deviation of the return on sales (cash flow/sales).



In the communication industry, the Telecommunications Act of 1996 opened both the long-distance and local phone markets to more competition from new communication technologies including fiber optic, cellular, cable and the Internet (Okoeguale, 2013). Figure 1c shows that the passage of the 1996 Act was followed by an increase in M&A activity (panel A) and an increase in the number of publicly traded firms, coupled with a sharp decrease in industry concentration (panel B). Cash flow volatility rose sharply in 1998 and remained at relatively high levels through 2001 (panel C). Inter-firm dispersion in ROS also increased after 1996 (panel D), indicating an increase in inter-firm dispersion in the quality of production technology.

Figure 1c: Communication Industry M&A Activity and Proxy Variables, 1980 – 2009

Panel A plots the time-series of M&A activity by value (solid line) and by count (dashed line). Major deregulation events during the sample period are identified. Panel B plots the time-series of HH INDEX (solid line), the Herfindahl-Hirschman index of industry concentration, and the Number of Firms (dashed line) listed on CRSP. Panel C plots the time-series of DISP CFLOW SHOCKS, the cross sectional standard deviation of firms' quarterly cash flow shocks, winsorized and scaled by quarter-end share price. Panel D plots the time-series of DISP ROS, the cross-sectional standard deviation of the return on sales (cash flow/sales).

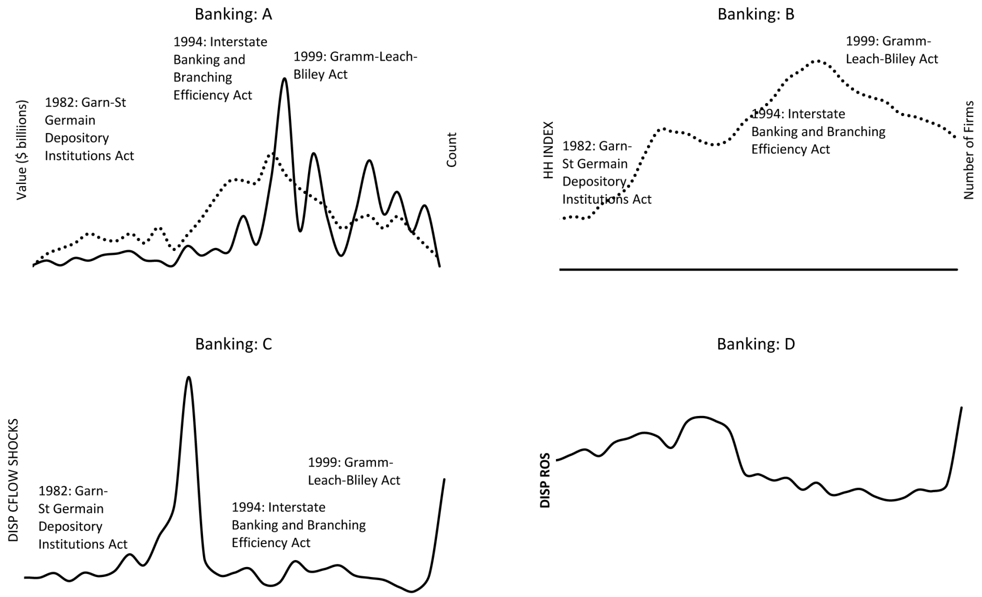


In the banking industry, the Interstate Banking and Branching Efficiency (IBBEA) Act of 1994 repealed the interstate restrictions of the Bank Holding Company Act of 1956, which prohibited bank holding companies headquartered in one state from acquiring a bank in another state. Prior to the 1994 Act, most states allowed interstate banking in some form. The watershed event of IBBEA was not the allowance of interstate banking but the explicit permission of interstate branching, which gave banking companies the freedom to consolidate bank subsidiaries into branch offices and to branch across state lines (Johnson and Rice, 2008).

Figure 1d shows that the passage of the IBBEA Act of 1994 occurred in the midst of an upward trend in both M&A activity (panel A) and the number of publicly listed banks (panel B) that can be traced to the beginning of the 1990s. This suggests that competitive forces had begun to impact the structure of the banking industry prior to the 1994 Act. Cash flow volatility (panel C) and inter-firm dispersion in ROS (panel D) had been on an upward trend in the late 1980s before peaking around 1990, followed by the decline in the value of commercial real estate and the 1990-1991 recession that weakened banking institutions. No dramatic increases in cash flow volatility or dispersion in ROS occur again until 1998, during the recent financial crisis.

Figure 1d: Banking Industry M&AActivity and Proxy Variables, 1980 – 2009

Panel A plots the time-series of M&A activity by value (solid line) and by count (dashed line). Major deregulation events during the sample period are identified. Panel B plots the time-series of HH INDEX (solid line), the Herfindahl-Hirschman index of industry concentration, and the Number of Firms (dashed line) listed on CRSP. Panel C plots the time-series of DISP CFLOW SHOCKS, the cross sectional standard deviation of firms' quarterly cash flow shocks, winsorized and scaled by quarter-end share price. Panel D plots the time-series of DISP ROS, the cross-sectional standard deviation of the return on sales (cash flow/sales).



In summary, the time-series patterns in Figures 1a through 1b suggest that deregulation in the 1990s facilitated merger activity and created a more competitive industry environment. We then examine whether the associations between the increases in M&A activity and the increases in competition following the major deregulation events of the 1990s are indeed significant, using a difference in means test. Table 5 shows that the 5-year average of M&A count increased significantly after each major deregulation event in all four industries. The change in the 5-year average of the value ($ billions in 2009 dollars) of M&A activity is significant in two industries, i.e. communication and banking. Table 5 also shows that, following each deregulation event (except for the 1992 deregulation in utilities), the increases in M&A activity are associated with significant increases in competition, measured using the 5-year averages of the number of new public listings (ENTRY), the Herfindahl-Hirschman index of industry concentration (HH INDEX) and the number of publicly listed firms (Number of Firms).

Table 5: Deregulation, M&A Activity and Entry Activity

This table presents 5-year averages, before and after deregulation events of the 1990s, for measures of M&A activity, by count and by value ($ billions in 2009 dollars), and measures of changes to industry competition. ENTRY is the count of new CRSP listed firms (share code 10 & 11). Number of Firms is the count of CRSP listed firms (share code 10 & 11). HH INDEX is the Herfindahl-Hirschman index of industry concentration, measured as the squared sum of the market shares in sales of the firms in an industry based on data from the CRSP/Compustat merged data file. % Change column shows the percentage changes in the 5-year averages of the measures from before deregulation to after deregulation. *t* (diff) measures the statistical significance of the changes.

	5-Year Averages			
	Before	After	% Change	*t* (diff)
Petroleum and Natural Gas (1992)				
M&A (count)	4.80	11.20	133%	2.20
M&A ($ billion)	2.24	6.28	180%	1.17
ENTRY	16.60	19.00	14%	0.37
Number of Firms	233.00	243.80	5%	2.57
HH INDEX	0.07	0.06	– 15%	– 6.96
Utilities (1992)				
M&A (count)	3.40	7.40	118%	2.48
M&A ($ billion)	2.38	11.51	384%	1.40
ENTRY	3.00	4.20	40%	1.50
Number of Firms	194.60	189.60	– 3%	– 2.99
HH INDEX	0.02	0.01	– 7%	– 0.93
Communications (1996)				
M&A (count)	8.80	25.20	186%	5.28
M&A ($ billion)	17.03	188.60	1007%	2.79
ENTRY	22.40	39.00	74%	2.94
Number of Firms	153.40	211.20	38%	8.93
HH INDEX	0.07	0.04	– 43%	– 18.29
Banking (1994)				

	5-Year Averages			
	Before	After	% Change	*t* (diff)
M&A (count)	53.00	119.00	125%	6.46
M&A ($ billion)	15.16	94.12	521%	2.04
ENTRY	52.00	107.00	106%	3.42
Number of Firms	558.80	775.60	39%	15.88
HH INDEX	0.03	0.02	– 30%	– 2.82

Table 6: Fixed-Effects Regression Analysis for Full Sample of 48 Industries

This table presents the results from regressions of industry-year M&A activity, by value ($ billions in 2009 dollars) and by count, on explanatory variables for the 1980 to 2009 full sample period. All regression models include year and industry fixed-effects. ENTRY is the count of new CRSP listed firms (share code 10 & 11). DISP CFLOW SHOCKS is the cross sectional standard deviation of firms' quarterly cash flow shocks, winsorized and scaled by quarter-end share price. DISP ROS is the cross-sectional standard deviation of the return on sales (cash flow/sales). DISP ROA is the cross-sectional standard deviation of the return on assets (ROA, cash flow/assets). To compute DISP ROS and DISP ROA I exclude firm-year observations where ROS or ROA is greater than 1 or less than –1, in order to remove the influence of extreme values. M/B is the natural log of industry market-to-book equity ratio, the mean of the individual firm-year observations. Statistical significance at the 1% and 5% levels are denoted by *** and **, respectively.

Panel A: Dependent Variable = M&A (Value)				
Explanatory Variables	Model I	Model II	Model III	Model IV
ENTRY	0.26*** (5.42)	0.26*** (5.46)		0.24*** (4.95)
DISP CFLOW SHOCKS	9.60*** (5.04)	9.74*** (5.12)		9.92*** (5.18)
DISP ROS	17.36 (1.38)			15.33 (1.21)
DISP ROA		15.48 (0.93)		

Panel A: Dependent Variable = M&A (Value)				
Explanatory Variables	Model I	Model II	Model III	Model IV
M/B			4.81** (2.37)	3.29 (1.59)
Constant	0.27 (0.05)	3.51 (0.71)	11.44 (2.49)	0.18 (0.03)
R-Square	0.31	0.31	0.29	0.32
Observations	1440	1440	1440	1440
Panel B: Dependent Variable = M&A (Count)				
Explanatory Variables	Model I	Model II	Model III	Model IV
ENTRY	0.17*** (11.44)	0.17*** (11.28)		0.16*** (10.69)
DISP CFLOW SHOCK	0.56 (0.94)	0.44 (0.74)		0.70 (1.17)
DISP ROS	– 11.29*** (–2.89)			– 12.18*** (–3.10)
DISP ROA		– 1.96 (–0.38)		
M/B			2.68*** (4.15)	1.44** (2.25)
Constant	12.05 (6.68)	9.08 (5.92)	11.73 (8.04)	12.01 (6.67)
R-Square	0.72	0.72	0.69	0.72
Observations	1440	1440	1440	1440

Table 7a: Summary Statistics of Industry-year Variables by Industry Group

This table presents summary statistics of industry-year observations for M&A activity, by count and by value ($ billions in 2009 dollars), and for proxy variables used in industry group sub-sample regressions, for the 1980 to 2009 sample period. ENTRY is the count of new CRSP listed firms (share code 10 & 11). Number of Firms is the count of CRSP listed firms (share code 10 & 11). HH INDEX is Herfindahl-Hirschman index of industry concentration, the sum of the squared market shares (sales over total industry sales) of firms in an industry in a given year. DISP CFLOW SHOCK is the cross sectional standard deviation of firms' quarterly cash flow shocks, winsorized and scaled by quarter-end share price. DISP ROS is the cross-sectional standard deviation of the return on sales (cash flow/sales). DISP ROA is the cross-sectional standard deviation of the return on assets (cash flow/assets). To compute DISP ROS and DISP ROA I exclude firm-year observations where ROS or ROA is greater than 1 or less than –1, in order to remove the influence of extreme values. AVG R&D/ASSETS is the median R&D scaled by assets. DISP R&D/ASSETS is the cross sectional standard deviation of R&D scaled by assets. M/B is the natural log of the market-to-book equity ratio, the mean of the individual firm-year observations.

Deregulated Industries	Mean	Median	Max	Min	Std. Dev.	Obs.
M&A (count)	17.05	6.00	*146.00	0.00	26.78	150
M&A ($ billions)	25.38	5.96	**397.89	0.00	52.31	150
ENTRY	22.35	12.00	151.00	0.00	29.13	150
Number of Firms	250.09	189.00	873.00	63.00	192.19	150
HH INDEX	0.05	0.04	0.33	0.01	0.05	150
DISP CFLOW SHOCK	0.17	0.10	1.99	0.02	0.25	150
DISP ROS	0.21	0.19	0.38	0.10	0.08	150
DISP ROA	0.09	0.09	0.19	0.03	0.04	150
AVG R&D/ASSETS	0.00	0.00	0.00	0.00	0.00	150
DISP R&D/ASSETS	0.01	0.00	0.08	0.00	0.01	150
M/B (log)	0.28	0.29	1.59	– 0.80	0.38	150
"High-Tech" Industries	Mean	Median	Max	Min	Std. Dev.	Obs.
M&A (count)	7.60	5.00	***60.00	0.00	9.11	210
M&A ($ billions)	9.39	1.68	***333.16	0.00	22.28	210
ENTRY	17.50	13.00	167.00	0.00	21.03	210
Number of Firms	179.87	165.50	613.00	22.00	113.05	210
HH INDEX	0.11	0.10	0.39	0.03	0.07	210
DISP CFLOW SHOCK	0.11	0.07	1.22	0.02	0.12	210
DISP ROS	0.21	0.20	0.39	0.05	0.07	210
DISP ROA	0.17	0.17	0.26	0.05	0.04	210
AVG R&D/ASSETS	0.06	0.07	0.13	0.00	0.03	210
DISP R&D/ASSETS	0.21	0.20	0.39	0.05	0.07	210
M/B (log)	0.81	0.83	1.73	– 0.10	0.36	210

Table 7b: Correlation Coefficients of Industry-year Variables by Industry Group

This table presents correlation coefficients for the proxy variables employed in the study based on industry-year observations. The industry-year data is computed from firm-year observations. ENTRY is the count of new CRSP listed firms (share code 10 & 11).HH INDEX is Herfindahl-Hirschman index of industry concentration, the sum of the squared market shares (sales over total industry sales) of firms in an industry in a given year based on data from CRSP/Compustat merged file. DISP ROS is the cross-sectional standard deviation of the return on sales (cash flow/sales). DISP ROA is the cross-sectional standard deviation of the return on assets (cash flow/assets). To compute DISP ROS and DISP ROA I exclude firm-year observations where ROS or ROA is greater than 1 or less than –1, in order to remove the influence of extreme values. AVG R&D/ASSETS is the median R&D scaled by assets. DISP R&D/ASSETS is the cross sectional standard deviation of R&D scaled by assets. DISP CFLOW SHOCKS is the cross sectional standard deviation of firms' quarterly cash flow shocks, winsorized and scaled by quarter-end share price. M/B is the mean market-to-book equity ratio (in natural logs) for each industry-year.

Deregulated Industries	ENTRY	HH INDEX	DISP CFLOW SHOCK	DISP ROS	DISP ROA	AVG R&D/ ASSETS	DISP R&D/ ASSETS	M/B (log)
ENTRY	1.00							
HH INDEX	– 0.05	1.00						
DISP CFLOW SHOCK	0.02	0.02	1.00					
DISP ROS	0.03	0.28	0.40	1.00				
DISP ROA	– 0.11	0.32	0.34	0.71	1.00			
AVG R&D/ASSETS						1.00		
DISP R&D/ASSETS	– 0.02	0.11	0.25	0.43	0.61		1.00	
M/B (log)	0.15	0.34	– 0.06	0.25	0.28		– 0.12	1.00
"High-Tech" Industries	ENTRY	HH INDEX	DISP CFLOW SHOCK	DISP ROS	DISP ROA	AVG R&D/ ASSETS	DISP R&D/ ASSETS	M/B (log)
ENTRY	1.00							
HH INDEX	– 0.33	1.00						
DISP CFLOW SHOCK	– 0.02	– 0.03	1.00					
DISP ROS	0.34	– 0.58	0.01	1.00				
DISP ROA	0.36	– 0.39	0.19	0.77	1.00			
AVG R&D/ASSETS	0.37	– 0.62	0.17	0.54	0.59	1.00		
DISP R&D/ASSETS	0.38	– 0.66	0.17	0.70	0.66	0.81	1.00	
M/B (log)	0.55	– 0.45	– 0.23	0.67	0.58	0.43	0.50	1.00

2. UNIVARIATE ANALYSES: "HIGH-TECH" INDUSTRIES

Technological changes are not readily identified as specific-time events and thus, in this univariate setting, we simply examine whether there are obvious patterns in the time-series of M&A activity and measures of industry competition for "high-tech" industries. For brevity, we focus our analysis on a representative set of "high-tech" industries, i.e. computer hardware, computer software, electronic equipment and pharmaceutical products. The patterns shown here for the above industries are similar to those (not shown here) exhibited by the other "high-tech" industries, i.e. medical equipment, aircraft, and measuring and control.

A notable pattern in Panel A of Figures 2a through 2d is that M&A activity in these "high-tech" industries peaks around the end of the 1990s and the peaks correspond to the troughs in the Herfindahl-Hirschman index of industry concentration (panel D). M&A activity reached over $130 billion in 1999 in the pharmaceutical industry, $330 billion in 2000 in the computer software industry, $115 billion in 2000 in the Electronic Equipment industry, and $30 billion in 2001 in the Computer Hardware industry. The peaks in the computer software and electronic equipment industries coincide with the crash of the technology heavy Nasdaq stock market, which had its index reach its climax in March 2000. The run-up in the Nasdaq is attributed in part to the rapid commercial growth of the Internet – record setting growth in start-up dot.com companies was aided by venture capital and IPOs – and investments in new communication and information technologies. These record investments contributed to substantial industry overcapacity and consolidation in the early 2000s.

Figure 2a: Computer Hardware Industry M&A Activity and Proxy Variables, 1980 – 2009

Panel A plots the time-series of M&A activity by value (solid line) and by count (dashed line). Panel B plots the time-series of DISP ROS (solid line), the cross-sectional standard deviation of the return on sales (cash flow/sales), and DISP R&D/ASSETS (dashed line), the cross sectional standard deviation of R&D scaled by book assets. Panel C plots the time-series of HH INDEX (solid line), the Herfindahl-Hirschman index of industry concentration, and AVG R&D/ASSETS (dashed line), the median R&D scaled by book assets. Panel D plots the time series of HH INDEX (solid line) and Number of Firms (dashed line) listed on CRSP.

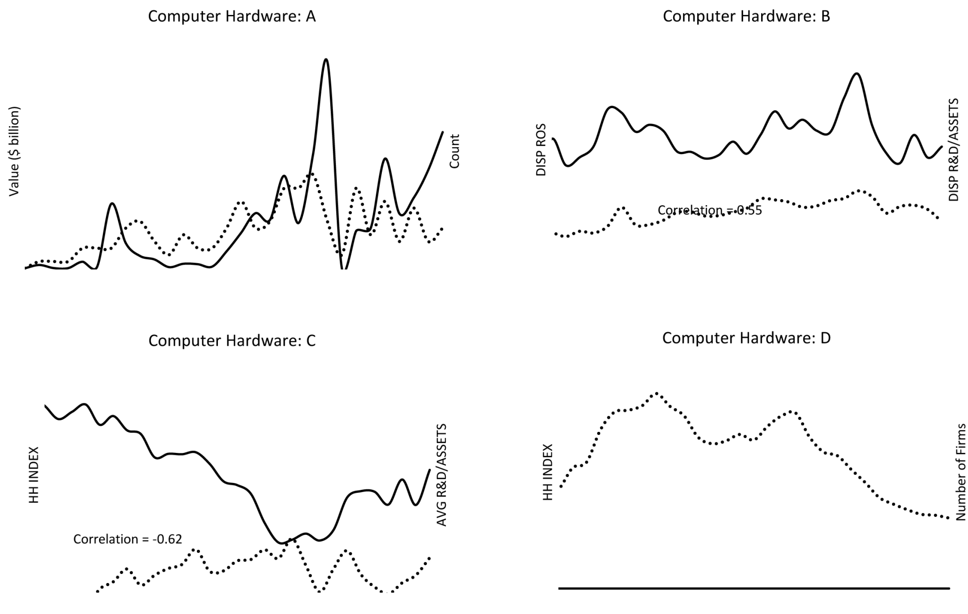


Figure 2b: Computer Software Industry M&A Activity and Proxy Variables, 1980 – 2009

Panel A plots the time-series of M&A activity by value (solid line) and by count (dashed line). Panel B plots the time-series of DISP ROS (solid line), the cross-sectional standard deviation of the return on sales (cash flow/sales), and DISP R&D/ASSETS (dashed line), the cross sectional standard deviation of R&D scaled by book assets. Panel C plots the time-series of HH INDEX (solid line), the Herfindahl-Hirschman index of industry concentration, and AVG R&D/ASSETS (dashed line), the median R&D scaled by book assets. Panel D plots the time series of HH INDEX (solid line) and Number of Firms (dashed line) listed on CRSP.

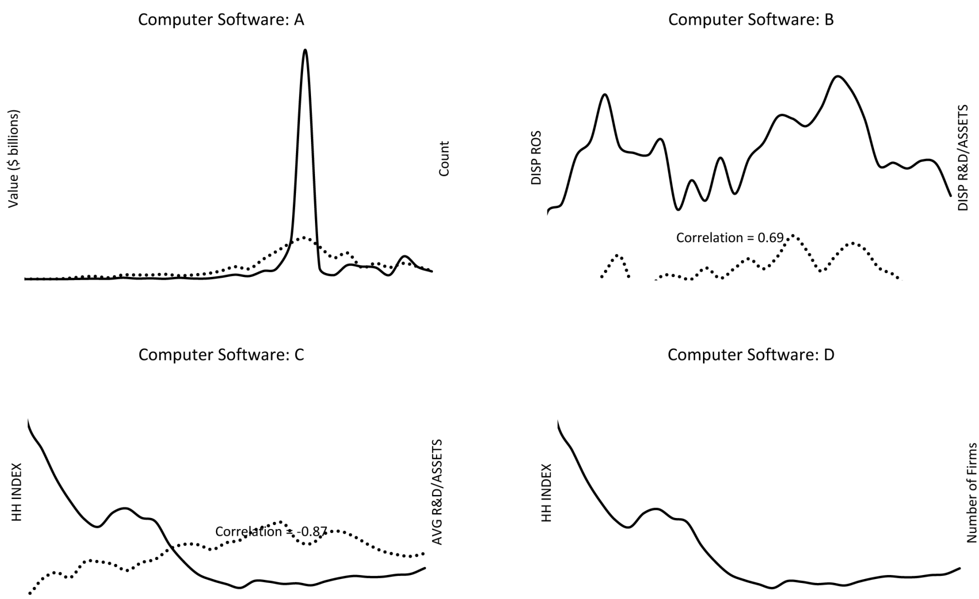


Figure 2c: Electronic Equipment Industry M&A Activity and Proxy Variables, 1980 – 2009

Panel A plots the time-series of M&A activity by value (solid line) and by count (dashed line). Panel B plots the time-series of DISP ROS (solid line), the cross-sectional standard deviation of the return on sales (cash flow/sales), and DISP R&D/ASSETS (dashed line), the cross sectional standard deviation of R&D scaled by book assets. Panel C plots the time-series of HH INDEX (solid line), the Herfindahl-Hirschman index of industry concentration, and AVG R&D/ASSETS (dashed line), the median R&D scaled by book assets. Panel D plots the time series of HH INDEX (solid line) and Number of Firms (dashed line) listed on CRSP.

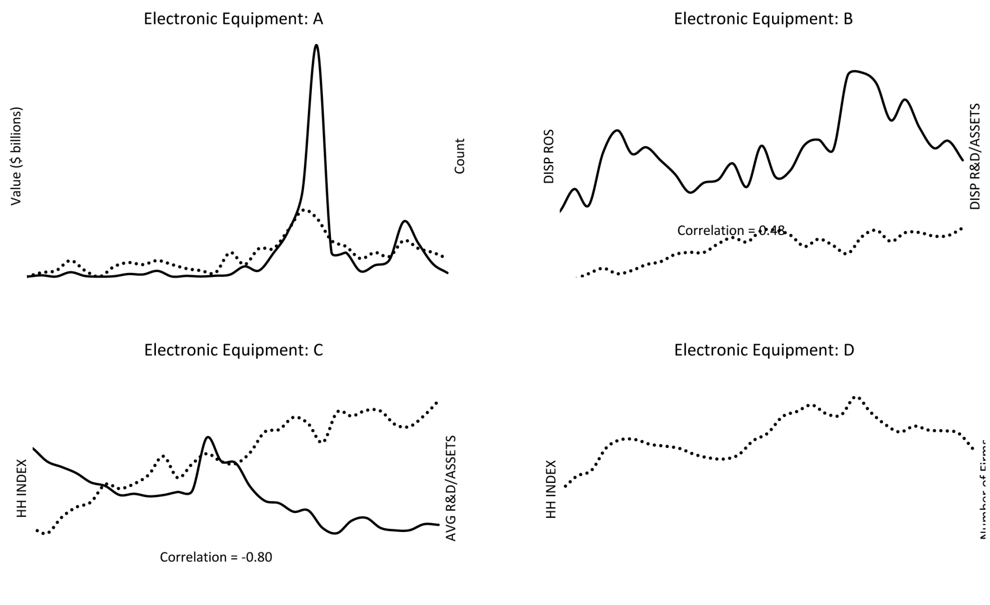
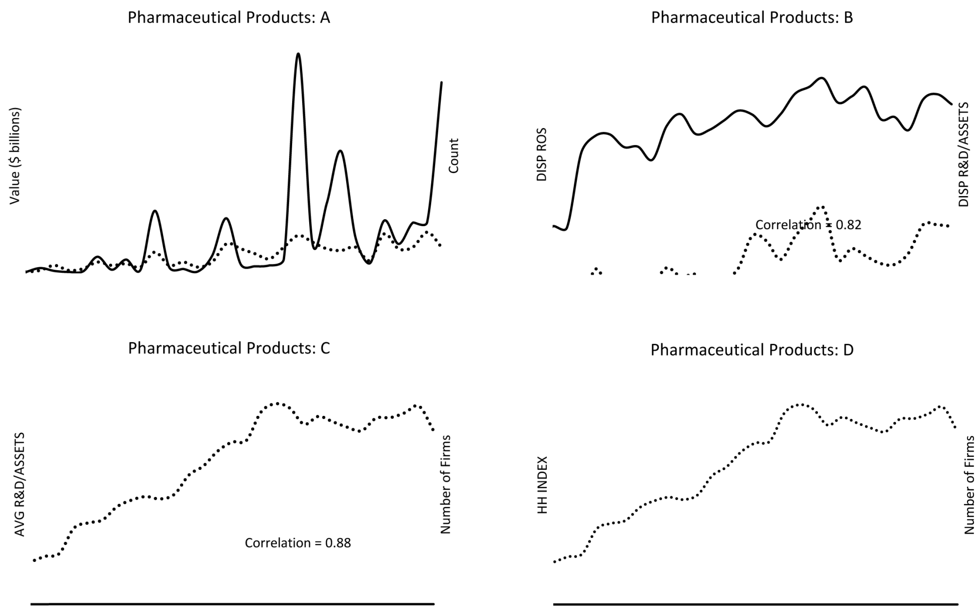


Figure 2d: Pharmaceutical Products Industry M&A Activity and Proxy Variables, 1980 – 2009

Panel A plots the time-series of M&A activity by value (solid line) and by count (dashed line). Panel B plots the time-series of DISP ROS (solid line), the cross-sectional standard deviation of the return on sales (cash flow/sales), and DISP R&D/ASSETS (dashed line), the cross sectional standard deviation of R&D scaled by book assets. Panel C plots the time-series of AVG R&D/ASSETS (solid line), the median R&D scaled by book assets, and Number of Firms (dashed line). Panel D plots the time series of HH INDEX (solid line), the Herfindahl-Hirschman index of industry concentration, and Number of Firms (dashed line) listed on CRSP.



The peaks of the late 1990s merger activity also appear to have coincided with the peaks in inter-firm dispersion in both ROS and R&D scaled by assets (see panel B of each figure). Across all four industries and over the sample period, both measures of dispersion in the quality of production technology exhibit high positive correlations, ranging from 0.48 in the electronic equipment industry to 0.82 in the pharmaceutical products industry. This suggests that periods of high inter-firm dispersion in ROS are often periods of high inter-firm dispersion in the rate of R&D investments. We plot in panel C of Figures 2a through 2d the time-series of the average rate of

R&D investment against the level of competition, measured by either the Herfindahl-Hirschman index or the number of firms. There is a high negative correlation between average R&D scaled by assets and the Herfindahl-Hirschman index (computer hardware, –0.62; computer software, –0.87; electronic equipment, –0.80). For the pharmaceutical products industry the correlation between average R&D scaled by assets and the number of firms is a positive 0.88. The data suggests that technological change plays a role in the observed associations between M&A activity and competition in "high-tech" industries. We examine this further in a multivariate setting.

VII. MULTIVARIATE TESTS: FULL SAMPLE

We employ fixed-effects regression model specifications for the multivariate tests. Table 6 shows the full sample results for the following regression equation with both year and industry fixed-effects.

$$M\&A_{jt} = b_0 + b_1 ENTRY_{jt} + b_2 DISP\ CFLOW\ SHOCKS_{jt} + b_3 DISP\ ROS_{jt} + b_4 M/B_{jt} + \alpha_t + \lambda_j + \varepsilon_{jt} \quad (5)$$

Panel A, presents full-sample regression results with industry-year M&A activity measured by value ($ billions in 2009 dollars) as the dependent variable, and Panel B shows the results with industry-year M&A activity measured by count as the dependent variable. Panel A shows a positive and significant association between industry M&A activity and ENTRY, indicating that the value of industry M&A activity increases with the level of entry. A one standard deviation increase in ENTRY increases industry M&A activity by $3.96 billion.

There is also a positive and significant association between industry M&A activity and DISP CFLOW SHOCKS, the proxy for cash flow volatility. A one standard deviation increase in DISP CFLOW SHOCKS increases industry M&A activity by $2.08 billion. The result from regression Model I shows that inter-firm dispersion in the quality of production technology, measured by DISP ROS, is positively but insignificantly associated with industry M&A activity. Model II substitutes DISP ROA for DISP ROS and the result is qualitatively similar. Model IV presents the result of regression equation (5). Here, conditioning on market valuation (M/B) to control for variation in the business cycle, growth opportunities and potential misvaluation, the associations between ENTRY and industry M&A activity, and between DISP CFLOW SHOCKS and industry M&A activity, remain positive and significant.

The full sample result shows that industry M&A activity is positively associated with the level of entry and cash flow volatility. This economically and statistically significant result is consistent with the hypothesis that industry merger activity is positively associated with industry competition. Panel B of Table 6 shows the regression result with M&A activity measured by count as the dependent variable. Similar to the result in Panel A, the coefficient on ENTRY is positive and significant, but the coefficient on DISP CFLOW SHOCKS is insignificant. In addition, the coefficient on DISP ROS is negative and significant, indicating that the count of industry M&A activity increases as inter-firm dispersion in the quality of production technology decreases. In order to draw clearer inferences about whether economic shocks from deregulation and technological change drive merger activity by increasing industry competition, we run separate regressions for deregulated and "high-tech" industries.

VIII. MULTIVARIATE TESTS: DEREGULATED AND HIGH-TECH INDUSTRIES

We run one set of regressions for deregulated industries and another set for "high-tech" industries to determine whether these shocks drive merger activity by increasing industry competition, and whether the channels differ in their importance to deregulation and technological change. The group of deregulated industries consists of industries – petroleum and natural gas, utilities, communication, banking and transportation – impacted by major deregulation events since the 1970s. The group of "high-tech" industries consists of industries – medical equipment, pharmaceutical, aircraft, computer hardware, computer software, electronic equipment, and measuring and control – classified as "high-tech" by the OECD (Organization for Economic Co-operation and Development) based on R&D intensity data from 1999. The communication industry also classifies as a "high-tech" industry but we treat it as a deregulated industry for the purpose of this analysis.

Panel A of Table 8 presents the regression results for the group of deregulated industries, with industry M&A activity measured by value. The result from regression Model IV indicates that entry and cash flow volatility are important channels through which deregulation drives M&A activity. Here a one standard deviation increase in ENTRY increases industry M&A activity by $6.70 billion. A one standard deviation increase in DISP CFLOW SHOCKS increases industry M&A activity by $30.91 billion, which shows that the cash flow volatility channel plays an important role in how deregulation drives merger activity and supports the idea that exit via merger is an alternative to exit via bankruptcy as cash flow volatility increases.

Table 8: Fixed-Effects Regression Analysis for Deregulated Industries

This table presents the results from sub-sample, by industry group, regressions of industry-year M&A activity, by value ($ billions in 2009 dollars) and by count, on explanatory variables for the sample period from 1980 to 2009. All regression models include year and industry fixed-effects. ENTRY is the count of new CRSP listed firms (share code 10 & 11). DISP CFLOW SHOCKS is the cross-sectional standard deviation of firms' quarterly cash flow shocks, winsorized and scaled by quarter-end share price. DISP ROS is the cross-sectional standard deviation of the return on sales (cash flow/sales). DISP ROA is the cross-sectional standard deviation of the return on assets (cash flow/assets). To compute DISP ROS I exclude firm-year observations where ROS is greater than 1 or less than –1, in order to remove the influence of extreme values. DISP R&D/AASETS is the cross–sectional standard deviation of R&D scaled by assets. M/B is the natural log of industry mean market-to-book equity ratio. Statistical significance at the 1% and 5% levels are denoted by *** and **, respectively.

Panel A: Dependent Variable = M&A (Value)					
Explanatory Variables	Model I	Model II	Model III	Model IV	Model V
ENTRY	0.37*** (2.76)	0.40*** (2.82)		0.23* (1.69)	0.18 (1.13)
DISP CFLOW SHOCKS	120.88*** (8.93)	106.96*** (8.42)		123.65*** (9.51)	107.97*** (8.68)
DISP ROS	– 236.23*** (–2.89)			– 239.49*** (–3.05)	
DISP R&D/AS-SETS		– 798.96* (–1.95)			27.20 (0.05)
M/B			28.95** (2.56)	29.63*** (3.32)	29.70** (2.45)
Constant	38.10 (1.76)	– 3.77 (–0.23)	41.39 (2.13)	50.01 (2.37)	7.58 (0.45)
R-Square	0.73	0.72	0.54	0.75	0.73
Observations	150	150	150	150	150
Panel B: Dependent Variable = M&A (Count)					
Explanatory Variables	Model I	Model II	Model III	Model IV	Model V
ENTRY	0.35*** (6.58)	0.34*** (5.77)		0.32*** (5.77)	0.31*** (4.51)

Panel B: Dependent Variable = M&A (Count)					
Explanatory Variables	Model I	Model II	Model III	Model IV	Model V
DISP CFLOW SHOCK	7.64 (1.44)	– 2.12 (–0.40)		8.21 (1.56)	– 2.00 (–0.37)
DISP ROS	– 156.85*** (–4.90)			– 157.51*** (–4.96)	
DISP R&D/AS-SETS		– 253.70 (–1.48)			– 157.98 (–0.70)
M/B			11.92*** (2.91)	6.03* (1.67)	3.44 (0.66)
Constant	63.07 (7.43)	35.27 (5.12)	49.49 (7.04)	65.50 (7.66)	36.59 (5.09)
R-Square	0.84	0.81	0.77	0.84	0.81
Observations	150	150	150	150	150

DISP ROS is negatively and significantly associated with industry M&A activity in deregulated industries. A one standard deviation decrease in DISP ROS increases industry M&A activity by $19.16 billion. This is consistent with the observation made earlier in the banking industry that the increase in M&A activity following the 1994 deregulation is associated with a decline in DISP ROS. The negative coefficient on DISP ROS indicates that, in deregulated industries, merger activity increases as inter-firm dispersion in operating efficiency decreases. This is a plausible result where deregulation, by increasing competition, forces less efficient firms to improve efficiency or exit via bankruptcy. For example, in the telecommunications industry, less efficient incumbents are not targeted for acquisitions but left to face exit via bankruptcy following the passage of the 1996 Telecommunications Act (Okoeguale, 2013).

In regression Model V, we substitute DISP R&D/ASSETS for DISP ROS to ensure an apples-to-apples comparison of the result for deregulated industries to the result for "high-tech" industries. We do, however, note that much of the R&D data for firms in deregulated industries, unlike those for firms in "high-tech" industries, is unavailable/non-existent. In regression Model V, DISP R&D/ASSETS, as well as ENTRY, is not significantly associated with industry M&A activity.

Panel B of Table 8 presents the regression results for the deregulated industries, with industry M&A activity measured by count. Regression Model IV shows a positive and significant association between ENTRY and industry M&A count. A one standard deviation increase in ENTRY increases industry M&A count by 9.32. The association between DISP ROS and industry M&A count is negative and significant. A one standard deviation decrease in DISP ROS increases industry M&A count by 12.6. In regression Model V, DISP R&D/ASSETS is not significantly associated with industry M&A count.

Table 9 Panel A presents the regression results for the "high-tech" industries, with industry M&A activity measured by value as the dependent variable. The level of entry is positively and significantly associated with industry M&A activity for "high-tech" industries. A one standard deviation increase in ENTRY increases industry M&A activity by $9.04 billion. Cash flow volatility is not significantly associated with industry M&A activity. Regression Model IV result shows that, unlike the result for the deregulated industries, DISP ROS and industry M&A activity are positively and significantly associated. This supports the hypothesis that technological change drives industry merger activity by increasing inter-firm dispersion in the quality of production technology. To test for robustness, Model V substitutes DISP R&D/ASSETS for DISP ROS. Here, a one standard deviation increase in DISP R&D/ASSETS increases industry M&A activity by $17.15 billion.

Table 9: Fixed-Effects Regression Analysis for "High-Tech" Industries

This table presents the results from sub-sample, by industry group, regressions of industry-year M&A activity, by value ($ billions in 2009 dollars) and by count, on explanatory variables for the sample period from 1980 to 2009. All regression models include year and industry fixed-effects. ENTRY is the count of new CRSP listed firms (share code 10 & 11). DISP CFLOW SHOCKS is the cross-sectional standard deviation of firms' quarterly cash flow shocks, winsorized and scaled by quarter-end share price. DISP ROS is the cross-sectional standard deviation of the return on sales (cash flow/sales). DISP ROA is the cross-sectional standard deviation of the return on assets (cash flow/assets). To compute DISP ROS I exclude firm-year observations where ROS is greater than 1 or less than –1, in order to remove the influence of extreme values. DISP R&D/AASETS is the cross– sectional standard deviation of R&D scaled by assets. M/B is the natural log of industry mean market-to-book equity ratio. Statistical significance at the 1% and 5% levels are denoted by *** and **, respectively.

Panel A: Dependent Variable = M&A (Value)					
Explanatory Variables	Model I	Model II	Model III	Model IV	Model V
ENTRY	0.30** (2.41)	0.33*** (2.70)		0.41*** (3.08)	0.43*** (3.24)
DISP CFLOW SHOCKS	– 0.09 (–0.01)	– 2.61 (–0.14)		– 6.33 (–0.35)	– 7.33 (–0.40)
DISP ROS	115.08* (1.82)			130.10** (2.06)	
DISP R&D/ASSETS		259.26* (1.86)			245.05* (1.77)
M/B			– 7.67 (–0.65)	– 27.68** (–2.19)	– 23.60* (1.87)
Constant	– 5.29 (–0.33)	– 2.03 (–0.14)	17.86 (1.45)	7.66 (0.45)	12.47 (0.76)
R-Square	0.36	0.36	0.32	0.38	0.37
Observations	210	210	210	210	210
Panel B: Dependent Variable = M&A (Count)					
Explanatory Variables	Model I	Model II	Model III	Model IV	Model V
ENTRY	0.13*** (4.45)	0.13*** (4.45)		0.16*** (5.13)	0.16*** (5.09)
DISP CFLOW SHOCK	2.71 (0.64)	0.80 (0.19)		1.03 (0.25)	– 0.58 (–0.14)
DISP ROS	– 0.38 (–0.03)			3.67 (0.25)	
DISP R&D/ASSETS		93.60*** (2.92)			89.43*** (2.82)
M/B			– 1.39 (–0.49)	– 7.45** (–2.50)	– 6.92** (–2.39)
Constant	4.32 (1.14)	– 2.48 (–0.74)	4.02 (1.35)	7.80 (1.97)	1.77 (0.47)
R-Square	0.66	0.67	0.61	0.67	0.68
Observations	210	210	210	210	210

Table 9 Panel B presents the regression results for the “high-tech” industries, with industry M&A activity measured by count. Here, industry M&A count is positively and significantly associated with both ENTRY and DISP R&D/ASSETS. A one standard deviation increase in ENTRY increases industry M&A count by 3.37; a one standard deviation increase in DISP R&D/ASSETS increases industry M&A count by 6.26. Cash flow volatility is not significantly associated with industry M&A count.

In summary, the results indicate that the channels differ in their importance to deregulation and technological change. Deregulation drives merger activity by increasing entry and cash flow volatility. Technological change, on the other hand, drives merger activity by increasing entry and inter-firm dispersion in the quality of production technology.

IX. CONCLUSION

Merger activity tends to cluster within a few industries during periods of high aggregate merger activity. Prior research provides strong empirical evidence linking the industry-level clustering of merger activity in the 1980s and 1990s to changes to industry structure brought about by economic shocks from deregulation (Mitchell and Mulherin, 1996; Mulherin and Boone, 2000; Andrade et al., 2001). Jovanovich and Rousseau (2002) use a Q-theory model of mergers to show that the merger waves of the 1980s and 1990s were a response to profitable reallocation opportunities attributable to economic shocks from technological changes. The evidence from prior research, notwithstanding, is less clear on the mechanism through which economic shocks from deregulation and technological change drive merger activity.

In this paper, we test whether economic shocks from deregulation and technological change drive industry merger activity by increasing industry competition, controlling for the effect of valuations. We show that these shocks drive merger activity through three channels related to industry competition and that differ in their importance to deregulation and technological change; deregulation drives merger activity by increasing entry and cash flow volatility; technological change drives merger activity by increasing entry and inter-firm dispersion in the quality of production technology. The evidence underscores the role of the competitive mechanism in how managers reallocate assets to more efficient uses via mergers and supports the view that the industry-level clustering of merger activity is an efficiency-driven restructuring response to increased competition.

Although the evidence linking increases in industry merger activity, following deregulation, to increases in competition supports the view that the industry-level clustering of merger activity is an efficiency/synergy-driven restructuring response, it does not nullify an alternative view that mergers following deregulation is motivated by collusion. Testing or teasing out these alternative views would be best suited for single-industry studies, less susceptible to noise given that a number of plausible underlying forces could be at work in different industries at the same time. For example, Becher, Mulherin and Walking (2012) distinguish between the synergy and collusion hypotheses by studying stock price returns to rivals of merging firms across several dimensions including deregulation in the utility industry. Their results are consistent with synergy and inconsistent with collusion.

An important implication of the findings from this study is that other sources of economic shocks such as industry overcapacity, financing innovations, globalization, international trade, demand shocks and input costs shocks potentially drive industry merger activity by inducing a more competitive environment. A possible area of future research would be to examine such shocks individually and its impact on the competitive environment as a whole or in a specific industry.

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