Banking Consolidation and Innovation in the United States

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Abstract

We examine the relationship between banking consolidation and innovation across U.S. states from 1994 to 2020. We find a nonlinear relationship between banking consolidation and innovation: marginal effects are positive at low to moderate levels of concentration but become negative at higher levels. We also document substantial regional heterogeneity, with stronger effects in the Northeast and South and weaker effects in the Midwest and West. Finally, when distinguishing between types of innovation, we find suggestive evidence that banking consolidation tends to foster incremental rather than disruptive innovation, implying that greater concentration in the traditional banking sector may slow more radical forms of technological progress.

Introduction

Banking institutions in the United States have consolidated at a notable pace over the past decades, transforming the financial landscape and, by extension, the broader economy. Since 2005, the number of banking institutions has fallen by 35% (FDIC, 2025), making it evident that consolidation is a prominent characteristic of the 21st century banking landscape. This wave of consolidation has been driven by several factors, including regulatory changes, advancements in financial technology, rural-to-urban migration, and the pursuit of economies of scale. Structural shifts such as these not only reshape the banking sector, but they also introduce systematic changes throughout the economy, notably in the formation of businesses and entrepreneurial trends (Hean & Jabas, 2024). Because entrepreneurship serves as a conduit for innovative output, banking consolidation may influence innovation. This interpretation aligns with Hean and Jabas (2024), who show that higher banking concentration can negatively affect entrepreneurship by making it more difficult for disruptive, high-risk innovations to obtain financing from the traditional banking system. Similarly, other studies have shown that bank mergers and acquisitions

can affect small businesses and broader economic outcomes (Garmais and Moskowitz, 2006; Nguyen, 2019).

In this paper, we examine the relationship between banking consolidation and innovation across U.S. states from 1994 to 2020. We begin by analyzing how banking concentration affects the quantity of innovation, measured by total patent counts and patents per 100,000 people. The analysis is conducted for all U.S. states and for disaggregated regions. To further understand the impact of banking consolidation, we examine how it influences different types of innovation based on their degree of disruptiveness, following Funk and Owen-Smith (2017) and Park et al. (2023). This approach allows us to assess how the structure of the banking market shapes not only the overall level of innovation but also its composition and quality.

Our results yield three primary findings. First, banking consolidation exhibits a pronounced nonlinear relationship with innovation: the marginal effects are positive at low to moderate levels of concentration but become negative as markets become highly concentrated. Second, there is substantial regional heterogeneity. The relationship is stronger in the Northeast and South, whereas the Midwest and West display weaker effects with lower statistical significance. Third, we find evidence that banking consolidation affects innovation differently depending on the type of innovative activity. Specifically, we document a nonlinear negative association between banking concentration and disruptive patenting, indicating that higher levels of concentration are associated with a decline in more radical forms of innovation. In contrast, we observe a nonlinear positive relationship between banking consolidation and non-disruptive patents, suggesting that more concentrated banking systems tend to support incremental or follow-on innovation. Taken together, these patterns imply that consolidation may shift banks' risk preferences, encouraging lending toward established firms and incremental innovation while reducing financing for riskier, startup-driven, disruptive activities. This interpretation aligns with Hean and Jabas (2024), who show that higher banking concentration can negatively affect entrepreneurship by making it more difficult for disruptive, high-risk innovations to obtain financing from the traditional banking system. Similarly, other studies have shown that bank mergers and acquisitions can affect small businesses and broader economic outcomes (Garmais and Moskowitz, 2006; Nguyen, 2019).

Previous studies have produced conflicting evidence regarding the effect of banking consolidation on innovation. On the one hand, Chava et al. (2013) support the market power hypothesis, which argues that concentrated banking markets may hinder

innovation, particularly among young firms. Amore, Schneider, and Žaldokas (2013) find that the Riegle–Neal Interstate Banking and Branching Efficiency Act (IBBEA), which permitted banks to operate across state lines, increased competition and improved banks' ability to diversify risk, thereby fostering greater investment in innovation. In contrast, Petersen and Rajan (1995) contend that banking market concentration can enhance access to financing for credit-constrained firms, consistent with the efficiency hypothesis. As a result, empirical findings to date remain mixed.

While there is extensive research on banking structure and firm financing, relatively few studies examine how these dynamics shape the geography and nature of innovation. Prior work often focuses on regulatory changes, using policy shocks as sources of identification to infer effects on innovation. By contrast, our study examines the relationship between banking consolidation and innovation, abstracting from specific regulatory events. This approach allows us to assess how long-term market structure influences innovative activity across states. Furthermore, existing studies rarely consider the type or quality of innovation, raising the question of whether consolidation affects not only the volume of innovation but also its composition, particularly the balance between disruptive and incremental innovations.

Our paper has important policy implications. Policymakers concerned with maintaining financial market efficiency and supporting U.S. innovation growth should consider how market structure affects not only the availability of credit that facilitates patenting activity but also the nature of innovation itself. Understanding these mechanisms is essential for designing banking systems and regulations that promote both financial stability and the efficient intermediation of funds to innovative firms.

The remainder of this paper proceeds as follows. Section 2 describes the data and presents trends in U.S. banking consolidation. Section 3 outlines the empirical strategy, and Section 4 reports the main results. Section 5 provides sensitivity analyses to assess robustness. Section 6 corroborates the findings by examining the nature of innovation, and Section 7 concludes.

Data

Our study includes the years 1994-2020.[1] We analyze all states across the United States but also incorporate regional subsamples to examine underlying heterogeneity. We examine four Census Bureau regions: the Northeast, Midwest, South, and West. The

[1] In the sensitivity analysis, some data are available only for the period from 2005 to 2020.

Northeast comprises Connecticut (CT), Maine (ME), Massachusetts (MA), New Hampshire (NH), Rhode Island (RI), Vermont (VT), New Jersey (NJ), New York (NY), and Pennsylvania (PA). The Midwest includes Illinois (IL), Indiana (IN), Iowa (IA), Kansas (KS), Michigan (MI), Minnesota (MN), Missouri (MO), Nebraska (NE), North Dakota (ND), Ohio (OH), South Dakota (SD), and Wisconsin (WI). The South includes Alabama (AL), Arkansas (AR), Delaware (DE), Florida (FL), Georgia (GA), Kentucky (KY), Louisiana (LA), Maryland (MD), Mississippi (MS), North Carolina (NC), Oklahoma (OK), South Carolina (SC), Tennessee (TN), Texas (TX), Virginia (VA), and West Virginia (WV). The West comprises Alaska (AK), Arizona (AZ), California (CA), Colorado (CO), Hawaii (HI), Idaho (ID), Montana (MT), Nevada (NV), New Mexico (NM), Oregon (OR), Utah (UT), Washington (WA), and Wyoming (WY).

We measure banking competition using the Herfindahl-Hirschman Index (HHI), a standard measure of market concentration. The Federal Deposit Insurance Corporation (FDIC) provides state-level HHI data computed from deposit shares held by financial institutions as follows:

$$HHI = 10{,}000 \left(\sum_{i=1}^{n} S_i^2 \right)$$

HHI is defined as the sum of the squared market shares of all firms in a market, where s_i denotes the percentage share of firm i. The index ranges from 0 to 10,000. Values near zero reflect highly competitive markets with many evenly sized firms, whereas higher values indicate greater concentration as a few firms dominate. The index is widely used by both the U.S. Department of Justice and the Federal Reserve to assess banking concentration (Hean & Jabas, 2024; Meyer, 2018). As a robustness check, we also incorporate the four-firm concentration ratio (CR4), which captures the combined market share of the four largest banks in each market.

The United States Patent and Trademark Office (USPTO) provides an annual breakdown of U.S. patent grants by state and by four different types (i.e., utility, design, plant, and reissue). Consistent with the existing innovation literature, we focus exclusively on utility patents, which account for the vast majority of patents granted in the United States and are widely regarded as a primary indicator of technological innovation (Hall et al., 2001; Hean & Partridge, 2022; Hean et al., 2023).

In addition to our primary patent-based indicators, we incorporate the CD5 index introduced by Funk and Owen-Smith (2017) and later refined by Park et al. (2023) to further capture the quality and influence of innovative output. While regional patent

grants reflect the quantity of patenting activity, the CD5 index provides a complementary perspective by assessing the technological impact of a patent. As described by Park et al. (2023), the CD5 index captures the distinction between consolidating and disruptive patents. A patent is considered consolidating when it builds upon or incrementally improves existing work, thereby strengthening established technological trajectories. In contrast, a disruptive patent renders prior knowledge less relevant by introducing new technological paradigms. To make this distinction, the index examines the citation behavior of subsequent patents. Specifically, it compares how frequently new patents cite a given patent relative to how frequently they also cite the given patent's predecessors. Put simply, if a patent is disruptive, subsequent work that cites it is less likely to also cite its predecessors. Conversely, if a patent is consolidating, subsequent work that cites it is more likely to also cite its predecessors. The intuition is that the prior ideas that contribute to a disruptive patent's production become less relevant, whereas the ideas that contribute to a consolidating patent's production remain relevant or become even more so.

We source data on disruptive and consolidating patents from Funk et al. (2022) and Park et al. (2023). The available data span 1994 to 2010, and we aggregate the observations to the state-year level. For each state-year, we compute the number of disruptive (CD5 > 0), consolidating (CD5 < 0), and neutral (CD5 = 0) patents. Because Funk et al. (2022) and Park et al. (2023) apply strict filtering criteria to construct the CD5 dataset (e.g., excluding patents with missing citation metadata), the CD5 dataset contains fewer observations than raw USPTO patent counts.

For state-level covariates, we adopt three key indices from Stansel et al. (2021): the state-level labor market regulation index, the taxation index, and the government spending index. The Labor Market Regulation Index encompasses minimum wage as a percentage of per capita income, government employment as a percentage of total state employment, and union density. The Taxation Index includes income and payroll tax revenue as a percentage of income, property tax and other tax as a percentage of income, and sales taxes as a percentage of income. The Government Spending Index includes consumption expenditures by government as a percentage of income, transfers and subsidies as a percentage of income, and insurance and retirement payments as a percentage of income. All indices are calculated on a scale from 0 to 10, where 10 indicates more relaxed labor regulations, lower taxes, or reduced government spending.[2]

[2] The Fraser Institute introduced a methodological update to the EFNA index beginning with its 2024 release, affecting the construction of the Government Spending, Taxation, and Labor Market Regulation components. We used the legacy version of the EFNA data available prior to this revision to maintain comparability across years.

Finally, we obtain population data from the U.S. Census Bureau, including the percentages of female, non-Hispanic Black, and Hispanic populations. We also obtain unemployment rates and per capita income data from the Federal Reserve Bank of St. Louis, and the housing price index from the Federal Housing Finance Agency. Table 1 presents descriptive statistics for the key variables.

Table 1. Descriptive Statistics

Variables	N	Mean	SD	Min	Max
Patents Granted	1,350	2,043.14	4,159.57	18	46,177
Patent Per 100k	1,350	28.15	21.80	2.65	136.31
HHI	1,350	1,022.75	841.35	114.77	6,400.90
CR4	1,350	0.51	0.17	0.15	0.97
Disruptive Patents	850	659.38	1,249.47	0	11,505
Neutral Patents	850	409.63	660.80	4	7,066
Consolidating Patents	850	485.41	809.24	4	8,425
Government Spending	1,350	6.52	1.69	0	9.70
Taxation Index	1,350	5.76	0.95	2.68	8.23
Labor Market Freedom	1,350	5.98	1.05	2.57	8.92
Home Price Index	800	538.80	190.84	284.08	1,406.60
% Bachelors	800	0.29	0.05	0.17	0.47
% Female Population	800	0.51	0.01	0.47	0.52
% Non-Hispanic Black Population	800	0.10	0.09	0	0.38
% Hispanic Population	800	0.11	0.10	0.01	0.49
Number of Banking Institutions	1,350	190.34	168.71	7.00	1,124
Number of Banking Offices	1,350	1,784.86	1,568.87	118.00	7,401
Unemployment	800	5.77	2.19	2.11	13.69
Per Capita Income	800	44,211.70	8,952.53	26,716.00	77,470
Establishment Deaths	800	17,029.32	23,141.33	1,618.00	175,882
Total Population	1,350	5,963,979.11	6,603,674.53	474,982.00	39,521,958

Notes: Patents are classified using the CD5 index from Park et al. (2023). Disruptive patents have CD5 > 0, indicating they make prior knowledge less relevant by introducing new technological paradigms. Consolidating patents have CD5 < 0, indicating they build upon and strengthen existing technological trajectories. Neutral patents have CD5 = 0.

To illustrate recent changes in the U.S. banking market, we summarize trends in banking consolidation since 1994. Figure 1 shows a consistent decline in banking institutions from approximately 13,000 in 1994 to roughly 7,000 by 2020, reflecting ongoing consolidation in the sector. In contrast, Figure 1.b shows that banking offices increased from about 81,000 in 1995 to a peak of approximately 98,000 around 2009, then declined sharply to about 85,000 by 2020, with the decline coinciding with the onset of the Great Recession. Figure 2 displays these trends by region, revealing similar patterns across regions, though with varying magnitudes.

Figure 1: Banking Institutions and Offices in the USA

1.a Banking Institutions

1.b Banking Offices

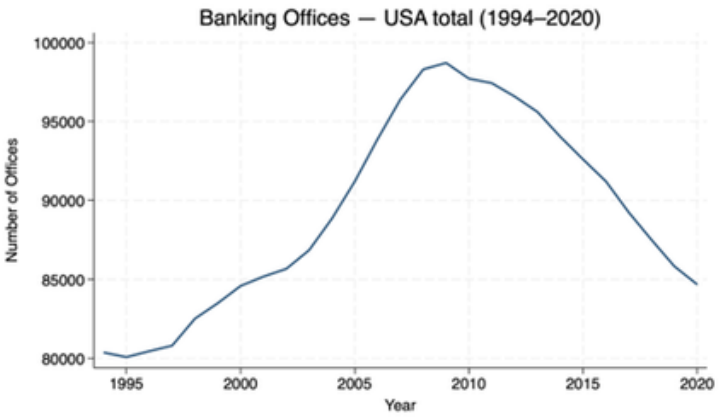
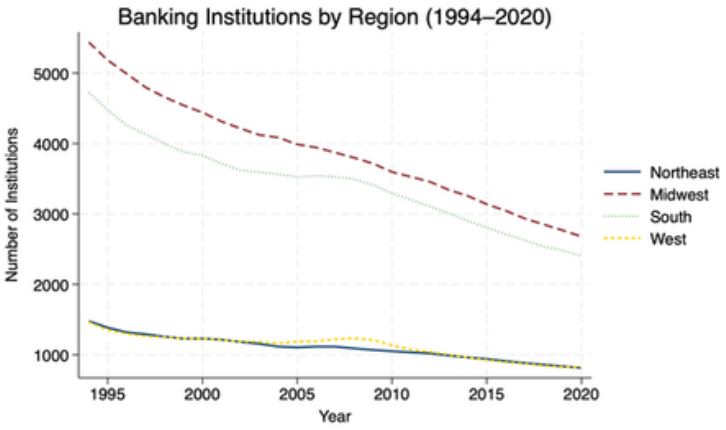
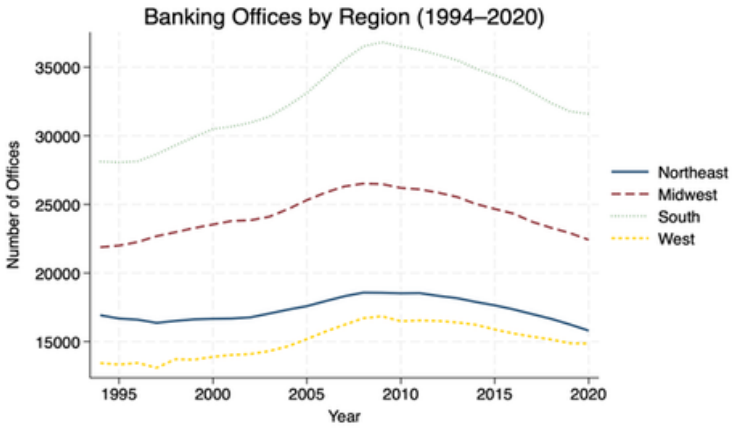


Figure 2: Banking Institutions and Offices by Region

2.a Banking Institutions



2.b Banking Offices



Empirical Strategy

To evaluate the effect of banking competition on innovation, we estimate the following fixed-effects linear regression model:

$$y_{st} = x'_{st}\beta + z'_{st}\omega + \delta_s + \tau_t + \varepsilon_{st}$$

Here, y_{st} denotes either the number of patents granted in state s and year t, or the number of patents granted per 100,000 people in state s and year t. To capture potential nonlinear functional forms of banking competition, X includes both the Herfindahl–Hirschman Index (HHI_st) and its squared term (HHI_st^2). As a robustness check, we replace HHI with the four-firm concentration ratio ($CR4$).

The vector Z represents our control variables, comprising state-level indices of government spending, taxation, and labor market freedom. In addition, we include state fixed effects to account for unobserved socioeconomic conditions at the state level, while year fixed effects control for aggregate shocks common to all states in each year. All regressions are estimated using bootstrapped standard errors to account for potential heteroskedasticity and serial correlation.

As noted earlier, we also examine whether banking consolidation affects different types of innovation, including disruptive, consolidating, and neutral patents. This empirical framework allows us to assess how changes in the banking market influence not only the overall volume of innovative activity but also the nature and quality of innovation, as reflected in its degree of disruptiveness.

Empirical Results

Table 2 presents regression estimates of the relationship between banking consolidation and innovation across U.S. states from 1994 to 2020, while Figures 3 and 4 show the marginal effects of banking consolidation on U.S. patenting. The results indicate a nonlinear, generally concave relationship between banking concentration and innovation, although the strength of this pattern varies across specifications.

In Column 1, with total patents granted as the dependent variable, the HHI coefficient is positive and statistically significant, whereas the coefficient on HHI^2 is negative and statistically significant, indicating a concave relationship between banking concentration

and innovation. This pattern suggests that innovation initially rises with moderate consolidation but declines once concentration becomes excessive. Column 2, which uses patents per capita as the dependent variable, yields coefficients with similar signs, although they are estimated less precisely.

Columns 3 and 4, which employ the four-firm concentration ratio (CR4), show similarly robust and statistically significant relationships for both total and per capita patent specifications. The positive linear and negative quadratic coefficients on CR4 indicate that moderate levels of market concentration, particularly when the largest banks hold substantial market shares, are associated with higher innovation, whereas excessive dominance tends to dampen innovative output.

Table 2. Effects of Banking Concentration on Patenting

	HHI		CR4	
	Patents Granted (1)	Patents per 100,000 people (2)	Patents Granted (3)	Patents per 100,000 people (4)
Banking Concentration	0.620**	0.002	4878.980***	28.092**
	(0.249)	(0.003)	(1461.040)	(11.163)
Banking Concentration^2	-0.00013***	-0.00000045	-3943.370***	-26.159***
	(0.000046)	(0.00000041)	(1143.53)	(8.989)
Controls				
Government Spending	215.317***	2.001***	226.590***	2.062***
	(55.200)	(0.469)	(55.320)	(0.468)
Taxation Index	-716.444***	-3.527***	-738.725***	-3.655***
	(179.652)	(0.900)	(180.705)	(0.905)
Labor Market Freedom	-363.174***	-3.158***	-376.941***	-3.266***
	(115.888)	(0.622)	(114.086)	(0.615)
Observations	1,350	1,350	1,350	1,350
R-squared	0.841	0.841	0.841	0.841

Notes: All regressions include year and state fixed effects. Bootstrap standard errors in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

In Appendix A, we show that the relationships between banking consolidation and patenting activity are similar across regions, although the magnitudes differ. As shown in Tables A.1 and A.2, the results indicate a generally positive and nonlinear relationship, broadly consistent with the national-level estimates. However, the Midwest and West display similar dynamics at smaller magnitudes and lower levels of significance, suggesting that innovative activity in these regions is less sensitive to variations in banking market structure. These findings highlight the non-uniform nature of the consolidation–innovation relationship across regions. The more pronounced positive effects observed in the Northeast and South underscore the importance of traditional bank-based funding provided by large institutions, whereas the weaker effects in the Midwest and West likely reflect differences in industrial composition and the availability of alternative financing channels that reduce dependence on large banks.

To sum up, our results suggest that increased banking concentration is associated with higher innovation output, particularly at moderate levels of concentration. This pattern is consistent with the idea that concentrated markets with dominant banks may be better positioned to extend credit to risky, innovative ventures. However, the nonlinear effects and regional differences indicate that the optimal level of banking concentration for promoting innovation likely depends on local economic conditions and the existing innovation ecosystem. In a later section, we show that this positive relationship holds only for incremental innovation, whereas banking consolidation may hinder disruptive innovation.

Figure 3. Marginal Effect of HHI on U.S. Patents Granted

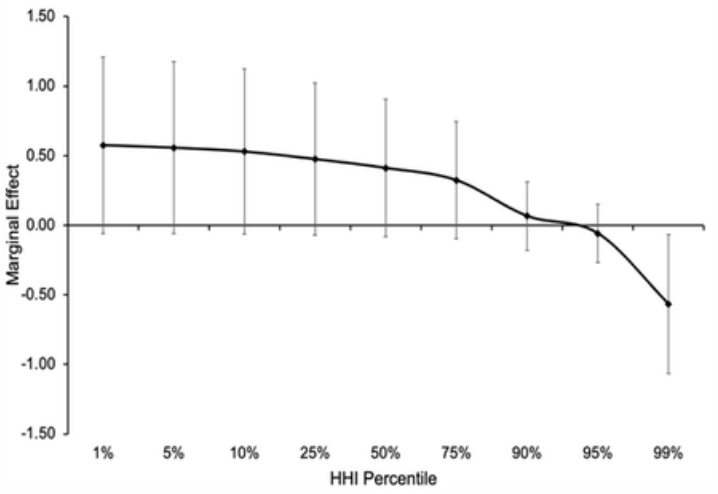
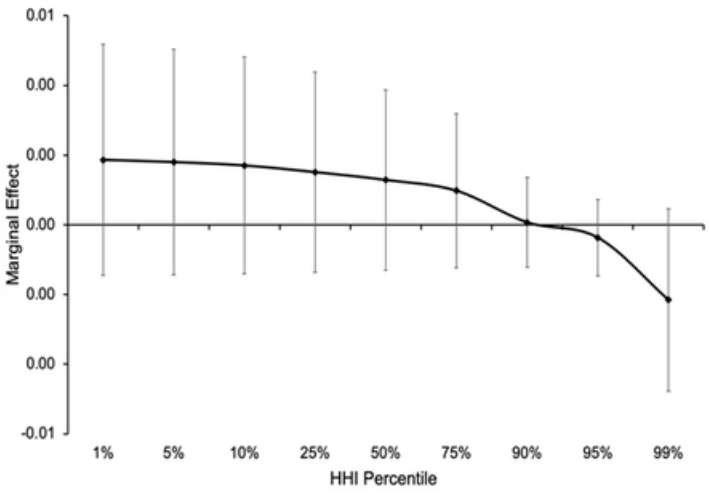


Figure 4. Marginal Effect of HHI on U.S. Patents per 100,000 people



Sensitivity Analysis

Our baseline specification is deliberately parsimonious. To further evaluate the robustness of the findings, Appendix B presents estimates that incorporate an expanded set of control variables. These controls capture key socioeconomic and demographic characteristics, including the unemployment rate, per capita income, the housing price index, the share of adults with a bachelor's degree, the proportion of the population that is female, the shares of non-Hispanic Black and Hispanic residents, and the number of business establishment closures per 10,000 inhabitants.[3]

The sensitivity analysis yields results that are broadly consistent with the baseline estimates. In particular, banking consolidation exhibits a nonlinear relationship with innovative activity: at moderate levels, consolidation is associated with greater risk-taking and higher levels of innovation, whereas excessive concentration in the banking sector is associated with a decline in innovative output.

Additional Analysis

To further understand the impact of banking consolidation on innovation, we examine how banking concentration affects different types of innovative activity. Disruptive innovation is typically driven by smaller, younger firms or startups that lack established collateral and stable cash flows (Chandy and Tellis, 2000). Consequently, as noted by Lerner and Nanda (2020), these firms often face limited access to traditional bank financing and instead rely more heavily on nonbank funding channels such as venture capital and private equity.

In contrast, Chandy and Tellis (2000) show that large incumbent firms with established banking relationships are more likely to engage in incremental innovation, enhancing existing products or technologies to reinforce their market position. Accordingly, incumbent firms tend to be less associated with disruptive or radical innovation, whereas smaller firms are more likely to lead such activity due to their greater organizational flexibility and the absence of legacy products and technologies that must be maintained.

To empirically capture these distinctions, we employ the CD5 index developed by Funk and Owen-Smith (2017) and refined by Park, Leahey, and Funk (2023) as an additional measure to assess the effects of banking consolidation on the quality and impact of patents. While our baseline measures capture the quantity of innovative output, the CD5

[3] Because most additional control variables are only available beginning in 2005, the sample size is substantially reduced.

index captures the direction and impact of innovation by distinguishing between disruptive, consolidating, and neutral patents.

For this analysis, we use data on disruptive and consolidating patents from Funk et al. (2022) and Park et al. (2023). The sample covers the period from 1994 to 2010, resulting in a smaller sample than in our baseline analysis. Table 3 reports the national-level estimates for disruptive, consolidating, and neutral patents and provides several insights into patent quality dynamics, while Appendix C presents the corresponding regional estimates.

First, across all patent classifications, the coefficients on HHI are generally small and statistically insignificant, suggesting that banking concentration, when measured across the full distribution of banks, has a limited and imprecise relationship with innovation quality. In contrast, the coefficients on CR4 are large, statistically significant, and display heterogeneous patterns across patent classifications. The strong statistical significance of CR4, coupled with the lack of significance for HHI, suggests that the type of innovation is more strongly influenced by the dominance of the largest banks in a given market than by overall market concentration.

Second, our results suggest that banking consolidation has heterogeneous effects across different types of innovation. Specifically, we find a nonlinear negative relationship between banking consolidation and disruptive patenting, indicating that higher levels of concentration tend to reduce the production of disruptive innovations. In contrast, banking consolidation exhibits a nonlinear positive relationship with non-disruptive patents, suggesting that more concentrated banking markets may facilitate incremental or consolidating forms of innovation. These findings suggest that banking consolidation leads banks to take on less risk, directing their lending toward incremental innovation activities and established firms rather than toward riskier investments in small startups.

Table 3. Effects of Banking Concentration on Innovation Type (CD5 Index)

	HHI			CR4		
	Disruptive (1)	Consolidating (2)	Neutral (3)	Disruptive (4)	Consolidating (5)	Neutral (6)
Banking Concentration	-0.082 (0.064)	0.019 (0.056)	0.048 (0.056)	-1259.610*** (319.037)	851.897*** (280.103)	1269.710*** (295.508)

	Disruptive (1)	Consolidating (2)	Neutral (3)	Disruptive (4)	Consolidating (5)	Neutral (6)
Banking Concentration^2	0.000014	-0.0000063	-0.000012	932.050***	-770.611***	-1107.650***
	(0.000011)	(0.000011)	(0.000011)	(237.256)	(218.478)	(231.272)
Controls						
Government Spending	41.017**	45.074***	39.243***	37.706***	47.533***	42.817***
	(13.963)	(11.992)	(11.875)	(14.115)	(11.568)	(11.305)
Taxation Index	45.889	-72.027**	-113.595***	48.196	-74.609**	-116.950***
	(39.514)	(33.037)	(34.032)	(39.336)	(32.860)	(33.330)
Labor Market Freedom	-73.967	-143.914***	-154.456***	-72.410	-145.960***	-157.606***
	(52.118)	(44.868)	(40.570)	(51.894)	(44.345)	(40.063)
Observations	847	847	847	847	847	847
R-squared	0.953	0.917	0.882	0.953	0.917	0.883

Notes: All regressions include year and state fixed. Bootstrap standard errors in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Conclusion

We explore how banking consolidation influences innovation in the United States. We find evidence of a nonlinear relationship between banking concentration and innovative activity. At moderate levels of consolidation, patenting tends to increase, but when concentration becomes excessive, innovation declines. The results are not uniform across regions. The estimates are weaker in Midwest and West likely reflect differences in industrial composition and the availability of alternative financing channels that reduce dependence on large banks.

Our corroborative analysis provides suggestive evidence that banking consolidation influences different types of innovation in distinct ways. We observe a nonlinear negative relationship between banking concentration and disruptive patenting, indicating that higher levels of concentration are associated with a reduction in more radical forms of innovation. In contrast, banking consolidation shows a nonlinear positive association with non-disruptive patents, suggesting that more concentrated banking markets tend to support incremental or follow-on innovation. Taken together, these findings imply that consolidation may shift banks' risk preferences, channeling credit toward established firms and incremental innovation while limiting financing for riskier, startup-driven, disruptive activities.

These findings carry important policy implications. Policymakers seeking to preserve financial stability while supporting long-run U.S. innovation should consider how the structure of the traditional financing system through banks shapes not only the overall supply of credit but also the type of innovation that receives funding. If greater concentration in the traditional banking sector channels financing toward safer, incremental projects and established firms, regulators may need to complement consolidation with policies that sustain credit access for startups and high-risk, high-impact innovation. This may include fostering competition in banking markets, supporting targeted lending programs, and encouraging greater participation from the private sector, such as venture capital, private equity, and other nonbank financial intermediaries that can finance riskier, disruptive innovations.

Our results point to several avenues for future research. Further work could examine the mechanisms through which consolidation alters banks' risk-taking behavior, explore how firms substitute between traditional bank financing and private sources of capital, and assess whether private sector financing can offset reduced bank lending to innovative startups. In addition, future studies could investigate how these relationships evolve with financial technology developments and regulatory changes, and extend the analysis to other institutional settings to evaluate the generalizability of these patterns.

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Appendix A

Table A.1. Effects of Banking Concentration on Patent Grants by Region

	HHI				CR4			
	Northeast (1)	Midwest (2)	South (3)	West (4)	Northeast (5)	Midwest (6)	South (7)	West (8)
Banking Concentration	2.893*** (0.666)	0.502** (0.201)	2.416*** (0.614)	1.508* (0.804)	15822.400*** (5120.420)	3653.700*** (971.749)	2899.960 (2536.330)	32387.900*** (10512.200)
Banking Concentration^2	-0.000631*** (0.000189)	-0.0000906** (0.0000363)	-0.000472*** (0.000158)	-0.000367** (0.000158)	-9455.980** (4664.140)	-3190.710*** (824.055)	1265.200 (2236.640)	-26523.700*** (7796.060)
Controls Government Spending	70.225 (99.758)	222.028*** (56.133)	206.126*** (36.641)	-36.358 (199.914)	172.742 (106.883)	259.810*** (57.019)	243.408*** (36.610)	90.687 (206.158)
Taxation Index	-192.308 (208.893)	-3.591 (80.510)	52.580 (99.430)	-2302.410*** (739.608)	-262.069 (188.349)	-31.037 (79.496)	22.096 (106.672)	-2438.750*** (764.873)
Labor Market Freedom	23.368 (139.557)	-178.050** (79.305)	11.233 (92.715)	-678.126* (396.516)	89.844 (143.215)	-193.575** (80.882)	-1.745 (90.002)	-667.323* (372.531)
Constant	478.732 (1129.720)	257.514 (584.651)	-2155.050*** (783.025)	15332.100*** (4037.450)	-3481.590** (1596.600)	-386.730 (576.566)	-2413.800** (970.547)	7445.400* (4244.350)
Observations	243	324	432	351	243	324	432	351
R-squared	0.936	0.942	0.910	0.843	0.936	0.942	0.910	0.844

Notes: All regressions include year and state fixed effects. Bootstrap standard errors in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Appendix A, cont.

Table A.2. Effects of Banking Concentration on Patent Grants per 100,000 People by Region

	HHI				CR4			
	Northeast (1)	Midwest (2)	South (3)	West (4)	Northeast (5)	Midwest (6)	South (7)	West (8)
Banking Concentration	0.030*** (0.009)	0.005** (0.002)	0.008** (0.003)	-0.003 (0.006)	15822.400*** (5120.420)	3653.700*** (971.749)	2899.960 (2536.330)	32387.900*** (10512.200)
Banking Concentration^2	-0.00000670*** (0.00000251)	-0.000000735* (0.000000383)	-0.00000180* (0.000000963)	-0.0000000510 (0.00000101)	-9455.980** (4664.140)	-3190.710*** (824.055)	1265.200 (2236.640)	-26523.700*** (7796.060)
Controls Government Spending	-3.563** (1.568)	2.812*** (0.662)	1.422*** (0.409)	0.010 (1.293)	-2.315 (1.571)	3.028*** (0.676)	1.465*** (0.338)	0.670 (1.216)
Taxation Index	3.100 (2.550)	-0.331 (0.688)	-1.059 (1.045)	-8.540*** (2.233)	2.944 (2.381)	-0.315 (0.693)	-1.255 (1.006)	-9.415*** (2.303)
Labor Market Freedom	-6.562*** (1.982)	-0.840 (0.782)	-0.779 (0.524)	-5.010*** (1.924)	-5.480*** (1.913)	-1.320 (0.842)	-1.171*** (0.451)	-5.275*** (1.952)
Constant	50.665*** (16.622)	2.527 (6.031)	11.076* (5.817)	88.106*** (15.661)	21.863 (24.667)	5.836 (6.427)	6.819 (6.381)	63.238*** (18.682)
Observations	243	324	432	351	243	324	432	351
R-squared	0.864	0.936	0.904	0.777	0.877	0.935	0.905	0.783

Notes: All regressions include year and state fixed effects. Bootstrap standard errors in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Appendix B

Table B.1. Effects of Banking Concentration (HHI) on Patent Grants by Region

Variables	U.S.	Northeast	Midwest	South	West
HHI	0.597* (0.319)	1.717* (0.957)	1.370*** (0.455)	3.692*** (1.004)	-2.141 (1.434)
HHI^2	-0.000109** (0.0000522)	-0.000346 (0.000273)	-0.000149*** (0.0000572)	-0.000753*** (0.000251)	0.000257 (0.000224)
Controls Recession	-6420.070*** (1424.340)	-4601.280** (1829.850)	1101.080 (791.982)	-3065.200*** (1111.750)	-20247.500*** (3880.320)
Government Spending	-318.276** (124.322)	46.156 (140.236)	-52.366 (90.729)	67.990 (71.362)	-950.953*** (314.669)
Taxation Index	-392.732** (184.586)	-138.782 (224.740)	61.357 (104.108)	211.332 (149.172)	-1010.080** (507.492)
Labor Market Freedom	81.621 (119.022)	-120.680 (160.194)	68.824 (93.714)	330.250*** (126.841)	-483.473 (467.192)
Unemployment	95.026 (73.407)	72.001 (89.662)	-29.225 (41.973)	95.529 (73.120)	81.899 (213.906)
Per Capita Income	0.460*** (0.131)	0.215*** (0.056)	0.016 (0.025)	-0.041 (0.054)	1.255*** (0.142)
Home Price Index	-0.202 (2.613)	1.783 (2.364)	-1.114 (2.701)	6.884*** (2.117)	-8.964** (4.331)
% Bachelors	-11030.100 (13140.000)	4399.940 (8822.580)	16399.800*** (6215.390)	20941.900*** (8048.760)	-3958.240 (22951.800)
% Female Pop	413831.000*** (115074.000)	221131.000* (121367.000)	-39866.600 (58411.900)	43867.200 (50416.500)	1199950.000*** (277235.000)
% Non-Hispanic Black Pop	-90594.900*** (30361.200)	-106741.000*** (38352.700)	-58085.700*** (17115.500)	28599.300*** (11037.800)	-704115.000*** (158453.000)
% Hispanic Pop	33296.400*** (8586.800)	30771.400** (13751.000)	-39599.800*** (11683.100)	51359.300*** (14009.200)	142287.000*** (51283.700)
Establishment Death Per 10k	-12.844 (16.947)	124.205*** (31.786)	-44.041*** (12.988)	18.164 (16.402)	44.095 (58.385)
Constant	-212002.000*** (56903.300)	-122334.000* (64462.000)	23142.300 (30242.100)	-44798.200* (26896.700)	-622032.000*** (140362.000)
Observations	800	144	192	256	208
R-squared	0.937	0.979	0.975	0.963	0.973

Notes: All regressions include year and state fixed effects. Bootstrap standard errors in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Appendix B, cont.

Table B.2. Effects of Banking Concentration (HHI) on Patent Grants per 100,000 People by Region

Variables	U.S.	Northeast	Midwest	South	West
HHI	0.004* (0.002)	0.002 (0.012)	0.018*** (0.004)	0.024*** (0.005)	-0.012* (0.007)
HHI^2	-0.000000565* (0.000000340)	-0.000000203 (0.00000322)	-0.00000183*** (0.000000450)	-0.00000592*** (0.00000160)	0.00000176* (0.00000106)
Controls Recession	-41.215*** (6.088)	-35.817 (25.573)	20.537*** (7.343)	3.475 (5.394)	-108.104*** (20.022)
Government Spending	-0.986* (0.522)	-2.212 (1.830)	-0.659 (0.727)	1.430*** (0.487)	-5.293*** (1.628)
Taxation Index	-3.214*** (0.979)	-1.327 (2.857)	0.565 (0.932)	0.363 (0.927)	-7.619** (3.390)
Labor Market Freedom	0.114 (0.662)	2.632 (3.191)	0.448 (0.868)	-0.477 (0.587)	0.933 (1.822)
Unemployment	-0.168 (0.331)	-0.869 (1.265)	-0.805** (0.410)	-0.018 (0.325)	0.560 (0.766)
Per Capita Income	0.002*** (0.000318)	0.003*** (0.000772)	-0.0000825 (0.000199)	-0.000844** (0.000406)	0.005*** (0.000937)
Home Price Index	-0.015** (0.007)	0.055 (0.034)	0.020 (0.030)	0.006 (0.007)	-0.051** (0.024)
% Bachelors	129.707** (65.380)	-203.314 (146.931)	78.933 (51.083)	236.188*** (55.312)	229.903** (111.647)
% Female Pop	613.780 (386.715)	6688.380*** (2327.840)	315.071 (619.275)	83.351 (296.537)	-686.364 (1055.680)
% Non-Hispanic Black Pop	-14.381 (82.888)	1721.040*** (354.501)	-294.175 (197.181)	-107.051* (63.229)	-259.212 (615.205)
% Hispanic Pop	197.086*** (66.036)	674.467*** (232.795)	-211.496** (104.741)	94.718** (37.615)	548.507*** (201.008)
Establishment Death Per 10k	-0.260* (0.154)	-0.119 (0.558)	-0.390*** (0.129)	0.023 (0.071)	-0.582 (0.366)
Constant	-378.499* (198.665)	-3653.810*** (1206.770)	-134.205 (323.490)	-71.127 (148.718)	198.540 (537.515)
Observations	800	144	192	256	208
R-squared	0.931	0.955	0.976	0.954	0.937

Notes: All regressions include year and state fixed effects. Bootstrap standard errors in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Appendix B, cont.

Table B.3. Effects of Banking Concentration (CR4) on Patent Grants by Region

Variables	U.S.	Northeast	Midwest	South	West
CR4	334.408 (3604.660)	-10064.800 (15209.200)	15269.800*** (3600.580)	11217.800** (5355.740)	-9646.480 (16022.800)
$CR4^2$	746.367 (3027.980)	12575.700 (13750.300)	-10522.100*** (2686.350)	-4371.900 (4713.820)	3686.210 (15239.900)
Controls Recession	-6502.650*** (1439.500)	-4486.280** (1956.660)	1522.530* (831.697)	-3096.680*** (1169.540)	-20587.600*** (4003.730)
Government Spending	-322.021** (125.182)	66.286 (132.263)	-77.697 (106.102)	102.298 (71.571)	-982.563*** (332.990)
Taxation Index	-394.778** (187.162)	-311.461 (208.422)	-59.235 (118.186)	186.204 (150.416)	-966.255* (507.030)
Labor Market Freedom	89.508 (121.028)	-37.650 (161.258)	-41.150 (85.796)	324.768** (127.391)	-484.189 (464.897)
Unemployment	94.334 (76.028)	65.588 (93.214)	-33.923 (43.316)	105.213 (72.320)	88.157 (206.937)
Per Capita Income	0.460*** (0.131)	0.205*** (0.060)	0.028 (0.023)	-0.035 (0.055)	1.256*** (0.144)
Home Price Index	-0.327 (2.616)	2.773 (2.473)	-0.954 (2.943)	7.164*** (2.087)	-8.445* (4.558)
% Bachelors	-10416.000 (12713.800)	3462.330 (8988.470)	12798.300** (5821.460)	19705.000** (8342.340)	1659.600 (23080.200)
% Female Pop	399896.000*** (116880.000)	146683.000 (123548.000)	-92459.500* (51819.800)	37211.100 (53314.500)	1199460.000*** (261243.000)
% Non-Hispanic Black Pop	-93966.300*** (31657.600)	-115938.000*** (41561.600)	-54828.100*** (17787.200)	29646.000*** (11369.900)	-698867.000*** (157127.000)
% Hispanic Pop	33020.700*** (8588.270)	31475.100** (14730.600)	-60607.200*** (15059.800)	49657.400*** (14311.000)	133751.000*** (50348.100)
Establishment Death Per 10k	-15.201 (17.121)	126.017*** (30.368)	-64.434*** (14.491)	13.801 (15.889)	37.400 (57.819)
Constant	-204588.000*** (57329.400)	-80511.800 (66051.100)	49751.200* (27169.100)	-43417.200 (29256.200)	-620136.000*** (132468.000)
Observations	800	144	192	256	208
R-squared	0.937	0.979	0.976	0.963	0.972

Notes: All regressions include year and state fixed effects. Bootstrap standard errors in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Appendix B, cont.

Table B.4. Effects of Banking Concentration (CR4) on Patent Grants per 100,000 People by Region

Variables	U.S.	Northeast	Midwest	South	West
CR4	62.094*** (23.677)	5.334 (190.180)	87.323** (39.041)	171.171*** (43.891)	-84.835 (65.291)
$CR4^2$	-40.925** (18.894)	9.537 (166.700)	-50.981* (29.307)	-128.618*** (44.874)	55.103 (55.750)
Controls Recession	-40.857*** (6.116)	-33.413 (25.694)	18.974** (7.886)	-0.497 (4.457)	-107.925*** (19.908)
Government Spending	-0.938* (0.521)	-2.188 (1.929)	-0.737 (0.788)	1.398*** (0.444)	-5.445*** (1.723)
Taxation Index	-3.301*** (0.964)	-1.344 (2.722)	-0.310 (1.012)	0.061 (0.942)	-7.760** (3.396)
Labor Market Freedom	0.104 (0.672)	2.541 (3.321)	-0.686 (0.982)	-0.334 (0.561)	1.116 (1.779)
Unemployment	-0.134 (0.329)	-0.884 (1.284)	-1.102** (0.498)	0.229 (0.303)	0.724 (0.742)
Per Capita Income	0.002*** (0.000314)	0.003*** (0.000791)	0.0000927 (0.000219)	-0.000708** (0.000314)	0.005*** (0.000929)
Home Price Index	-0.016** (0.007)	0.055 (0.036)	-0.004 (0.036)	0.007 (0.007)	-0.046** (0.023)
% Bachelors	117.430* (65.422)	-211.498 (147.644)	107.793* (56.022)	262.371*** (57.638)	230.918** (116.424)
% Female Pop	615.040* (362.768)	6624.360*** (2271.180)	-130.898 (532.162)	357.372 (266.546)	-352.366 (1008.230)
% Non-Hispanic Black Pop	6.559 (83.316)	1652.960*** (387.305)	-153.550 (229.883)	-72.070 (49.534)	-108.444 (574.268)
% Hispanic Pop	195.352*** (66.392)	650.432*** (245.563)	-312.921** (144.027)	79.243** (38.228)	454.198** (214.725)
Establishment Death Per 10k	-0.271* (0.154)	-0.117 (0.563)	-0.514*** (0.157)	-0.024 (0.070)	-0.580 (0.361)
Constant	-393.965** (185.860)	-3614.850*** (1153.480)	86.409 (281.171)	-262.694* (137.543)	55.390 (521.302)
Observations	800	144	192	256	208
R-squared	0.931	0.955	0.971	0.959	0.937

Notes: All regressions include year and state fixed effects. Bootstrap standard errors in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Appendix C

Table C.1. Effects of Banking Concentration on Disruptive Patents (CD5>0) by Region

	HHI				CR4			
Variables	Northeast	Midwest	South	West	Northeast	Midwest	South	West
Concentration	0.164 (0.104)	0.089 (0.099)	0.192* (0.112)	0.220 (0.271)	2519.680*** (776.257)	1140.480*** (388.196)	439.884 (555.662)	8933.140** (4016.540)
Concentration^2	-0.0000503* (0.0000303)	-0.0000161 (0.0000223)	-0.0000579* (0.0000339)	-0.0000525 (0.0000493)	-2083.250*** (658.161)	-1015.360*** (357.746)	-189.995 (519.063)	-6887.660** (2877.250)
Controls Government Spending	-3.802 (31.570)	60.905*** (23.376)	28.095*** (7.908)	71.054 (45.392)	-5.785 (30.266)	74.745*** (21.561)	28.269*** (7.758)	94.385** (47.729)
Taxation Index	125.096*** (45.836)	25.111 (35.784)	-24.957 (24.246)	-315.205*** (111.516)	118.416*** (41.122)	7.671 (33.325)	-26.502 (24.153)	-365.648*** (126.885)
Labor Market Freedom	-6.044 (30.547)	-15.786 (37.415)	-33.442* (19.570)	-333.419*** (86.839)	-12.102 (29.531)	22.303 (33.978)	-28.263 (20.286)	-331.129*** (80.090)
Constant	-748.449** (375.191)	-785.807*** (184.243)	-10.258 (298.613)	1902.040*** (652.277)	-1017.990** (449.045)	-595.975*** (213.277)	170.952 (290.208)	99.826 (1092.280)
Observations	153	204	272	221	153	204	272	221
R-squared	0.969	0.971	0.967	0.958	0.969	0.972	0.967	0.9587

Notes: All regressions include year and state fixed effects. Bootstrap standard errors in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Appendix C, cont.

Table C.2. Effects of Banking Concentration on Consolidation Patents (CD5<0) by Region

	HHI				CR4			
Variables	Northeast	Midwest	South	West	Northeast	Midwest	South	West
Concentration	0.107 (0.144)	-0.021 (0.065)	-0.292* (0.171)	0.182 (0.252)	1350.920 (1285.090)	-674.668 (425.077)	-1114.460* (666.533)	6978.670 (4451.260)
Concentration^2	-0.0000289 (0.0000406)	0.00000549 (0.0000131)	0.000104** (0.0000524)	-0.0000443 (0.0000459)	-1106.450 (1058.950)	595.456 (400.144)	916.696 (610.532)	-5404.460* (3206.140)
Controls Government Spending	6.468 (39.947)	56.420*** (19.421)	3.837 (13.866)	126.924** (54.936)	5.607 (40.366)	48.868** (21.967)	4.855 (13.413)	145.544*** (55.700)
Taxation Index	324.984*** (61.819)	-6.939 (36.927)	39.856 (42.255)	-191.749 (119.073)	321.123*** (61.257)	11.230 (41.601)	40.327 (44.029)	-230.836* (136.142)
Labor Market Freedom	-2.648 (43.511)	211.604*** (30.367)	46.381 (39.984)	-282.815*** (97.942)	-5.713 (41.564)	189.534*** (33.365)	40.867 (35.977)	-282.749*** (91.776)
Constant	-748.449** (375.191)	-785.807*** (184.243)	-10.258 (298.613)	1902.040*** (652.277)	-1017.990** (449.045)	-595.975*** (213.277)	170.952 (290.208)	99.826 (1092.280)
Observations	153	204	272	221	153	204	272	221
R-squared	0.969	0.971	0.967	0.958	0.969	0.972	0.967	0.959

Notes: All regressions include year and state fixed effects. Bootstrap standard errors in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Appendix C, cont.

Table C.3. Effects of Banking Concentration on Neutral Patents (CD5=0) by Region

	HHI				CR4			
Variables	Northeast	Midwest	South	West	Northeast	Midwest	South	West
Concentration	0.349**	0.096	0.337**	0.149	3335.300***	1140.930***	607.939	8694.810**
	(0.163)	(0.079)	(0.154)	(0.276)	(1166.730)	(240.639)	(681.774)	(3736.430)
Concentration^2	-0.0000883*	-0.0000185	-0.0000951**	-0.0000387	-2562.120***	-1022.260***	-130.153	-6791.320**
	(0.0000471)	(0.0000185)	(0.0000483)	(0.0000503)	(973.159)	(229.146)	(593.416)	(2680.700)
Controls								
Government Spending	14.838	10.964	28.006***	39.742	14.113	24.256	28.891***	64.144
	(40.223)	(16.142)	(10.763)	(44.048)	(39.787)	(15.317)	(10.459)	(47.024)
Taxation Index	-24.168	16.380	-50.531	-307.452***	-34.545	-2.255	-53.972*	-360.001***
	(66.305)	(26.724)	(31.020)	(110.373)	(60.542)	(25.610)	(31.010)	(123.523)
Labor Market Freedom	-9.575	-72.759**	-70.806***	-308.563***	-15.766	-36.030	-61.797**	-303.882***
	(33.065)	(30.789)	(23.582)	(79.752)	(32.392)	(30.229)	(24.691)	(73.864)
Constant	293.058	407.431**	505.868**	2808.340***	-370.679	43.840	405.889	516.034
	(357.416)	(166.501)	(229.922)	(631.231)	(473.399)	(185.263)	(260.175)	(1009.330)
Observations	153	204	272	221	153	204	272	221
R-squared	0.956	0.960	0.920	0.876	0.958	0.960	0.920	0.883

Notes: All regressions include year and state fixed effects. Bootstrap standard errors in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

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