REGIONAL CLUSTERS AND PRODUCT MARKET OUTCOMES DURING TURBULENT TIMES

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Abstract

We examine whether location within a dense regional cluster of interconnected businesses affected firm performance during the Great Recession and the subsequent recovery. Firms in denser regional clusters experienced faster sales growth than their rivals in less dense clusters, especially firms operating in more competitive industries and those more able to reap agglomeration benefits. They also faced lower uncertainty, invested more in both physical capital and intangible capital, and maintained higher employment growth. Their greater resiliency and agility led to significant increases in their valuations. These results suggest that regional clusters provide competitive advantages during turbulent times.

Keywords: regional clusters; competitive advantages; agility and resiliency; firm performance; turbulent times; Great Recession

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I. Introduction

The geographic agglomeration of interconnected businesses (e.g., firms producing similar products, customer and supplier firms, service providers, and coordinating intermediaries) has attracted significant attention from academics and policymakers. These "regional clusters", such as information technology in Seattle, biotech in Boston, or marine manufacturing in eastern North Carolina, account for significant fractions of economic output in the U.S. and abroad. The widespread existence of regional clusters suggests that they provide competitive advantages for firms (Porter (1998)). However, there is surprisingly scant empirical evidence on whether firms located in regional clusters outperform their industry rivals located in other areas.

In this paper, we examine whether location within a regional cluster provides firms with competitive advantages that boost their performance in product markets. The challenge in addressing this question is that unobserved variables may simultaneously influence a firm's decision to locate within a dense regional cluster and its competitive performance, which can confound the inferences. Although product market advantages of regional clusters can be important in both good and bad times, to alleviate the endogeneity concern, we focus on the Great Recession (GR) of 2008-2009 – a large unexpected shock – and the ensuing expansion.

Importantly, economic downturns are also a useful setting to study how various decisions impact firms' product market performance (Opler and Titman (1994), Campello (2003)). The GR was characterized by a large increase in uncertainty and turbulence in product markets (Bloom et al. (2018), Aghion et al. (2021)).[1] The large decrease in demand at the onset of the GR intensified competition among rival firms in a setting where they could only obtain growth by capturing market share from each other. Recessions also highlight a firm's resilience to adversity

[1] More precisely, the GR was characterized by a decrease in output and an increase in uncertainty, so we study the joint effect of these two forces on product market outcomes. Distinguishing among them is empirically challenging.

and agility when business conditions change rapidly, as they offer unique opportunities for firms to outmaneuver rivals and gain market share during the subsequent economic expansion.[2]

The agglomeration benefits highlighted by Marshall (1920), Porter (1990, 1998), and Saxenian (1994) - operating flexibility/efficiency, labor pooling, and knowledge/information spillovers - can boost the performance of firms in denser regional clusters during recessions. These benefits (discussed in Section II) can help firms navigate challenges, exploit investment opportunities, and make better strategic decisions, all of which can impact their market shares. However, agglomeration might also entail costs in recessions, e.g., inter-firm linkages can spread shocks across firms (Barrot and Sauvagnat (2016)), and competition for labor can reduce a firm's ability to retain its talent when it is in financial distress (Baghai, Silva, Thell, and Vig (2021)). Ultimately, the net effect of agglomeration on competitive outcomes is an open empirical question.

Identifying regional clusters is challenging because they rarely conform to standard industry classifications. We use the U.S. Benchmark Cluster Definitions (BCDs) developed by Delgado, Porter, and Stern (2016), which group related industries that sell their products and services across the U.S. and abroad based on input-output links, similarity in labor occupations, and co-location patterns of employment and establishments. The BCDs identify related industries more accurately than prior classifications that rely on a single type of industry link, use data for only some regions, or consider only certain activities.[3] Using employment data by industry and region, we calculate each BCD's density (or "cluster density") in 179 regions as the share of the BCD in the employment of the region relative to the share of the BCD in total U.S. employment. We then assign a cluster density value to each firm using its industry and headquarters location.

[2] See Rhodes and Stelter (2009), Sull (2009a, 2009b, 2010), and Gulati, Nohria, and Wohlgezogen (2010).
[3] See Feldman and Audretsch (1999), Porter (2003), Feser (2005), and Neffke, Henning, and Boschma (2011).

Our empirical tests examine how changes in firm performance, investment, and valuation during the GR and its aftermath depend on the pre-GR density of a firm's regional cluster. The limitation is that our cluster density variable is potentially endogenous: firms' pre-GR locations are likely not random and omitted variables correlated with cluster density could bias our results. Our identification strategy assumes that firms' pre-GR locations, and thus the density of their regional clusters, contain some element of randomness. The GR was an unexpectedly large shock that likely changed firms' optimal long-run locations, but firms could not relocate their operations immediately. As a result, firms had to maneuver during the GR in their pre-GR locations, which deviated from their new long-run optimal locations. Alternatively, randomness might exist if firms had not fully optimized their location choices before the GR. For example, location choices might be affected by idiosyncratic historical factors and high relocation costs.

Under this assumption, as long as the omitted variables concern is addressed adequately, our tests shed light on how regional cluster density affects product market outcomes. To this end, our tests include a host of pre-GR control variables interacted with timing indicators for the periods associated with the GR and its aftermath. The firm-level interacted controls include firm size, firm age, asset tangibility, net leverage, profitability, and growth opportunities. We also include BCD-region level interacted controls that gauge the ex-ante exposure of firms in the regional cluster to aggregate shocks and the pre-GR business conditions in the cluster. Our regressions further include firm fixed effects and either BCD-year and region-year fixed effects or more granular six-digit NAICS-year and county-year fixed effects. These fixed effects absorb differences in the impact, dynamics, and duration of the GR across industry groupings or geographical areas that might have shaped outcomes around the GR.[4]

[4] For example, the fixed effects ensure that our results are not driven by differences across regions in proximity to financial centers, availability of financial services, natural advantages, or local demand conditions.

We find that firms in denser regional clusters experienced market share growth relative to firms in less dense clusters during the GR and its aftermath. Timings tests show that this outperformance in product markets by firms in denser clusters manifested in 2009, persisted during the initial years of the economic expansion, and tempered down afterward. Our results hold if we focus on firms with more geographically concentrated operations for which the assignment of regional cluster density based on their headquarters' address is less noisy. Our evidence thus suggests that firms in denser regional clusters enjoyed competitive advantages around the GR that outweighed any potential disadvantages of location within regional clusters.

Firms in denser regional clusters also experienced relative increases in market value at the onset of the GR, and their valuations remained higher when the economy rebounded. Hence, the investors of firms in denser clusters anticipated value-creating market share gains during the GR and its aftermath. Firms in denser regional clusters also faced less uncertainty during the GR, as measured by unlevered stock return and asset volatility. These results reinforce the view that denser regional clusters increased firms' resiliency and agility during the GR and its aftermath, and that their benefits are a key driver of firms' competitive performance in turbulent times.

To shed light on how firms in denser regional clusters were able to outperform their peers during the GR, we examine their investment behavior. Agglomeration benefits, such as information spillovers and flexible arrangements with trusted business partners, could help these firms resolve difficulties, adopt strategic innovations, or exploit new opportunities that appear during downturns. Further, they experienced lower uncertainty, so a real-options effect might have concurrently played a role, i.e., such firms likely had fewer incentives to delay irreversible investments, although this effect cannot be distinguished from the effects of the economic contraction. Supporting these conjectures, firms in denser regional clusters increased their capital expenditures and employment growth during the GR relative to their peers in less dense regional clusters. They also raised investment in intangible capital, which includes both organizational and knowledge capital. In sum, firms in denser regional clusters invested more during the GR to improve their production and sales capabilities, which allowed them to seize future opportunities.

Gains from location within a regional cluster result from closely-intertwined agglomeration benefits that are hard to disentangle empirically (Porter (1990, 1998)). We first attempt to shed light on which agglomeration benefits might be important by estimating our regressions using measures of cluster density that emphasize specific benefits, including supply-chain links, labor market pooling, and knowledge spillovers. The results using these variables are similar to those in our main tests, suggesting that each benefit plays an important role. However, these variables are correlated, so it is not easy to distinguish among the mechanisms with this approach.

We then condition the effect of cluster density on proxies for a firm's ex-ante ability to reap specific agglomeration benefits in recessions. Prior work shows that firms with greater stocks of knowledge capital can more easily absorb and exploit knowledge and information spillovers (Cohen and Levinthal (1990)). Further, Hombert and Matray (2018) highlight how a larger stock of knowledge allows firms to adapt and perform better when competition increases. Suggesting that these spillovers are important, the positive effect of cluster density on market share growth during and after the GR is larger for firms with higher pre-GR capitalized R&D expenses.

The operating flexibility and cost-saving advantages are likely greater when there is more scope for business dealings among firms located in the same region, i.e., when a firm's industry and the other industries in the region rely on more similar customer and supplier industries. Likewise, the benefits of fluid labor markets should be greater when workers' skills are more transferrable across firms in the region, i.e., when occupations in a firm's industry are more similar to those of the other industries in the region. Suggesting these benefits also play a role, the effect of cluster density on market share growth during the GR is larger when the input-output links of industries in the firm's region are more similar, and the effect during the rebound is larger when the occupations used by industries in the firm's region are more similar.[5]

We next examine whether the advantages of denser regional clusters around the GR depend on firms' pre-GR competitive environments. Firms in concentrated industries are naturally more resilient to recessions, but those in competitive industries are likely more vulnerable because they have lower profit margins, are more likely to fail, and face greater pressure to quickly adapt to negative shocks. Suggesting that regional clusters help firms succeed when they face intense competition (Porter (1998)), the positive impact of cluster density on market share growth is larger for firms in more competitive industries. Further, within competitive industries, the effects are more pronounced for smaller firms, which generally have more fragile market positions and are less likely to survive downturns. This result is also consistent with the argument in Porter (1998) that clusters are especially beneficial for small firms because they allow such firms to collectively tap inputs, information, and labor pools as if they had a larger scale.

Our paper fits in the literature on what drives success in product markets. A strand of this literature examines changes in market share around downturns and highlights factors that increase a firm's resiliency and agility around such events. These factors include financial slack (Opler and Titman (1994), Campello (2003)), foreign ownership (Alfaro and Chen (2012)), and centralization of decisions (Aghion et al. (2021)). Another strand identifies factors that impact a firm's market share growth more generally, such as financial leverage (Campello (2006)), going public (Chod and Lyandres (2011), Chemmanur and He (2011)), exposure to hedge-fund

[5] If we use all proxies concurrently, a greater potential for customer-supplier deals among firms in the cluster is the key benefit during the GR, and a greater ability to absorb information spillovers is the key benefit in its aftermath.

activism (Aslan and Kumar (2016)), information environment (Billett, Garfinkel, and Yu (2017)), investment in innovation (Hombert and Matray (2018)), and protection of trade secrets (Nguyen, Pham, and Qiu (2022)). We add to this work by showing that location within a dense regional cluster provides vital strategic benefits that allow a firm to compete more successfully.

Related research also identifies variation in the impact of downturns on firm value due to family ownership (Baek, Kang, and Park (2004), Lins, Volpin, and Wagner (2013)), social capital (Lins, Servaes, and Tamayo (2017)), and antitakeover provisions (Guernsey, Sepe, and Serfling (2022)). Other studies examine what drives the impact of the GR on firms' investment and employment. Investment cuts were smaller for firms with stronger balance sheets and better access to capital (Duchin, Ozbas, and Sensoy (2010), Bernstein, Lerner, and Mezzanotti (2019)). Employment growth was lower for firms with high leverage (Giroud and Mueller (2017)) and less healthy lenders (Chodorow-Reich (2014)). We further show that the density of a firm's regional cluster can impact its value, performance, and investment decisions around downturns.

Our paper also relates to the policy debate on regional clusters.[6] Delgado and Porter (2021) show that regional clusters boost local employment. They find that industry employment grew faster around the GR in regions with denser clusters. Our firm-level analyses further show that denser regional clusters endow firms with competitive advantages over their industry rivals around economic downturns, especially if they have a greater ex-ante ability to reap agglomeration benefits or they operate in a more competitive industry. These advantages lead to higher incentives to invest in physical and intangible capital and can allow firms to gain market share and increase their long-term value around downturns.

[6] See, for instance, Muro and Katz (2010), Bergman and Feser (2020), and Wilson, Wise, and Smith (2022).

II. Competitive Advantages from Regional Clusters and Firm Location Choices

A. Regional Clusters and Sources of Competitive Advantages

The literature highlights that firms in regional clusters enjoy advantages that stem from agglomeration economies, i.e., an ability to operate more efficiently and flexibly than other firms (Marshall (1920), Porter (1990, 1998), and Saxenian (1994)). These advantages originate from three main sources and can be especially valuable when firms are under competitive pressure.

First, proximity to specialized suppliers allows firms to source inputs locally, which reduces shipping and coordination costs, shortens delays in receiving goods, and reduces the need to hold large inventories. Repeated business dealings combined with personal relationships and community ties foster trust and cooperation between companies, mitigating problems in arm's-length relationships between firms while avoiding inflexible vertical integration or formal contracts (e.g., strategic alliances or partnerships). Co-location of related firms thus enables firms to specialize in particular phases of the production process and to maintain greater efficiency and flexibility (Holmes (1999), Gilson, Sabel, and Scott (2009)).

Second, regional clusters are characterized by the local availability of a large pool of workers with various skills, facilitating firms' access to labor and key talent. Fluid labor markets that allow workers to easily shift across employers also lead to better worker-firm matches (Helsey and Strange (1990)), increasing both worker and firm productivity (Diamond and Simon (1990), Krugman (1991)). Labor market pooling further increases firm productivity and performance by incentivizing workers to invest in their human capital because mobile workers reap the benefits of their investment in industry-specific human capital (e.g., Rotemberg and Saloner (2000)).[7]

[7] We note that competition among employers also creates the risk that neighboring firms could poach a firm's key talent, which can increase the wage bill for firms within regional clusters (Combes and Duranton (2006)).

Third, the co-location of firms in related industries increases knowledge spillovers and information exchanges. The flow of information and ideas via face-to-face meetings between the upper-level managers of the firms in a regional cluster allows them to make better strategic decisions. Further, through their close personal interactions, workers from different companies rapidly learn skills from each other, increasing their industry-specific human capital and their firms' productivity. Last, the diffusion of information and knowledge through informal contact stimulates innovation and is important to the success of regional clusters focused on various types of activities (e.g., Jaffe, Trajtenberg, and Henderson (1993), Saxenian (1994), Audretsch and Feldman (1996), Dahl and Pedersen (2004), and Arzaghi and Henderson (2008)).

B. Regional Clusters and Competitive Advantages Around Macroeconomic Shocks

The agglomeration benefits discussed in Section II.A can have product market effects both in recessions and in normal times, but our empirical tests focus more narrowly on the GR and the immediate subsequent economic expansion. Thus, it is useful to discuss the relevance of this particular empirical setting to the study of product market effects in general and the role that agglomeration benefits might play in this specific context.

Recessions are characterized by sharp increases in uncertainty and economic turbulence (Bloom et al. (2018)). Importantly, they increase competition among rival firms that can only obtain growth by stealing market share from each other. Consistent with competition intensifying during downturns, Bernard and Okubo (2016) and Aghion et al. (2021) find higher product churn rates (i.e., higher rates of new product additions and subtractions) during these periods. Hence, understanding the role that agglomeration benefits may play during a major economic downturn and subsequent expansion is very relevant in the context of the product markets literature.

Prior research also highlights that economic downturns offer unique opportunities for firms to outmaneuver their rivals and gain market share during the subsequent economic rebound (e.g., Rhodes and Stelter (2009), Sull (2009a, 2009b, 2010), and Gulati et al. (2010)). This work underscores that, during recessions, firms can gain long-lasting competitive advantages by increasing marketing, investing in physical and knowledge capital, raising efficiency by reorganizing production activities, building relationships with new suppliers, investing in employee training, and introducing new products. Importantly, the opportunity costs associated with these activities are often lower in bad times.[8]

The competitive advantages of regional clusters can be especially important during recessions and their aftermaths by making firms more resilient and agile when business conditions change. In such scenarios, firms can share valuable information with their local business partners regarding changing industry conditions, cost-cutting strategies, and new product introductions. The ability to hire skilled workers from a deep local pool facilitates a firm's investment, as the firm introduces changes needed to succeed when the economy recovers. Flexible operations and reliable supply chains help firms cope with unexpected challenges (e.g., supply chain disruptions) and exploit new business opportunities (e.g., launching new products or adopting new cost-cutting technologies) that may arise during these periods. Importantly, prior work highlights the benefits of regional clusters when demand is uncertain (Piore and Sabel (1984), Storper (1989), and Kranton and Minehart (2000)).

However, there are also potential disadvantages of regional clusters that could mitigate or offset the advantages during bad times. In particular, co-location could propagate negative shocks across economically related firms (e.g., Hertzel, Li, Officer, and Rodgers (2008), Barrot

[8] For example, Zhang (2019) argues that the costs of switching technologies and introducing automation are smaller during recessions, when productivity and the cost of disruptions in production needed to adjust factor use are low.

and Sauvagnat (2016)). Also, there is often significant labor poaching within regional clusters (e.g., Almazan, De Motta, and Titman (2007)), which can reduce a firm's ability to retain its important employees, particularly if it becomes financially distressed during a downturn (e.g., Brown and Matsa (2015), Baghai et al. (2021)). Ultimately, whether regional clusters boost or hurt firm performance during periods of turbulence in product markets is an empirical question.

C. Regional Clusters and Firms' Location Choices

Our empirical tests compare the performance of related firms that are located inside and outside dense clusters around the GR. The presence in our data of similar firms inside and outside dense regional clusters implies that, besides agglomeration benefits, other factors affect their location choices. It also suggests that firms face frictions in relocating their activities. Below, we discuss in more detail why a firm might be located outside a dense regional cluster.

Entrepreneurs might choose to locate their new firms outside a regional cluster for various reasons. First, local governments outside regional clusters often attract new businesses using incentives, such as tax abatements, subsidies, or simplified regulations (Coughlin, Terza, and Arromdee (1991)). Second, entrepreneurs tend to start firms in areas close to their residence because they are familiar with the advantages and disadvantages of such areas, whereas searching for information about alternative locations in unfamiliar areas is costly (Figueiredo, Guimaraes, and Woodward (2002)). Likewise, entrepreneurs have a propensity to start and run their businesses close to their homes for livability reasons if they believe the area where they reside provides a high quality of life for themselves and their families (Ferreira et al. (2016)).

The evidence also suggests that relocating established firms is costly and infrequent, partly for reasons analogous to those described above. In addition, relocations are costly because a firm could lose many of its workers who are unwilling to make a long-distance move (Van Dijk and

Pellenbarg (2000)). Further, a firm could lose valuable relationships with local suppliers and customers (Figueiredo et al. (2002)). Prior work shows that while firm relocations to a new region generally boost firm performance in the long run, they can hurt it in the short run (Gregory, Lombard, and Seifert (2005), Knoben, Oerlemans, and Rutten (2008)). Consistent with high relocation costs, Bai, Fairhurst, and Serfling (2020) find that only 12% of publicly traded firms relocated their headquarters to a different state during the period 1969-2003.

In sum, a firm's historical location choice is based on complex tradeoffs between expected benefits and costs of potential locations at the time of its founding, of which only some are related to geographic agglomeration, and it is also affected by idiosyncratic factors. As a result, firms with similar operations often choose their initial location in different regions. In addition, when changing conditions make the original location choice less appealing, firms might remain at their locations for long periods of time because changing their locations is exceedingly costly.

III. Main Variables, Sample, and Empirical Framework

A. Density of a Firm's Regional Cluster

To identify interconnected industries, we use the Benchmark Cluster Definitions (BCDs) from Delgado et al. (2016) developed as follows.[9] First, "traded industries" that concentrate in certain regions but sell their output nationwide are separated from "local industries" that only sell in their primary location and are geographically dispersed (e.g., retail and restaurants). Second, inter-industry similarity matrices that measure the relatedness between pairs of traded industries are created based on (i) input-output links that take into account buyer and supplier relationships, (ii) use of similar labor occupations that facilitate labor market pooling, and (iii) co-location patterns of employment and establishments that facilitate knowledge spillovers. Third, clustering

[9] The BCDs are made available by the U.S. Cluster Mapping Project, http://www.clustermapping.us/.

analysis techniques are used to group industries into clusters based on their similarity matrices. The algorithm creates many cluster configurations and chooses the set of BCDs that captures the broadest range of inter-industry linkages. Last, judgment is used to fine-tune the BCDs, resulting in 51 traded and 16 local BCDs that can be used to assess cluster density in any regional unit.

Table IA1 in the Internet Appendix lists the 51 traded BCDs and the number of NAICS codes in each BCD. It highlights that each BCD comprises various related but distinct economic activities. We exclude the 16 local BCDs (those grouping industries that serve local markets in proportion to regional population) from our tests. Table IA2 reports the industry breakdown of two selected BCDs and highlights that BCDs are distinct from standard industry classifications and represent economically meaningful groupings of industries with different operations.

We identify 179 distinct regions in the U.S. using the Bureau of Economic Analysis (BEA) definitions of economic areas that delineate regional markets. The BEA regions consist of one or more economic nodes – metropolitan or micropolitan statistical areas that serve as regional centers of economic activity – and the surrounding counties that are economically related to the nodes. These regions represent the relevant regional markets for labor, products, and information. They are mainly determined by labor commuting patterns that delineate local labor markets and serve as proxies for local markets where businesses in the areas sell their products.

We measure the density of each BCD in these BEA regions using detailed employment data by NAICS industry and region from the Census Bureau's County Business Patterns (CBP) database for pre-GR years from 2005 to 2007. Following prior work on regional clusters, we calculate the density of a given BCD in a region (DENSITY) using a standard location quotient, defined as the share of the BCD in the region's employment relative to the share of the BCD in nationwide employment. Thus, higher values of DENSITY indicate greater regional clustering of the economic activity defined in the BCD, with values higher (lower) than one indicating a stronger (weaker) presence of that BCD in that region relative to its nationwide presence.

There is large variation in cluster densities across the U.S., as depicted in Figure 1 for the "Automotive," "Medical Devices," and "Aerospace Vehicles and Defense" BCDs. The Automotive BCD is denser in parts of the Midwest and South, and much less dense in the rest of the country. The Aerospace Vehicles and Defense BCD is agglomerated in various regions, but it is relatively more present in the Mountain and West South-Central regions. In contrast, the Medical Devices BCD exhibits major agglomeration in various regions across the country.

[Figure 1 about here]

Figure IA1 shows the number of BCDs by their density scores for the 20 largest economic areas in the U.S. For example, the New York-Newark-Bridgeport, NY-NJ-CT-PA region has 11 BCDs with densities above 1.2, and the St. Louis-St. Charles-Farmington, MO-IL has 14. The figure shows that most regions exhibit high density for at least a few BCDs and that there are large differences in the densities of specific BCDs within a region.

After calculating the density of each BCD in each BEA region, we assign each firm to a BCD and region based on its NAICS industry and headquarters' location county recorded right before the GR. We identify a firm's pre-GR industry and region using its historical NAICS code and county of headquarters' location from the CRSP/Compustat Merged dataset.[10] We then keep a firm's pre-GR industry and location fixed for our entire sample period to avoid confounding effects due to potentially endogenous changes in operations or headquarters relocations.

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[10] If only a five-digit NAICS code is available but all six-digit NAICS codes within that five-digit code are in the same BCD, we assign the firm to that BCD. If the six-digit NAICS codes within that five-digit code are related to multiple clusters, we discard the observation. For both industry codes and headquarters locations, we use a firm's 2005 values if available, its 2006 values if its 2005 values are missing, and its 2007 values if both are missing.

A limitation of our approach to match firms to BCD-region cells is that firms often have operations outside the region of their headquarters. However, the largest benefits of spatial agglomeration arise from the close proximity of a firm's headquarters to a significant number of other businesses (Davis and Henderson (2008)). In particular, access to talent and information exchanges are most valuable for the strategic decision-making of top management and for the activities of other high-rank employees located at headquarters. In Section IV.B, we show that our results hold after dropping firms with large operations outside their headquarters region.

B. Sample, Variables, and Descriptive Statistics

Our sample includes firms in the CRSP/Compustat Merged database whose NAICS codes clearly map into one of the 49 non-financial traded BCDs and are headquartered in one of the 179 BEA regions. We discard firms in the "Financial Services" and "Insurance Services" BCDs. We also exclude firms with less than $1 million in average sales or assets over 2005-2007 and observations with missing values for the key variables. Our baseline sample period is 2005-2012, which is centered around the GR of 2008-09 and includes three years before and after. We winsorize all financial ratios and growth rates at their 1st and 99th percentiles each year.

Table 1 reports summary statistics of the key variables we use, which are described in the Appendix. The statistics for standard variables are similar to those in other studies, so we focus our discussion on DENSITY. The pre-GR regional cluster density of the median firm is 1.19, indicating that the median firm is in a region where its BCD is slightly denser than it is in the country. There is, however, significant variation in cluster densities across firms, ranging from 0.81 at the 25th percentile to 2.20 at the 75th percentile. Importantly, because cluster density is right-skewed with a mean of 2.13, we use the natural logarithm of DENSITY in our tests.

[Table 1 about here]

C. Empirical Strategy

1. Regression Specification

We gauge the effect of regional cluster density on product market and other corporate outcomes during the GR and its aftermath, taking pre-GR location decisions and thus the density of a firm's regional cluster as given. Our difference-in-differences regression approach follows the literature on how various firm or industry attributes affect the impact of the GR on firm outcomes (e.g., Duchin et al. (2010), Lins et al. (2013), Aghion et al. (2021), and Delgado and Porter (2021)). Throughout the paper, we estimate regression models of the following form:

$$(1) \quad y_{i,c,r,t} = \beta_1 \, Ln(DENSITY_{c,r}) \times I_{2008-09,t} + \beta_2 \, Ln(DENSITY_{c,r}) \times I_{2010-12,t} + \gamma_1 \, X_i \times I_{2008-09,t} + \gamma_2 \, X_i \times I_{2010-12,t} + \delta_1 \, Z_{c,r} \times I_{2008-09,t} + \delta_2 \, Z_{c,r} \times I_{2010-12,t} + \alpha_i + OTHER\_FE + \varepsilon_{i,c,r,t},$$

where, $y_{i,c,r,t}$ is our outcome variable of interest for firm *i* in BCD *c* and in region *r* in year *t*. $\mathrm{Ln(DENSITY_{c,r})}$ is the natural logarithm of the pre-GR density of a firm's regional cluster, normalized to have a standard deviation of one and a mean of zero. $\mathrm{I_{2008\text{-}09}}$ equals one for the years of the GR (2008-2009), and zero otherwise. $\mathrm{I_{2010\text{-}12}}$ equals one for the years after the GR (2010-2012), and zero otherwise.[11] Eq. (1) omits $\mathrm{Ln(DENSITY_{c,r})}$, $\boldsymbol{X}_i$, and $\boldsymbol{Z}_{c,r}$, the time-invariant variables whose coefficients cannot be estimated due to the inclusion of firm fixed effects. Similarly, $\mathrm{I_{2008\text{-}09}}$ and $\mathrm{I_{2010\text{-}12}}$ are omitted because they are subsumed by our BCD-year, six-digit NAICS-year, region-year, or county-year fixed effects (OTHER_FE) discussed below. We cluster the standard errors by BCD-region, but the results are similar if we cluster by firm.

The vector $\boldsymbol{X}_i$ includes pre-GR firm characteristics (Ln(SIZE), Ln(AGE), TANGIBILITY, NET_LEVERAGE, PROFITABILITY, and TOBINS_Q). The vector $\boldsymbol{Z}_{c,r}$ includes pre-GR BCD-region variables that gauge trends in establishment and employment growth in the firm's

[11] The GR started in the fourth quarter of 2007, but its real effects were felt most vividly during 2008 and 2009. We therefore refer to these two years as "during the GR" and the years between 2010 and 2012 as its "aftermath".

regional cluster (CR_ESTAB_GROWTH and CR_EMP_GROWTH). It also includes proxies for a BCD-region's exposure to economic downturns: the sensitivity of a BCD-region's employment growth to GDP growth (CR_BETA_EG), the BCD-region sensitivity of firms' sales growth to GDP growth (CR_BETA_SG), and the BCD-region average equity beta (CR_BETA_RET). All pre-GR variables are time-invariant. The sensitivity variables are calculated over the 1998-2007 period; other variables are calculated by taking their average over 2005-2007.

We include firm fixed effects (α_i) in all regressions and consider two alternative sets of other fixed effects (OTHER_FE). One set includes BCD-year and region-year fixed effects, which control for any possible time-varying factors that may differentially affect firms' performance across BCDs or economic regions, such as the type of economic activity, proximity to financial centers and services, natural advantages, or demand conditions. The other set is more granular and includes six-digit NAICS-year and county-year fixed effects. It addresses the concern that there could be heterogeneity across industries within a BCD or across counties within a region.

We first estimate Eq. (1) over the baseline period 2005-2012. To investigate effects in the longer run, we then use the period 2003-2014 (adding two extra years before and after the GR) after augmenting Eq. (1) to include β_3Ln(DENSITY$_{c,r}$)$\times$I$_{2013\text{-}14,t}$, γ_3X$_i$$\times$I$_{2013\text{-}14,t}$, and δ_3Z$_{c,r}$$\times$I$_{2013\text{-}14,t}$, where I$_{2013\text{-}14}$ equals one for the years 2013-2014, and zero otherwise. Last, we estimate a version of Eq. (1) based on binary indicators for each individual year interacted with Ln(DENSITY) over the period 2003-2014 and use it to generate our timing figures. In all cases, we consider alternative specifications that use both sets of fixed effects discussed above.

2. Identification Assumptions and Limitations

The main challenge is that DENSITY is potentially endogenous in Eq. (1). First, firms' pre-GR locations are likely not random, i.e., firms might have selected them optimally taking into account the benefits of agglomeration, the history of adverse shocks they faced, and various other firm-, industry-, and regional-level factors. Second, omitted variables such as financial health and access to capital, regional exposure to shocks, and local business conditions could spuriously drive the relation between cluster density and corporate outcomes. Lacking a good instrument for DENSITY, we are unable to make strong causal statements regarding the impact of DENSITY on competitive outcomes. Still, under the plausible assumptions discussed below (analogous to those in Aghion et al. (2021)), we can shed light on our research question.

The "weak exogeneity" assumption underlying our tests is that firms' pre-GR locations - and thus DENSITY - contain some element of randomness. The GR was an unexpectedly large shock, and it is unlikely that firms had fully considered such an event when choosing their pre-GR locations. The advent of the GR likely changed firms' optimal long-run locations, but given the costly adjustment of firms' locations in the short run, firms were forced to maneuver in their pre-GR locations. This suggests that firms' pre-GR locations likely deviate from their optimal long-run choices at the onset of the GR, which plausibly introduces some randomness in DENSITY. Alternatively, some randomness might exist if firms had not fully optimized their location choices before the GR. As noted in Section II.C, idiosyncratic historical factors might partly drive such choices, and firms might face frictions or inertia that make relocation costly.

Under the weak exogeneity assumption, the estimates of β_1 and β_2 in Eq. (1) shed light on how regional cluster density affects product market outcomes during the GR and its aftermath. Ultimately, the key threat to our identification strategy is that omitted variables correlated with DENSITY could drive the observed differential response of firms in high- and low-density clusters around the GR. Our tests are thus informative as long as omitted variable bias is unlikely to be large. More generally, this is also the usual challenge in prior research that examines cross-sectional variation in the impact of the GR and other macro shocks cited in Section III.C.1.

Table IA3 shows the correlation of pre-GR DENSITY with our pre-GR control variables (the vectors $\boldsymbol{X}_i$ and $\boldsymbol{Z}_{c,r}$). Financial flexibility is unlikely to drive our results, since DENSITY is largely uncorrelated with the firm attributes in $\boldsymbol{X}_i$, which include proxies for access to capital and financial condition, and also with additional proxies for financial constraints. Regarding the economic conditions or exposure to downturns of firms in a BCD-region cell, DENSITY is correlated with two of the BCD-region variables (CR_EMP_GROWTH and CR_BETA_EG), but not with the other ones. Overall, these low correlations suggest that differences across firms in more- and less-dense regional clusters are unlikely to spuriously drive our results.

Nevertheless, we also estimate models that include the interactions of our timing indicators with all the firm and BCD-region control variables, but this does not affect our results. We also estimate models that include six-digit NAICS-year fixed effects and county-year fixed effects, which alleviates the concern that certain industries or counties were more exposed to the GR. To the extent that these extensive controls are indeed exhaustive, then differences in firms' performance around the GR can be attributed to their differential exposure to agglomeration benefits. However, we cannot rule out the presence of more nuanced omitted variables correlated with DENSITY. This limitation should be taken into account when interpreting our results.

IV. Effect of Cluster Density on Product Market Performance Around the GR

A. Effect on Sales Growth

As in prior work, our main measure of performance is a firm's sales growth rate. With the inclusion of BCD-year fixed effects or six-digit NAICS-year fixed effects in our regressions, we gauge the effect of regional cluster density on a firm's sales growth relative to the sales growth of its peer group. This measure is motivated by Bolton and Scharfstein (1990) and Chevalier and Scharfstein (1996). It incorporates the combined effects of pricing and other competitive strategies and is consistently measured across firms with different economic activity.

The regressions in Table 2 use SALES_GROWTH as the dependent variable. In columns (1)-(4), the sample period is 2005-2012. In column (1), we only include $I_{2008\text{-}09}$, $I_{2010\text{-}12}$, and firm fixed effects. The sales growth rate of the average firm decreased by 18.3 percentage points during the GR and was still 8.1 percentage points lower than pre-GR growth rates in the recovery period. Column (2) estimates Eq. (1) with BCD-year and region-year fixed effects and no controls. The coefficient on Ln(DENSITY)×$I_{2008\text{-}09}$ indicates that the sales growth rates of firms with cluster density one-standard deviation above the mean were 1.6 percentage points higher during the GR. Relative to the coefficient on $I_{2008\text{-}09}$ in column (1), high cluster density offsets the effect of the GR by 8.7% (0.016/0.183). The coefficient on Ln(DENSITY)×$I_{2010\text{-}12}$ shows that the sales growth rates of firms with cluster density one-standard deviation above the mean remained 2.1 percentage points higher after the GR. Column (3) shows that adding all firm and BCD-region control variables interacted with $I_{2008\text{-}09}$ and $I_{2010\text{-}12}$ has little effect on the results.

[Table 2 about here]

In column (4), we use six-digit NAICS-year and county-year fixed effects instead of BCD-year and region-year fixed effects. Noteworthy, this enables us to examine the effect of cluster density on a firm's sales growth relative to its direct industry peers, which proxies for its market share growth. During the GR the sales growth rates of firms with cluster density one-standard deviation above the mean were 2.5 percentage points higher than that of their industry rivals. Further, in the years 2010-2012, firms with high cluster density continued to outperform their industry rivals at about the same rate. Column (5) extends the sample period to 2003-2014 (five years before and five years after the GR) and adds Ln(DENSITY)×$I_{2013-14}$. The coefficient on this interaction is positive but statistically insignificant, suggesting that the competitive gains of firms in denser regional clusters were largely concentrated during and right after the GR.

Figure 2 plots the year-by-year dynamics of the estimated impact of cluster density on sales growth during the period 2003-2014 and the 90% confidence intervals. The figure is based on regression models similar to those in Table 2 that interact Ln(DENSITY) with binary indicator variables for each of the years (leaving 2006 as the left-out reference period) and include all interacted control variables. We use a specification with BCD-year and region-year fixed effects and another with six-digit NAICS-year and county-year fixed effects.

The figure shows that cluster density has little or no effect on sales growth in the years preceding the GR, albeit a small and statistically insignificant spike in 2004. In 2008, the effect is positive but not statistically significant. In 2009, the worst year of the GR, there is a large and statistically significant positive impact of cluster density on sales growth. This is followed by an unexpected dip in 2010, but the effect remains positive and statistically significant in 2011 and 2012. The effect appears to weaken and becomes statistically insignificant in the following two years, suggesting a transitory effect. The results in Table 2 and Figure 2 are consistent with the hypothesis that regional clusters provide competitive advantages in turbulent product markets.

[Figure 2 about here]

B. Additional Sales Growth-Related Tests

1. Controlling for the Likelihood of Receiving Targeted Government Support

Politicians might attract firms to their electoral regions and then, with a vested interest in their survival, favor targeted public policies to support them during downturns. We thus consider whether firms in denser regional clusters might have fared better during the GR because they were more likely to receive targeted government support, a competitive advantage that is distinct from the traditional agglomeration benefits discussed in Section II.A. In particular, we are interested in whether this advantage, which is political in nature, could drive our results.

To this end, in Table IA4, we add interactions of $I_{2008\text{-}09}$ and $I_{2010\text{-}12}$ with proxies for the likelihood that firms received targeted government support during the GR. Our proxies are based on the idea that industries that represent a larger share of local employment, firms that are government suppliers, and firms that lobby more intensely are more likely to receive support. We use the share of a firm's six-digit NAICS industry in the employment of its county, the fraction of firms in the firm's BCD-region that are government suppliers, and the total lobbying expenses of firms in the BCD-region. We also consider the firm-level versions of the latter two variables, i.e., binary indicators for whether the firm is a government supplier and the firm's total lobbying expenses. Adding these interacted controls has little effect on the estimated coefficients of Ln(DENSITY)×$I_{2008\text{-}09}$ and Ln(DENSITY)×$I_{2010\text{-}12}$, suggesting that the superior performance of firms in denser regional clusters around the GR is unlikely to be driven solely by targeted relief.

2. Measurement of Density and Non-Linearities

To mitigate concerns that we use firms' headquarters location to identify their regional cluster but firms often operate in multiple states, in Table IA5, we re-estimate our main specifications after discarding firms that are likely to have dispersed operations. First, we use data from Garcia and Norli (2012) to identify and discard from the sample firms that operate in a number of states above the sample median. Second, we drop firms in dispersed industries (retail trade, wholesale trade, and transportation). With both approaches, our results are unaffected. Further, to ensure that our BCD-year and region-year fixed effects properly control for time-varying shocks to BCDs and regions, we also re-estimate our regressions after requiring that each BCD-year and region-year cell has at least four firms. Doing so does not affect our results.

To further mitigate concerns that endogenous location choices might affect our inferences, we conduct two analyses. First, Table IA5 also shows that our results remain similar when we re-estimate our specifications after discarding firms that relocated to a different region anytime between 2002 and 2007. Thus, endogenous location decisions related to firms' anticipation of the GR are unlikely to drive our findings. Second, we find that although DENSITY is persistent over time, past DENSITY is far from a perfect predictor of future DENSITY: DENSITY measured in 1986 only explains 17%-23% of the variation in DENSITY across BCD-region cells measured in 2007. This suggests that firms' past location choices, which were based on historical factors, are unlikely to be driven by their advantages during and after the GR.

Our main tests use Ln(DENSITY) because DENSITY is right-skewed. Table IA6 shows that our main results are similar if we replace Ln(DENSITY) with an indicator variable for whether DENSITY is above the 50^{th}, 66^{th}, or 75^{th} sample percentile. Table IA7 documents that our main results are also similar when we use DENSITY instead of Ln(DENSITY). Table IA7 further use indicators for whether DENSITY is in the second or third tercile of its empirical distribution, and also for whether it is in the second, third, or fourth quartile. The estimated coefficients are larger as we move from the bottom toward the top of the empirical distribution of DENSITY, and the coefficient is statistically significant for the top tercile (quartile). This suggests that the benefits of regional clusters manifest once a region achieves a sufficiently high level of agglomeration.

Last, in Table IA8, we consider an alternative measure of regional cluster density – the fraction of a BCD's national employment that is concentrated in a specific region (the numerator of the location quotient). This measure focuses exclusively on the economic importance of a specific region for the nationwide activities of the BCD, with no adjustment for differences in the level of economic activity across regions. The results are similar to those reported in Table 2.

V. Effect of Cluster Density on Uncertainty, Investment, Valuations, and Profitability

A. Effect on Uncertainty and Investment

To shed light on how firms in denser regional clusters were able to outperform their peers around the GR, we examine how cluster density affected firm-level uncertainty, a key driver of investment, and then directly examine firms' investment behavior. Agglomeration benefits can allow firms in denser regional clusters to more easily identify and exploit investment opportunities in times of economic turbulence. Further, firms delay investments in uncertain times, such as during recessions, when the real option to wait is more valuable (e.g., Bloom et al. (2018)). If agglomeration benefits mitigate uncertainty for firms in denser regional clusters, such firms might also invest more during the GR through a real-options channel. We note, however, that the GR concurrently involved an increase in uncertainty and a major economic contraction, so our tests below cannot empirically isolate the effect of uncertainty on investment.

1. Effect on Uncertainty

In Table 3, we examine the effect of cluster density on two measures of uncertainty. In columns (1)-(5), the dependent variable is UNLEVERED_VOLATILIY. Column (1) shows that, for the average firm, unlevered volatility increased by 14 percentage points during the GR and then decreased afterward (its level during the rebound was 1.0 percentage points lower than it was prior to the GR). Columns (2) and (3) document statistically significant negative coefficients on Ln(DENSITY)×$I_{2008\text{-}09}$. Relative to the coefficient on $I_{2008\text{-}09}$ in column (1), the estimate in column (2) suggests that higher cluster density offsets the effect of the GR on unlevered volatility by 7.1% (0.01/0.14). The coefficients on Ln(DENSITY)×$I_{2010\text{-}12}$ are statistically insignificant and small. Column (4) shows that these results also hold in the specification with six-digit NAICS-year and county-year fixed effects. In column (5), we extend the sample period to 2003-2014 and find that cluster density does not affect volatility in the longer post-GR period.

[Table 3 about here]

In columns (6)-(10) of Table 3, the dependent variable is ASSET_VOLATILITY. Column (6) shows that asset volatility increased by 14.5 percentage points during the GR and was still 5.7 percentage points higher when the economy rebounded. Columns (7) and (8), which use BCD-year and region-year fixed effects, show negative but statistically insignificant coefficients on Ln(DENSITY)×$I_{2008\text{-}09}$. The coefficients on Ln(DENSITY)×$I_{2010\text{-}12}$ are also statistically insignificant. In column (9), which uses six-digit NAICS-year and county-year fixed effects, the coefficient on Ln(DENSITY)×$I_{2008\text{-}09}$ is negative and statistically significant at the 1% level, but the coefficient on Ln(DENSITY)×$I_{2010\text{-}12}$ remains statistically insignificant. In column (10), we use the sample period 2003-2014 and additionally find a negative and statistically significant coefficient on Ln(DENSITY)×$I_{2013\text{-}14}$, but it is unclear whether this effect is related to the GR.

Graphs A and B of Figure 3 plot the year-by-year dynamics of the estimated impact of cluster density on uncertainty during 2003-2014 and their 90% confidence intervals. The graphs are based on specifications similar to those in Table 3 that interact Ln(DENSITY) with binary indicator variables for each of the years and include all interacted controls variables. We use a specification with BCD-year and region-year fixed effects and another with six-digit NAICS-year and county-year fixed effects. Cluster density had no impact on the uncertainty firms faced before the GR. However, firms in denser regional clusters experienced a marked decline in uncertainty during the GR relative to their peers in less dense clusters.

[Figure 3 about here]

2. Effect on Physical Investment and Employment Growth

In columns (1)-(5) of Table 4, the dependent variable is CAPITAL_EXPENDITURES. Column (1) shows that investment rates decreased by 7.5 percentage points during the GR and were still 5.7 percentage points lower when the economy recovered. The coefficient on Ln(DENSITY)×$I_{2008\text{-}09}$ in column (2) indicates that the investment rates of firms with cluster density one-standard deviation above the mean were 1.4 percentage points higher during the GR, offsetting the effect of the GR from column (1) by 18.7% (0.014/0.075). The coefficient on Ln(DENSITY)×$I_{2010\text{-}12}$ further shows that the investment rates of these firms remained 1.1 percentage points higher after the GR. Including interacted control variables in column (3) or using six-digit NAICS-year and county-year fixed effects in column (4) does not affect the results. Column (5), which extends the event window, shows that cluster density no longer impacted physical capital investment rates during 2013 and 2014.

Columns (6)-(10) use EMPLOYMENT_GROWTH as the dependent variable. Columns (6) and (7) show that firms in denser regional clusters also reduced their employment growth to a lower extent. The employment growth of firms with cluster density one-standard deviation above the mean was 1.7 percentage points higher during the GR and 1.2 percentage points higher during the next two years. This implies that, during the GR, higher cluster density offsets the negative effect of the GR on employment growth by 16.2% (0.017/0.105). Columns (8) and (9) show that the results are similar if we add interacted control variables or use six-digit NAICS-year and county-year fixed effects. Finally, column (10) documents that cluster density continued to have a positive impact on employment growth during 2013 and 2014.

[Table 4 about here]

Graphs C and D of Figure 3 show the timing of the effects of cluster density on investment in physical capital and employment growth. Before the GR, firms' investment and employment growth rates were unrelated to the density of their regional cluster. At the onset of the GR, investment and employment growth rates increased for firms in denser regional clusters relative to their peers in less dense clusters. These effects became smaller as the economy recovered.

The evidence in Table 4 and Figure 3 suggests that firms in denser regional clusters invested to upgrade production facilities and boost productivity, which is less costly to do during recessions (Zhang (2019)). It also suggests that they avoided the costs of firing and retraining workers, which can be large, especially for skilled workers (Ghaly, Dang, and Stathopoulos (2017)). More generally, the higher investment and employment growth likely supported the market share gains obtained by firms in denser regional clusters during the GR. Noteworthy, firms in denser clusters did not make more acquisitions during or after the GR (see Table IA9). Hence, organic sales growth rather than acquisitions of rivals drove their market share gains.

3. Effect on Investment in Intangible Capital

In Table 5, we examine how regional cluster density affected investment in intangible capital around the GR. In columns (1)-(5), the dependent variable is INTANGIBLE_INVESTMENT, defined following Peters and Tayor (2017) as the sum of SG&A expenses times 0.3 plus R&D expenses scaled by the average stock of intangible assets.[12] Column (1) shows that intangible investment decreased for the average firm during the GR and its aftermath. Column (2) shows statistically significant positive coefficients on Ln(DENSITY)×$I_{2008\text{-}09}$ and Ln(DENSITY)×$I_{2010\text{-}}$

[12] SG&A expenses include salaries, wages, and bonuses of white-collar workers and managers, and are viewed as investment in human and organizational capital (Eisfeldt and Papanikolaou (2013)). R&D expenses include wage payments to scientists, engineers, and other technology workers, so they represent an investment in knowledge capital (Bloom, Schankerman, and Van Reenen (2013)). R&D spending is also associated with product differentiation, which increases consumers' willingness to pay for a firm's products (Shaked and Sutton (1987)).

12. The first coefficient implies that a one-standard deviation higher cluster density offsets the negative effect of the GR on intangible investment by 16.7% (0.005/0.030). Columns (3) and (4) show that the results are similar when we add interacted control variables and when we use six-digit NAICS-year and county-year fixed effects. Further, column (5) shows that cluster density continued to have a positive effect on intangible investment during 2013 and 2014. We also decompose intangible investment into its two components. The dependent variables in columns (6)-(8) and (9)-(11) are R&D_EXPENDITURES and SG&A_EXPENDITURES, respectively. During the GR and its aftermath, firms in denser clusters spent relatively more on both R&D and SG&A.

[Table 5 about here]

Figure 4 provides evidence on the timing of the effects using an approach analogous to that in our prior figures. Before the GR, cluster density had no effect on intangible investment. However, in 2009, the figure shows a sharp increase in the intangible investment of firms in denser regional clusters relative to that of their peers in less dense regional clusters. Likewise, the positive impact of cluster density on intangible investment holds in the aftermath of the GR.

[Figure 4 about here]

Put together, our findings in Table 5 and Figure 4 suggest that higher investment in human and organizational capital, knowledge capital, and product differentiation during the GR was a key differential feature of the behavior of firms situated in denser clusters that likely played a prominent role in strengthening their product market performance.

B. Effect on Valuations

In Table 6, we examine the effect of regional cluster density on firm value around the GR. In columns (1)-(5), the dependent variable is TOBINS_Q. Column (1) shows a decrease in

TOBINS_Q for the average firm during the GR. Despite a subsequent increase, average TOBINS_Q remained below its pre-GR level afterward. Column (2) shows that firms in denser regional clusters maintained higher valuations than those in less dense regional clusters both during and after the GR. The coefficient on Ln(DENSITY)$\times I_{2008\text{-}09}$ implies that a one-standard deviation higher cluster density offsets the negative valuation effect of the GR by 10.4% (0.070/0.676). The coefficient on Ln(DENSITY)$\times I_{2010\text{-}12}$ is also positive and statistically significant. Columns (3) and (4) document that the results are similar when we add interacted control variables and when we use six-digit NAICS-year and county-year fixed effects instead of BCD-year and region-year fixed effects. Column (5) shows the valuation effects persist during 2013-2014.

[Table 6 about here]

In columns (6)-(10), the dependent variable is Ln(MVA), an alternative proposed by Bartlett and Partnoy (2020) to address the concern that inaccuracies in calculating the replacement cost of assets might bias Tobin's Q. Column (6) shows that the market value of the average firm's assets decreased 26% during the GR and was back to its pre-GR level afterward. Column (7) documents that firms in denser regional clusters maintained higher valuations during and after the GR. The valuations of firms with cluster density one-standard deviation above the mean were 3.6% higher during the GR and 5.9% higher after the GR, which are economically significant magnitudes. Adding the interacted control variables in column (8) does not affect the results, and using six-digit NAICS-year and county-year fixed effects increases the magnitude of the effects. Finally, column (10) shows that the higher valuations of firms in more dense clusters persisted over the years 2013-2014.

Figure 5, which is constructed using an approach like that of our prior figures, shows the timing of the effects of cluster density on firm valuations. The graph for TOBINS_Q shows that small relative valuation gains had already manifested by December 2007, when the GR officially started. These relative valuation gains peaked in 2011 and persisted through 2014. The graph for Ln(MVA) shows that relative valuation gains began in 2008 and persisted through 2014.

[Figure 5 about here]

Overall, Table 6 and Figure 5 show that, as firms in denser regional clusters gained market share during the GR and its aftermath, they simultaneously experienced significant value gains. This evidence underscores the importance of competitive advantages provided by regional clusters during periods of economic turbulence in product markets.

C. Effect on Profitability

Whether the market share gains of firms in denser regional clusters during the GR should be accompanied by higher return on assets (ROA) and profit margins is not obvious. Firms in denser regional clusters prioritized market share growth and thus increased their capital, SG&A, and R&D expenditures, which reduced their profitability. In contrast, firms in less dense regional clusters might have prioritized cutting expenses to boost their profitability at the expense of market share growth. Further, while higher R&D and SG&A expenses directly lower profits, greater capital expenditures increase total assets, making the net effect on ROA ambiguous.

In Figure IA2, we provide evidence on the impact of cluster density on profit margins (EBITDA/Sales) and profitability rates (ROA) over the period 2003-2014 using the same approach as in our prior figures. Cluster density does not impact profitability rates or margins before or during the GR. The fact that relative profitability did not decrease for firms in dense clusters despite their greater investment rates and market share gains speaks to the resiliency of these firms. Interestingly, there is some indication that the relative profitability rates and margins of firms in dense clusters increased in 2013 and 2014 (but it is statistically insignificant), which suggests that these firms might have experienced higher profitability rates in the long run.

VI. Specific Benefits from Agglomeration

The gains to a firm from location within a regional cluster arise from the combined effects of various closely-intertwined agglomeration benefits that are hard to disentangle empirically and are not mutually exclusive. Still, in the following two subsections, we use alternative approaches to provide some insights into what specific types of agglomeration benefits might be at play.

A. Measures of Regional Cluster Density Based on Specific Types of Agglomeration Benefits

We use alternative measures of regional cluster density developed by Delgado and Porter (2021) that more directly capture specific types of agglomeration benefits. We gauge benefits related to input-output links using DENSITY_SUP and DENSITY_CUS, the density of a region's BCD based on potential supplier and customer links among industries in the BCD, respectively. We measure potential benefits of labor market pooling using DENSITY_OCC, the strength of a region's BCD based on the similarity of the occupations used by industries in the BCD. We quantify benefits from knowledge spillovers using DENSITY_KNOW, the strength of a region's BCD based on its stock of patented innovation (or stock of knowledge). Last, DENSITY_BREADTH, gauges the strength of a region's BCD based on the breadth of its industrial activity.

Table IA10 reports the results of analyses analogous to those in columns (3) and (4) of Table 2 but using the alternative cluster density measures described above. For all cluster density measures, we find results that are similar in magnitude and statistical significance to the baseline results based on DENSITY. One interpretation of these findings is that all channels likely play important roles in improving firms' product market performance in regional clusters during and after the GR. However, in untabulated tests, we find that these variables are correlated with one another, and as a result, none of them are statistically significant if they are all included simultaneously in the regression model. Ultimately, this test is limited in its ability to tease out which of the closely intertwined agglomeration forces might be more important.

B. Cross-Sectional Analyses Based on Ex-Ante Ability to Reap Agglomeration Benefits

If specific agglomeration benefits drive our main results, then the impact of cluster density on market share growth should be more pronounced when firms are more likely to reap a particular benefit of agglomeration. To examine this issue, in Table 7, we extend our Eq. (1) to condition the impact of cluster density during the GR and its aftermath on proxies for a firm's *ex-ante* ability to reap specific agglomeration benefits. Our regression model is:

$$
\begin{aligned}
(2) \qquad y_{i,c,r,t} = {} & \beta_1\, Ln(DENSITY_{c,r}) \times I_{2008-09,t} + \beta_2\, Ln(DENSITY_{c,r}) \times I_{2010-12,t} \\
& + \beta_3\, Ln(DENSITY_{c,r}) \times I_{2008-09,t} \times HB_i \\
& + \beta_4\, Ln(DENSITY_{c,r}) \times I_{2010-12,t} \times HB_i + \pi_1 HB_i \times I_{2008-09,t} \\
& + \pi_2 HB_i \times I_{2010-12,t} + \gamma_1\, X_i \times I_{2008-09,t} + \gamma_2\, X_i \times I_{2010-12,t} \\
& + \delta_1\, Z_{c,r} \times I_{2008-09,t} + \delta_2\, Z_{c,r} \times I_{2010-12,t} + \alpha_i + OTHER\_FE + \varepsilon_{i,c,r,t},
\end{aligned}
$$

where HB_i equals one when firm *i* has a high ex-ante ability to reap an agglomeration benefit (measured pre-GR), and zero otherwise. In the table, the coefficients of $HB_i \times I_{2008-09,t}$ and $HB_i \times I_{2010-12,t}$ are omitted for brevity.[13] We are interested in whether the impact of cluster density is significant for firms with HB = 1 (i.e., $\beta_1 + \beta_3 \neq 0$ and $\beta_2 + \beta_4 \neq 0$), for firms with HB = 0 (i.e., $\beta_1 \neq 0$ and $\beta_2 \neq 0$), and whether there is a significant difference in the impact of cluster density across firms with HB = 1 and HB = 0 (i.e., whether $\beta_3 \neq 0$ and $\beta_4 \neq 0$). Using Eq. (2), we consider three different *HB* indicators, each of which captures a specific benefit.

[13] Other variables that would normally be needed for a proper triple interaction approach (HB_i and $Ln(DENSITY_{c,r}) \times HB_i$ are time invariant and thus omitted from Eq. (2) as it includes firm fixed effects.

First, a firm's ability to absorb knowledge and information spillovers from other firms – its "absorptive capacity" – is determined by its stock of knowledge (Cohen and Levinthal (1990)). Hombert and Matray (2018) also highlight how a larger stock of knowledge allows firms to adapt their strategies and boost their performance when they face negative shocks. For each firm, we calculate $KNOWLEDGE\_CAPITAL_i$ by capitalizing R&D expenses as in Peters and Taylor (2017) and Bloom et al (2013), and average it over 2005-2007. The variable $KNOW_i$ equals one if firm *i*'s pre-GR $KNOWLEDGE\_CAPITAL_i$ is above the sample median and zero otherwise.

Second, the operating flexibility and cost savings advantages are likely greater when there is more scope for business dealings among firms co-located in the same region. These advantages can be especially important in downturns, when changing economic conditions might require a firm to find new suppliers or customers and when supply-chain reliability is valuable. To this end, we calculate the average similarity of input-output links between a firm's industry and all other industries located in the firm's region, weighting each link by the share of the other industries in regional employment ($IO\_SIMILARITY_i$). The variable IO_SIM_i equals one if firm *i*'s pre-GR $IO\_SIMILARITY_i$ is above the sample median, and zero otherwise.

Third, the benefits of fluid labor markets are likely larger when workers' skills are more transferrable across the firms located in the same region. Access to workers can increase firms' resiliency in bad times and their ability to hire the talent required to exploit new business opportunities during the rebound. We calculate the average similarity between the occupations used in a firm's industry and those used in all other industries located in the firm's region, weighting the similarity of occupations between each industry pair by the share of the other industry in regional employment ($OCC\_SIMILARITY_i$). The variable OCC_SIM_i equals one if firm *i*'s pre-GR $OCC\_SIMILARITY_i$ is above the sample median, and zero otherwise.

In columns (1)-(2) of Table 7, we consider the role of potential knowledge spillovers. Based on column (2), for firms with a high pre-GR stock of knowledge capital, the estimated impact of cluster density on sales growth during the GR is 0.046, and it is 0.058 in its aftermath; both effects are statistically significant. In contrast, the effects are statistically insignificant and small for firms with low pre-GR stocks of knowledge capital. Further, the differences in the impact of cluster density across firms with high and low stocks of knowledge capital are both statistically significant. These findings suggest that a greater ability to absorb knowledge and information spillovers was a driver of competitive success both during and especially after the GR.

In columns (3)-(4), we consider the role of supply chains. Based on column (4), for firms with a high pre-GR input-output similarity, the estimated impact of cluster density on sales growth during the GR is 0.041 and statistically significant. The estimated impact in the GR's aftermath is 0.019, but it is statistically insignificant. In comparison, the effects are statistically insignificant and smaller for firms with low pre-GR input-output similarity. The difference in the impact of cluster density across high and low input-output similarity firms is statistically and economically significant during the GR, but statistically insignificant in its aftermath. Hence, supply-chain links among firms in a regional cluster seem to have provided significant advantages mostly during the GR.

[Table 7 about here]

In columns (5)-(6), we consider the role of labor market pooling. Based on column (6), the impact of cluster density on sales growth during the GR is 0.020 and marginally statistically significant for firms with low occupational similarity, and it is statistically insignificant and of negligible magnitude (0.002) for firms with high occupational similarity. The difference in the effect across firms with high and low occupational similarity is statistically insignificant. In contrast, the impact of cluster density in the GR's aftermath is 0.045 and statistically significant for firms with high occupational similarity, and it is small (0.003) and statistically insignificant for firms with low occupational similarity. The difference in the effect across firms with high and low occupational similarity is large and statistically significant. This suggests that labor pooling provided firms in denser regional clusters with an advantage during the post-GR rebound.

In columns (7)-(8), we simultaneously include interactions of cluster density with KNOW, IO_SIM, and OCC_SIM. The results are consistent with those in columns (1)-(6). The effect of cluster density is larger for firms with a high stock of knowledge capital during and after the GR, but the difference is only statistically significant after the GR. The effect during the GR is also larger for firms with a high input-output similarity, and the difference is statistically significant. Last, the differential effect for firms with high occupational similarity during the GR is positive, but statistically insignificant. In sum, including all interactions simultaneously weakens the statistical significance of the individual effects, but the evidence suggests an important role of input-output similarity during the GR and of knowledge and information spillovers over the rebound. Labor pooling likely plays a smaller role which takes place during the rebound.

C. Cross-Sectional Analyses Based on the Intensity of Competition in an Industry

Motivated by prior work that shows industry structure impacts a firm's conduct and performance, we examine whether the advantages of location within dense clusters during economic downturns depend on the degree of competition in the industry. In less competitive industries, barriers to entry entrench incumbent firms in their market positions, leading to higher profit margins and a high resiliency to economic downturns. In contrast, in more competitive industries, firms face the constant threat that new entrants will challenge their market positions. This reduces their profitability and survival rates and creates strong pressure for those firms to operate efficiently. This implies that the cost efficiency and flexibility advantages of location within dense regional clusters around downturns might be greater in more competitive industries.

In columns (1)-(2) of Table 8, we use an approach similar to that in Section VI.B to condition the effect of cluster density on sales growth during the GR and its aftermath on the competitive environment in a firm's industry. Using the four-firm concentration ratio from the U.S. Census Bureau averaged over the two census years 2002 and 2007, we construct an indicator, $LOWC4_i$, which equals one if the four-firm concertation ratio in a firm's industry is below the sample median, and zero otherwise. Column (1) reports the results of our specification with BCD-year and region-year fixed effects, and column (2) reports the results for the specification with six-digit NAICS-year and county-year fixed effects. We include interacted controls in both.

In column (1), we find no effect of Ln(DENSITY) on sales growth during the GR or its aftermath for firms in less competitive industries. For firms in more competitive industries, the effects are positive and statistically significant both during the GR and the rebound (the coefficients are 0.035 and 0.046, respectively). The differences in the effect of cluster density across less competitive and more competitive industries are statistically and economically significant in both cases (3.2 percentage points higher during the GR and 3.6 percentage points higher after the GR for firms in more competitive industries). The results in column (2) are similar. Cluster density has no effect on sales growth during or after the GR in less competitive industries, but it has a positive and statistically significant effect both during and after the GR in more competitive industries (0.037 and 0.074, respectively). The difference in the effect across less competitive and more competitive industries is statistically and economically significant after the GR (6.1 percentage points higher for firms in more competitive industries). The difference is smaller (0.015) and statistically insignificant during the GR.

[Table 8 about here]

We also examine whether the benefits from location within a denser regional cluster around the GR differ across small and large firms in competitive industries. Regional clusters may provide greater benefits for smaller firms, since they allow these firms to collectively tap inputs, information, and labor pools as if they had greater scale (Porter (1998)). These benefits are likely more important in industries where intense competitive pressure makes it difficult for small firms to survive, and especially during major recessions when small firms account for a large share of firm exits. To this end, in columns (3)-(4), we focus exclusively on the subsample of firms in competitive industries and condition the effect of cluster density on sales growth during and after the GR on the pre-GR size of the firm. The regression specification is similar to that in columns (1)-(2), but uses the interaction of Ln(DENSITY) with the indicator SMALL_FIRM, which equals one if the firm's pre-GR sales are below the sample median, and zero otherwise.

In column (3), the estimated effects for small firms are positive and statistically significant both during the GR (0.059) and the rebound (0.098), while the coefficients are smaller and marginally significant or insignificant for large firms. The difference in the impact of cluster density across small and large firms is large (8.8 percentage points) and highly statistically significant after the GR, while the difference during the GR is smaller (3.2 percentage points) and statistically insignificant. In column (4), the effects for small firms are positive and statistically significant both during the GR (0.060) and the rebound (0.110), while the effects are smaller and statistically insignificant for large firms. The differences in the effect of cluster density across small and large firms are large (5.0 percentage points higher during the GR and 7.6 percentage points higher afterward), but only of marginal statistical significance.

Overall, the results in Table 8 suggest that the advantages of being located within a denser regional cluster in periods of economic turbulence are potentially larger for firms in more competitive industries and especially for smaller firms. This is likely because, in such industries, maintaining cost efficiency and flexibility is vital in bad times when a lack of agility in responding to changes in the economic environment can drive a firm out of business.

VII. Conclusion

During the GR and the subsequent economic expansion, firms in denser regional clusters gained market share at the expense of their rivals in less dense regional clusters. These firms were more resilient and agile during this period, likely due to a superior ability to operate flexibly with the help of trusted business partners, absorb information and knowledge spillovers from economically related neighbors, and access deep pools of locally available talented workers. The product market benefits of location in a dense regional cluster were most pronounced for firms that had a greater ex-ante ability to reap agglomeration-related benefits and for those that operated in a more competitive industry. Firms in denser clusters achieved market share gains by investing more in physical assets, employment growth, and organizational and knowledge capital. Ultimately, these firms experienced significant long-lasting value gains, suggesting that the advantages of regional clusters outweighed any potential disadvantages.

Our analyses centered around the GR highlight that location in a dense regional cluster can have a major impact on a firm’s subsequent performance in product markets, investment decisions, and valuation. However, since the GR is a specific shock, further research is needed to assess the competitive advantages of regional clusters more broadly. For example, it would be useful to examine such advantages in the advent of other negative shocks, such as increases in foreign or domestic competition, changes in consumer tastes, new regulation, or policy uncertainty. Further, the benefits of clusters might also be large around large positive shocks to investment opportunities, such as the creation of a common market in the European Union, industry deregulation, increases in demand, or the emergence of new technologies.

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Appendix: Variable Definitions

AGE: number of years since a firm first appeared in the Compustat database, averaged over 2005-2007 (time invariant).

ASSET_VOLATILITY: annualized asset volatility from the distance to default model (Bharath and Shumway (2008)).

CAPITAL_EXPENDITURES: capital expenditures (*capx*) scaled by the average of beginning and end of year net property, plant, and equipment (*ppent*).

CR_BETA_EG: the estimated coefficients from regressions of annual BCD-region employment growth on US GDP growth, estimated by BCD-region over 1999-2007 (time invariant). Employment data are from the CBP database.

CR_BETA_RET: the estimated coefficients from regressions of firms' monthly stock returns on the CRSP value-weighted index return, estimated by BCD-region over 1998-2007 (time invariant).

CR_BETA_SG: the estimated coefficients from regressions of firms' annual sales growth rates on US GDP growth, estimated by BCD-region over 1998-2007 (time invariant).

CR_EMP_GROWTH: annual growth in the number of employees in a BCD-region, averaged over 2005-2007 (time invariant). Employment data are from the CBP database.

CR_ESTAB_GROWTH: annual growth in the number of establishments in a BCD-region, averaged over 2005-2007 (time invariant). Establishment data are from the CBP database.

DENSITY: density (location quotient) of BCD *c* in region *r* based on employment, averaged over 2005-2007 (time invariant). $DENSITY_{c,r} = \left(\frac{1+emp_{c,r}}{emp_{c,N}}\right) \Big/ \left(\frac{emp_r}{emp_N}\right)$, where $emp_{c,r}$ is employment of BCD *c* in region *r*, $emp_{c,N}$ is employment of BCD *c* in the nation, emp_r is employment in region *r*, and emp_N is national employment. The variable is calculated for individual years using data from the CBP database and then averaged over 2005-2007.

EMPLOYMENT_GROWTH: change in employment (*emp*) scaled by the average of beginning and end of year number of employees.

FOUR-FIRM_CONCENTRATION: percent of an industry's output captured by the largest four firms in the firm's NAICS industry (U.S. Census Bureau), averaged over the Census years 2002 and 2007 (time invariant).

$I_{2008\text{-}09}$, $I_{2010\text{-}12}$, $I_{2013\text{-}14}$: indicator variables that equal one for the years 2008-2009, 2010-2012, and 2013-2014, respectively, and zero otherwise.

INTANGIBLE_INVESTMENT: research and development expenditures (*xrd)* plus 30% of selling, general, and administrative expenses (*xsga*) scaled by the average of beginning and end of year stock of intangible assets from Peters and Taylor (2017).

IO_SIMILARITY: similarity of input-output links between a NAICS6 industry and all other NAICS6 industries located in region *r*, averaged over 2005-2007 (time invariant). For each industry *i* in region *r*, we calculate $IO\_SIMILARITY_{i,r} = \sum_{j \neq i} IO_{i,j} \times \frac{emp_{j,r}}{emp_r}$, where $emp_{j,r}$ is employment of industry *j* in region *r* and emp_r is employment in region *r*. $IO_{i,j}$ is $Max\{input_{i\rightarrow j}, input_{i\leftarrow j}, output_{i\rightarrow j}, output_{i\leftarrow j}\}$, where $input_{i\rightarrow j}$ is the share of industry *i*'s total value of inputs that comes from industry *j* and $output_{i\rightarrow j}$ is the share of industry *i*'s total value of outputs that goes to industry *j*. Employment data are from CBP and input-output data are from Delgado, Porter, and Stern (2016). The variable is calculated for each year and then averaged over 2005-2007.

KNOWLEDGE_CAPITAL: a firm's stock of knowledge capital, constructed as capitalized R&D expenditures scaled by book assets as in Peters and Taylor (2017) based on *xrd* and *at*, averaged over 2005-2007 (time invariant).

MVA: market value of assets (*prcc_f*×*csho*+*at*-*ceq*).

NET_LEVERAGE: debt in current liabilities plus long-term debt minus cash and short-term securities scaled by book assets [(*dlc+dltt-che)/at*], averaged over 2005-2007 (time invariant).

OCC_SIMILARITY: similarity of occupations between a NAICS6 industry and all other NAICS6 industries located in region *r*, averaged over 2005-2007 (time invariant). For each industry *i* in region *r*, we calculate $OCC\_SIMILARITY_{i,r} = \sum_{j \neq i} OS_{i,j} \times \frac{emp_{j,r}}{emp_r}$, where $emp_{j,r}$ is employment of industry *j* in region *r* and emp_r is employment in region *r*. $OS_{i,j}$ is the correlation between the occupations used in industries *i* and *j* (Corr(Occ_i,Occ_j)), where Occ_i is a vector with the percentage of each of the 792 Occupational Employment Statistics occupations in the total occupational employment of industry *i*. Employment data are from CBP and occupational similarity data are from Delgado, Porter, and Stern (2016). The variable is calculated for each year and then averaged over 2005-2007.

PROFITABILITY: operating income before depreciation and amortization scaled by book assets (*oibdp/at*), averaged over 2005-2007 (time invariant).

R&D_EXPENDITURES: research and development expenditures (*xrd)* scaled by the average of beginning and end of year stock of intangible assets from Peters and Taylor (2017).

SALES_GROWTH: one-year percent change in sales [Ln($sale_t/sale_{t-1}$)].

SG&A_EXPENDITURES: selling, general, and administrative expenditures (*xsga)* multiplied by 0.3 and scaled by the average of beginning and end of year stock of intangible assets from Peters and Taylor (2017).

SIZE: book value of assets (*at* in millions), averaged over 2005-2007 (time invariant).

TANGIBILITY: book value of net property, plant, and equipment scaled by book assets (*ppent/at*), averaged over 2005-2007 (time invariant).

TOBINS_Q: market value of assets scaled by book value of assets [(*prcc_f×csho+at-ceq)/at*]. When Tobin's Q is a pre-recession control variable, we average it over 2005-2007 (time invariant).

UNLEVERED_VOLATILITY: annualized standard deviation of daily stock returns over a firm's fiscal year multiplied by the average of beginning and end of year market leverage [(*csho*×*prcc_f*)/(*at-ceq*+*csho*×*prcc_f*)].

FIGURE 1
Density of Selected Benchmark Cluster Definitions Across Regions

The figure shows the DENSITY of three selected Benchmark Cluster Definitions (BCDs) across all U.S. regions, using subsequently darker red colors to identify regions with DENSITY between 0.0-0.4, 0.4-0.8, 0.8-1.2, 1.2-1.6, 1.6-2.0, and >2.0, respectively. DENSITY is defined in the Appendix.

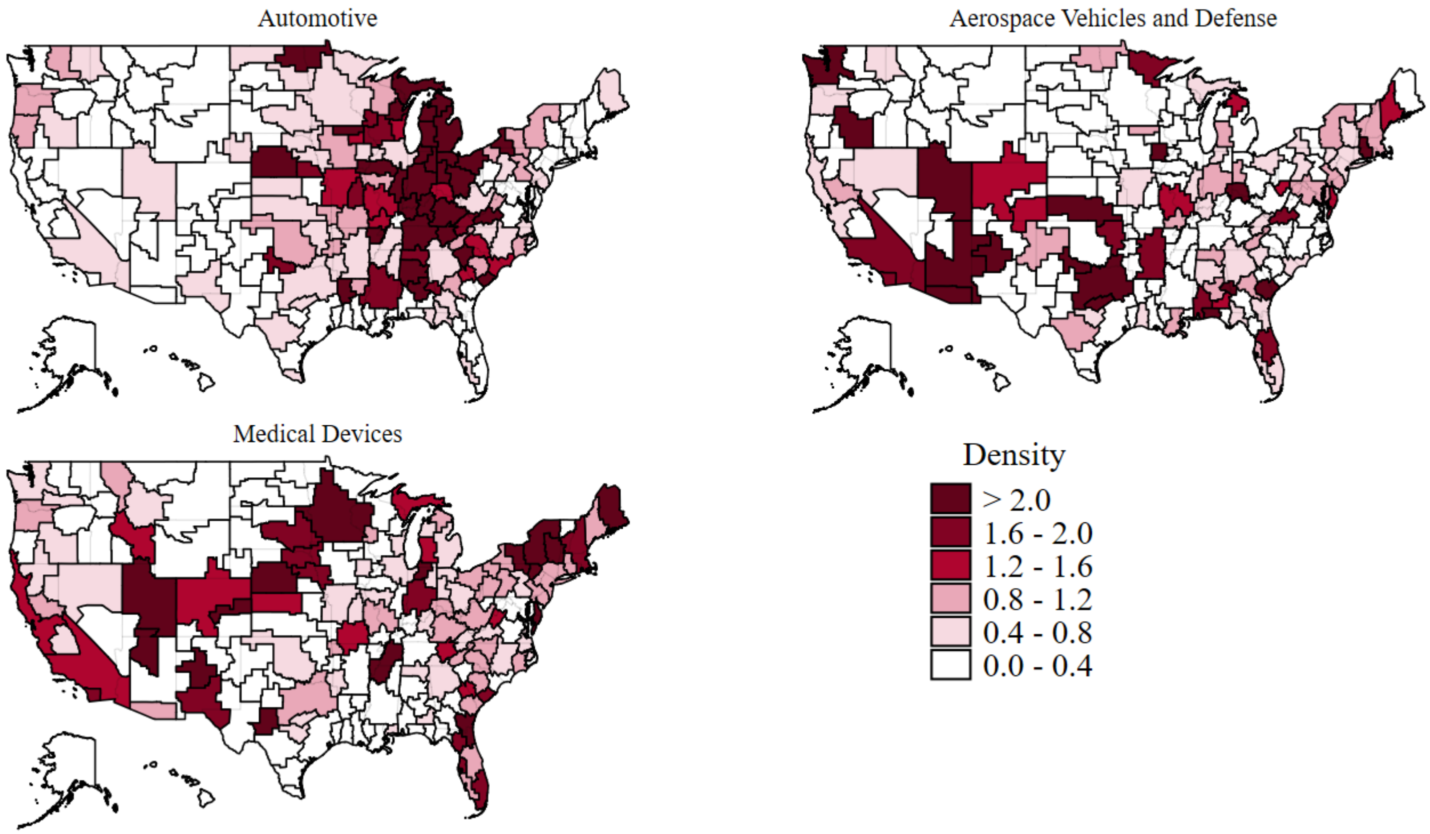

FIGURE 2
Dynamic Effects of Regional Cluster Density on Sales Growth

The figure plots the estimated impact of Ln(DENSITY) on SALES_GROWTH in each of the individual years within the period 2003-2014 as well as the associated 90% confidence intervals based on standard errors clustered by BCD×Region. The coefficients are based on a fully dynamic version of Eq. (1) that includes interactions of Ln(DENSITY) with year dummies (year 2006 is the left-out reference period), all control variables interacted with the year dummies, and firm fixed effects. As in Table 2, the two alternative specifications further include either BCD-year and region-year fixed effects (solid line) or NAICS6-year and county-year fixed effects (dashed line).

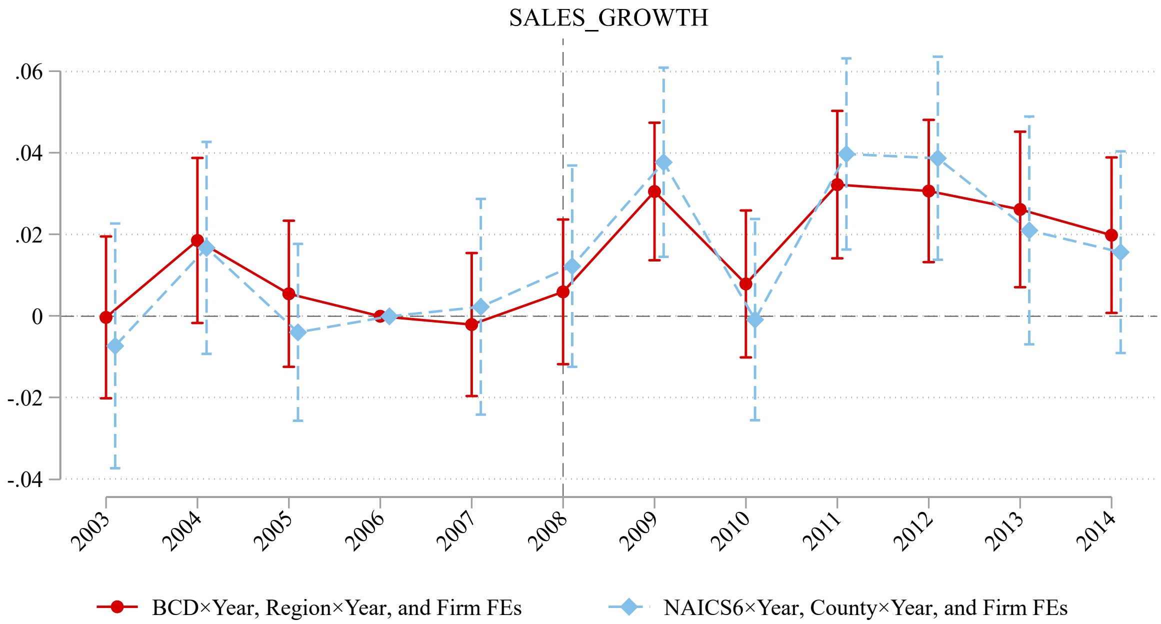

FIGURE 3

Dynamic Effects of Regional Cluster Density on Uncertainty, Capital Expenditures, and Employment Growth

The figure plots the estimated impact of Ln(DENSITY) on UNLEVERED_VOLATILITY (Graph A), ASSET_VOLATILITY (Graph B), CAPITAL_EXPENDITURES (Graph C), and EMPLOYMENT_GROWTH (Graph D) in each of the individual years within the period 2003-2014 as well as the associated 90% confidence intervals based on standard errors clustered by BCD×Region. The estimated coefficients are based on a fully dynamic version of Eq. (1) that includes interactions of Ln(DENSITY) with year dummies (year 2006 is the left-out reference period), all control variables interacted with the year dummies, and firm fixed effects. As in Tables 3 and 4, the two alternative specifications further include either BCD-year and region-year fixed effects (solid line) or NAICS6-year and county-year fixed effects (dashed line).

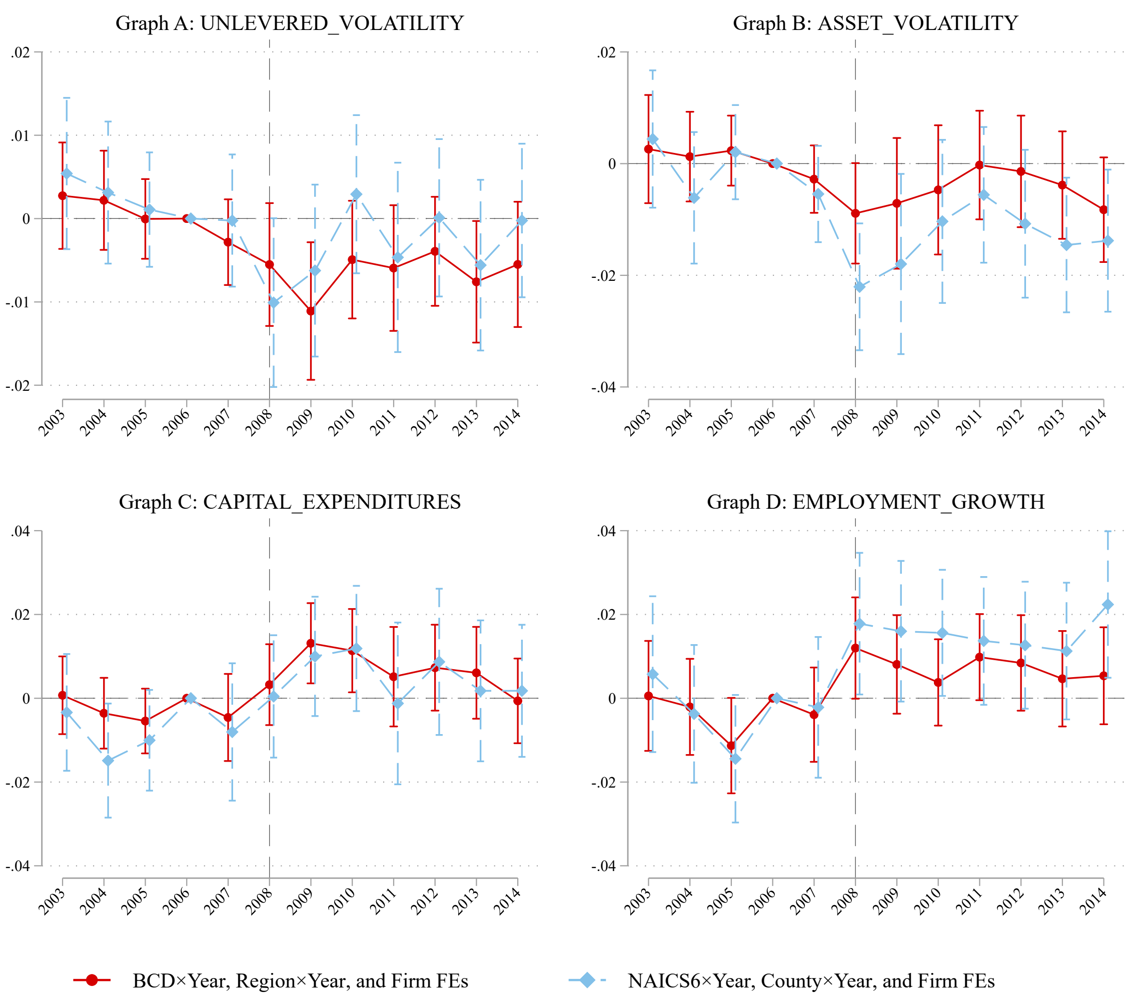

FIGURE 4
Dynamic Effects of Regional Cluster Density on Investment in Intangibles

The figure plots the estimated impact of Ln(DENSITY) on INTANGIBLE_INVESTMENT (Graph A), R&D_EXPENDITURES (Graph B), and SG&A_EXPENDITURES (Graph C) in each of the individual years within the period 2003-2014 as well as the associated 90% confidence intervals based on standard errors clustered by BCD×Region. The estimated coefficients are based on a fully dynamic version of Eq. (1) that includes interactions of Ln(DENSITY) with year dummies (year 2006 is the left-out reference period), all control variables interacted with the year dummies, and firm fixed effects. As in Table 5, the two alternative specifications further include either BCD-year and region-year fixed effects (solid line) or NAICS6-year and county-year fixed effects (dashed line).

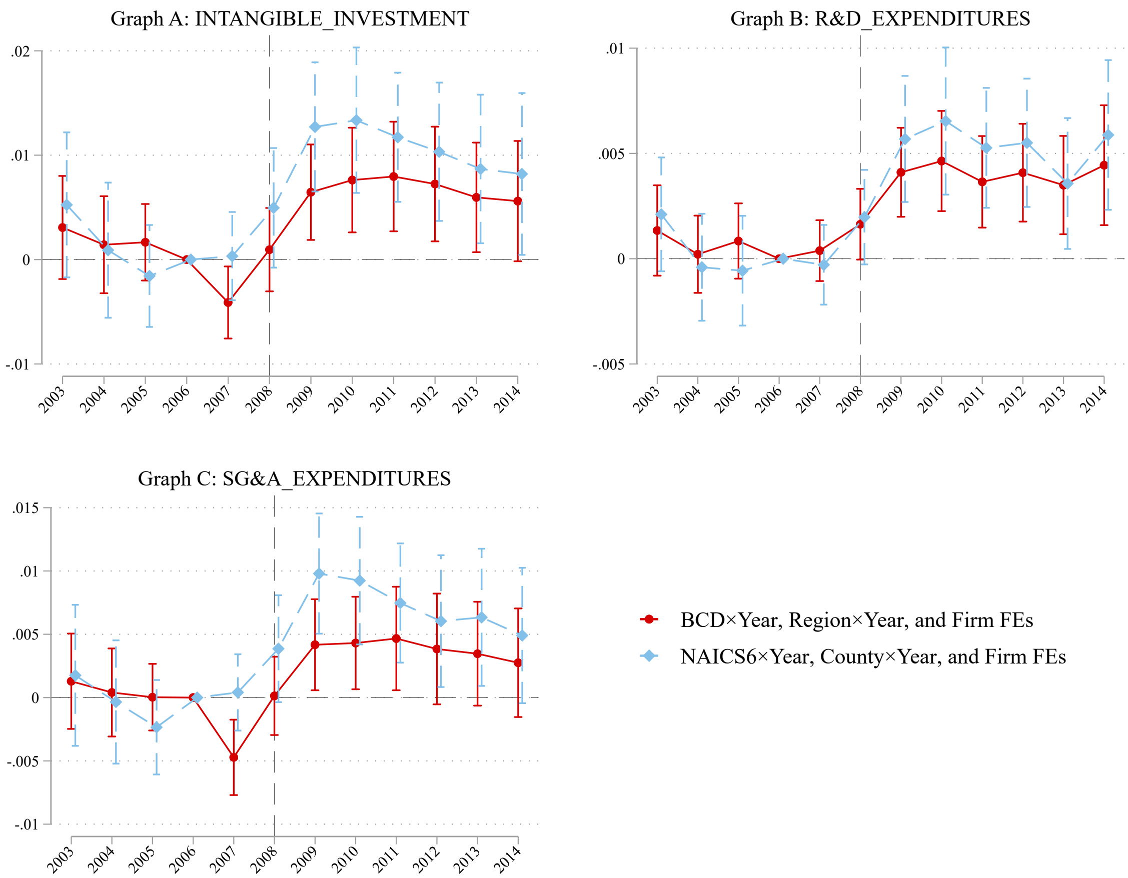

FIGURE 5
Dynamic Effects of Regional Cluster Density on Firm Value

The figure plots the estimated impact of Ln(DENSITY) on TOBINS_Q (Graph A) and Ln(MVA) (Graph B) in each of the individual years within the period 2003-2014 as well as the associated 90% confidence intervals based on standard errors clustered by BCD×Region. The estimated coefficients are based on a fully dynamic version of Eq. (1) that includes interactions of Ln(DENSITY) with year dummies (year 2006 is the left-out reference period), all control variables interacted with the year dummies, and firm fixed effects. As in Table 6, the two alternative specifications further include either BCD-year and region-year fixed effects (solid line) or NAICS6-year and county-year fixed effects (dashed line).

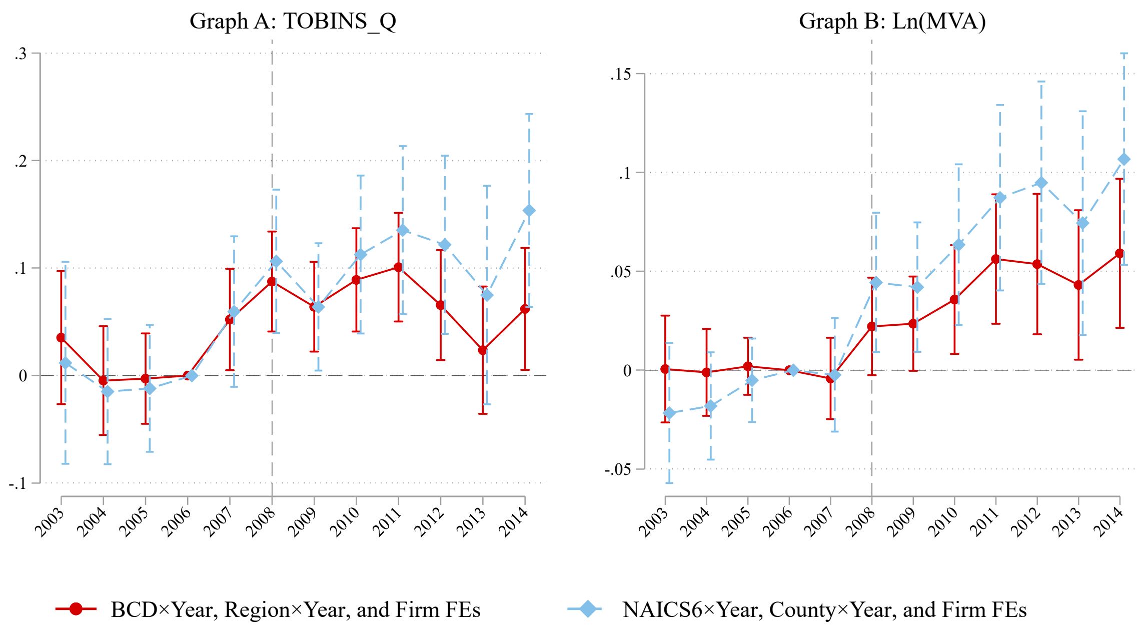

TABLE 1
Summary Statistics

The table reports summary statistics for the main sample, which spans the years 2005 to 2012. Summary statistics for predetermined variables are based on one observation per firm. Firm-level variables are winsorized at their 1st and 99th percentiles by year. All variables are defined in the Appendix.

	Obs	Mean	Std Dev	P25	P50	P75
Dependent Variables						
SALES_GROWTH	19,752	0.089	0.331	-0.034	0.079	0.206
UNLEVERED_VOLATILITY	19,343	0.359	0.207	0.210	0.319	0.461
ASSET_VOLATILITY	16,115	0.455	0.233	0.290	0.410	0.567
CAPITAL_EXPENDITURES	19,636	0.293	0.245	0.124	0.219	0.386
EMPLOYMENT_GROWTH	19,098	0.038	0.217	-0.046	0.029	0.119
INTANGIBLE_INVESTMENT	18,074	0.213	0.122	0.130	0.192	0.267
SG&A_EXPENDITURES	18,074	0.153	0.094	0.091	0.132	0.190
R&D_EXPENDITURES	19,570	0.064	0.084	0.000	0.028	0.103
TOBINS_Q	19,744	2.013	1.483	1.148	1.536	2.298
Ln(MVA)	19,745	6.617	2.073	5.117	6.564	8.013
Predetermined Density and Control Variables						
DENSITY	3,155	2.132	3.707	0.809	1.194	2.199
LN(DENSITY)	3,155	0.280	0.928	-0.212	0.177	0.788
SIZE	3,155	2318.4	6450.4	76.3	304.4	1303.2
TANGIBILITY	3,155	0.228	0.229	0.059	0.139	0.312
AGE	3,155	19.520	16.595	9.000	14.000	24.000
NET_LEVERAGE	3,155	-0.047	0.416	-0.308	-0.009	0.208
PROFITABILITY	3,155	0.026	0.401	0.011	0.097	0.155
TOBINS_Q	3,155	2.576	4.483	1.360	1.808	2.734
CR_ESTAB_GROWTH	3,155	0.003	0.037	-0.025	0.000	0.024
CR_EMP_GROWTH	3,155	0.010	0.072	-0.036	0.005	0.037
CR_BETA_EG	3,155	0.359	4.109	-0.880	0.462	1.890
CR_BETA_SG	3,155	4.966	9.029	0.651	4.423	8.139
CR_BETA_RET	3,155	1.348	0.671	0.833	1.258	1.865

TABLE 2
Regional Cluster Density and Sales Growth

The table reports the results from OLS regressions relating a firm's sales growth rate to regional cluster density estimated over the years 2005-2012 in columns (1)-(4) and 2003-2014 in column (5). The dependent variable is a firm's sales growth rate (SALES_GROWTH). DENSITY is the density of a firm's BCD in its region. $I_{2008\text{-}09}$ equals one for the years 2008 and 2009, and zero otherwise. $I_{2010\text{-}12}$ equals one for the years 2010-2012, and zero otherwise. $I_{2013\text{-}14}$ equals one for the years 2013 and 2014, and zero otherwise. The pre-recession control variables include Ln(SIZE), TANGIBILITY, Ln(AGE), NET_LEVERAGE, PROFITABILITY, TOBINS_Q, CR_EMP_GROWTH, CR_ESTAB_GROWTH, CR_BETA_EG, CR_BETA_SG, and CR_BETA_RET. All variables are defined in the Appendix. The *t*-statistics in parentheses are calculated from heteroscedasticity-robust standard errors clustered by BCD×Region. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	SALES_GROWTH				
	(1)	(2)	(3)	(4)	(5)
$I_{2008\text{-}09}$	-0.183***				
	(-25.00)				
$I_{2010\text{-}12}$	-0.081***				
	(-11.83)				
Ln(DENSITY) × $I_{2008\text{-}09}$		0.016**	0.017**	0.025***	0.023**
		(2.34)	(2.45)	(2.65)	(2.47)
Ln(DENSITY) × $I_{2010\text{-}12}$		0.021***	0.021***	0.024***	0.022**
		(2.90)	(3.12)	(2.63)	(2.56)
Ln(DENSITY) × $I_{2013\text{-}14}$					0.016
					(1.52)
Firm FEs	✓	✓	✓	✓	✓
BCD × Year FEs		✓	✓		
Region × Year FEs		✓	✓		
Controls × $I_{2008\text{-}09}$			✓	✓	✓
Controls × $I_{2010\text{-}12}$			✓	✓	✓
Controls × $I_{2013\text{-}14}$					✓
NAICS6 × Year FEs				✓	✓
County × Year FEs				✓	✓
Observations	19,752	19,501	19,501	16,395	24,010
Adjusted R^2	0.125	0.183	0.191	0.123	0.095

TABLE 3
Regional Cluster Density and Uncertainty

The table reports the results from OLS regressions relating a firm's unlevered stock return volatility and asset volatility to regional cluster density estimated over the years 2005-2012 in columns (1)-(4) and (6)-(9) and 2003-2014 in columns (5) and (10). The dependent variables are a firm's annualized unlevered stock return volatility (UNLEVERED_VOLATILITY) in columns (1)-(5) and asset volatility (ASSET_VOLATILITY) in columns (6)-(10). DENSITY is the density of a firm's BCD in its region. $I_{2008\text{-}09}$ equals one for the years 2008 and 2009, and zero otherwise. $I_{2010\text{-}12}$ equals one for the years 2010-2012, and zero otherwise. $I_{2013\text{-}14}$ equals one for the years 2013 and 2014, and zero otherwise. The pre-recession control variables include Ln(SIZE), TANGIBILITY, Ln(AGE), NET_LEVERAGE, PROFITABILITY, TOBINS_Q, CR_EMP_GROWTH, CR_ESTAB_GROWTH, CR_BETA_EG, CR_BETA_SG, and CR_BETA_RET. All variables are defined in the Appendix. The *t*-statistics in parentheses are calculated from heteroscedasticity-robust standard errors clustered by BCD×Region. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	UNLEVERED_VOLATILITY					ASSET_VOLATILITY				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$I_{2008\text{-}09}$	0.140***					0.145***				
	(44.08)					(37.31)				
$I_{2010\text{-}12}$	-0.010***					0.057***				
	(-4.28)					(13.79)				
Ln(DENSITY) × $I_{2008\text{-}09}$		-0.010***	-0.007**	-0.009**	-0.010**		-0.008	-0.007	-0.016***	-0.019***
		(-2.87)	(-2.03)	(-2.13)	(-2.22)		(-1.56)	(-1.51)	(-2.63)	(-2.88)
Ln(DENSITY) × $I_{2010\text{-}12}$		-0.003	-0.004	-0.001	-0.002		-0.002	-0.001	-0.005	-0.008
		(-0.96)	(-1.19)	(-0.24)	(-0.46)		(-0.43)	(-0.31)	(-0.86)	(-1.41)
Ln(DENSITY) × $I_{2013\text{-}14}$					-0.004					-0.014**
					(-1.05)					(-2.34)
Firm FEs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
BCD × Year FEs		✓	✓				✓	✓		
Region × Year FEs		✓	✓				✓	✓		
Controls × $I_{2008\text{-}09}$			✓	✓	✓			✓	✓	✓
Controls × $I_{2010\text{-}12}$			✓	✓	✓			✓	✓	✓
Controls × $I_{2013\text{-}14}$					✓					✓
NAICS6 × Year FEs				✓	✓				✓	✓
County × Year FEs				✓	✓				✓	✓
Observations	19,306	19,049	19,049	15,963	23,339	16,011	15,756	15,756	12,799	18,804
Adjusted R^2	0.723	0.735	0.742	0.721	0.724	0.653	0.732	0.737	0.727	0.731

TABLE 4
Regional Cluster Density and Capital Expenditures and Employment Growth

The table reports the results from OLS regressions relating a firm's capital expenditure and employment growth rate to regional cluster density estimated over the years 2005-2012 in columns (1)-(4) and (6)-(9) and 2003-2014 in columns (5) and (10). The dependent variables are a firm's capital expenditures scaled by average beginning and end of year net PP&E (CAPITAL_EXPENDITURES) in columns (1)-(5) and employment growth rate (EMPLOYMENT_GROWTH) in columns (6)-(10). DENSITY is the density of a firm's BCD in its region. $I_{2008\text{-}09}$ equals one for the years 2008 and 2009, and zero otherwise. $I_{2010\text{-}12}$ equals one for the years 2010-2012, and zero otherwise. $I_{2013\text{-}14}$ equals one for the years 2013 and 2014, and zero otherwise. The pre-recession control variables include Ln(SIZE), TANGIBILITY, Ln(AGE), NET_LEVERAGE, PROFITABILITY, TOBINS_Q, CR_EMP_GROWTH, CR_ESTAB_GROWTH, CR_BETA_EG, CR_BETA_SG, and CR_BETA_RET. All variables are defined in the Appendix. The *t*-statistics in parentheses are calculated from heteroscedasticity-robust standard errors clustered by BCD×Region. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	CAPITAL_EXPENDITURES					EMPLOYMENT_GROWTH				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$I_{2008\text{-}09}$	-0.075***					-0.105***				
	(-13.91)					(-23.19)				
$I_{2010\text{-}12}$	-0.057***					-0.038***				
	(-14.08)					(-8.62)				
Ln(DENSITY) × $I_{2008\text{-}09}$		0.014***	0.011***	0.011*	0.012**		0.017***	0.016***	0.024***	0.020***
		(3.13)	(2.75)	(1.88)	(2.25)		(3.02)	(3.05)	(3.12)	(2.98)
Ln(DENSITY) × $I_{2010\text{-}12}$		0.011**	0.011**	0.012*	0.014**		0.012***	0.014***	0.021***	0.017***
		(2.24)	(2.41)	(1.65)	(1.97)		(2.61)	(3.04)	(3.03)	(3.03)
Ln(DENSITY) × $I_{2013\text{-}14}$					0.009					0.019***
					(1.19)					(2.74)
Firm FEs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
BCD × Year FEs		✓	✓				✓	✓		
Region × Year FEs		✓	✓				✓	✓		
Controls × $I_{2008\text{-}09}$			✓	✓	✓			✓	✓	✓
Controls × $I_{2010\text{-}12}$			✓	✓	✓			✓	✓	✓
Controls × $I_{2013\text{-}14}$					✓					✓
NAICS6 × Year FEs				✓	✓				✓	✓
County × Year FEs				✓	✓				✓	✓
Observations	19,633	19,382	19,382	16,278	23,835	19,067	18,810	18,810	15,719	23,094
Adjusted R^2	0.452	0.457	0.468	0.408	0.389	0.160	0.162	0.172	0.132	0.109

TABLE 5
Regional Cluster Density and Investment in Intangible Assets

The table reports the results from OLS regressions relating a firm's investment in intangible assets to regional cluster density estimated over the years 2005-2012 in columns (1)-(4), (6)-(7), and (9)-(10) and 2003-2014 in columns (5), (8), and (11). The dependent variables are a firm's total investment in intangible assets (INTANGIBLE_INVESTMENT) in columns (1)-(5), R&D expenditures (R&D_EXPENDITURES) in columns (6)-(8), and SG&A expenditures (SG&A_EXPENDITURES) in columns (9)-(11). DENSITY is the density of a firm's BCD in its region. $I_{2008\text{-}09}$ equals one for the years 2008 and 2009, and zero otherwise. $I_{2010\text{-}12}$ equals one for the years 2010-2012, and zero otherwise. $I_{2013\text{-}14}$ equals one for the years 2013 and 2014, and zero otherwise. The pre-recession control variables include Ln(SIZE), TANGIBILITY, Ln(AGE), NET_LEVERAGE, PROFITABILITY, TOBINS_Q, CR_EMP_GROWTH, CR_ESTAB_GROWTH, CR_BETA_EG, CR_BETA_SG, and CR_BETA_RET. All variables are defined in the Appendix. The t-statistics in parentheses are calculated from heteroscedasticity-robust standard errors clustered by BCD×Region. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	INTANGIBLE_INVESTMENT					R&D_EXPENDITURES			SG&A_EXPENDITURES		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
$I_{2008\text{-}09}$	-0.030***										
	(-17.88)										
$I_{2010\text{-}12}$	-0.045***										
	(-20.96)										
Ln(DENSITY) × $I_{2008\text{-}09}$		0.005**	0.006***	0.010***	0.008***	0.002***	0.004***	0.004***	0.005***	0.008***	0.007***
		(2.57)	(3.13)	(3.75)	(2.81)	(3.04)	(3.61)	(2.97)	(3.02)	(3.55)	(2.91)
Ln(DENSITY) × $I_{2010\text{-}12}$		0.009***	0.010***	0.013***	0.011***	0.004***	0.006***	0.006***	0.007***	0.008***	0.008***
		(3.01)	(3.54)	(4.14)	(3.52)	(3.49)	(4.31)	(3.72)	(2.93)	(3.30)	(2.99)
Ln(DENSITY) × $I_{2013\text{-}14}$					0.007**			0.005***			0.006*
					(1.99)			(2.73)			(1.90)
Firm FEs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
BCD × Year FEs		✓	✓			✓			✓		
Region × Year FEs		✓	✓			✓			✓		
Controls × $I_{2008\text{-}09}$			✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls × $I_{2010\text{-}12}$			✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls × $I_{2013\text{-}14}$					✓			✓			✓
NAICS6 × Year FEs				✓	✓		✓	✓		✓	✓
County × Year FEs				✓	✓		✓	✓		✓	✓
Observations	18,049	17,815	17,815	14,782	21,622	19,324	16,261	23,803	17,815	14,782	21,622
Adjusted R^2	0.767	0.775	0.789	0.777	0.724	0.879	0.865	0.840	0.805	0.803	0.760

TABLE 6
Regional Cluster Density and Firm Value

The table reports the results from OLS regressions relating a firm's value to regional cluster density estimated over the years 2005-2012 in columns (1)-(4) and (6)-(9) and 2003-2014 in columns (5) and (10). The dependent variable is a firm's market value of assets scaled by book value of assets (TOBINS_Q) in columns (1)-(5) and the natural logarithm of a firm's market value of assets (Ln(MVA)) in columns (6)-(10). DENSITY is the density of a firm's BCD in its region. $I_{2008\text{-}09}$ equals one for the years 2008 and 2009, and zero otherwise. $I_{2010\text{-}12}$ equals one for the years 2010-2012, and zero otherwise. $I_{2013\text{-}14}$ equals one for the years 2013 and 2014, and zero otherwise. The pre-recession control variables include Ln(SIZE), TANGIBILITY, Ln(AGE), NET_LEVERAGE, PROFITABILITY, CR_EMP_GROWTH, CR_ESTAB_GROWTH, CR_BETA_EG, CR_BETA_SG, and CR_BETA_RET. All variables are defined in the Appendix. The *t*-statistics in parentheses are calculated from heteroscedasticity-robust standard errors clustered by BCD×Region. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	TOBINS_Q					Ln(MVA)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$I_{2008\text{-}09}$	-0.676***					-0.260***				
	(-28.51)					(-20.22)				
$I_{2010\text{-}12}$	-0.488***					0.025				
	(-19.52)					(1.33)				
Ln(DENSITY) × $I_{2008\text{-}09}$		0.070***	0.052**	0.059**	0.072**		0.036***	0.027**	0.046***	0.052***
		(3.20)	(2.43)	(2.07)	(2.46)		(3.17)	(2.40)	(2.99)	(2.91)
Ln(DENSITY) × $I_{2010\text{-}12}$		0.074***	0.063***	0.093**	0.110***		0.059***	0.052***	0.085***	0.089***
		(3.08)	(2.61)	(2.45)	(2.68)		(3.54)	(3.16)	(3.43)	(3.45)
Ln(DENSITY) × $I_{2013\text{-}14}$					0.100*					0.098***
					(1.87)					(3.00)
Firm FEs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
BCD × Year FEs		✓	✓				✓	✓		
Region × Year FEs		✓	✓				✓	✓		
Controls × $I_{2008\text{-}09}$			✓	✓	✓			✓	✓	✓
Controls × $I_{2010\text{-}12}$			✓	✓	✓			✓	✓	✓
Controls × $I_{2013\text{-}14}$					✓					✓
NAICS6 × Year FEs				✓	✓				✓	✓
County × Year FEs				✓	✓				✓	✓
Observations	19,741	19,490	19,490	16,384	23,995	19,742	19,491	19,491	16,385	23,996
Adjusted R^2	0.658	0.661	0.668	0.638	0.599	0.959	0.960	0.961	0.957	0.946

TABLE 7
Regional Cluster Density and Sales Growth: Chanel Analysis

The table reports the results from OLS regressions relating a firm's sales growth rate to regional cluster density estimated over the years 2005-2012 (see Eq. (2) in the text for the full empirical model). The dependent variable is a firm's sales growth rate (SALES_GROWTH). DENSITY is the density of a firm's BCD in its region. $I_{2008\text{-}09}$ equals one for the years 2008 and 2009, and zero otherwise. $I_{2010\text{-}12}$ equals one for the years 2010-2012, and zero otherwise. KNOW is an indicator variable equal to one if pre-recession KNOWLEDGE_CAPITAL is above the median, and zero otherwise. IO_SIM is an indicator variable equal to one if pre-recession IO_SIMILARITY is above the median, and zero otherwise. OCC_SIM is an indicator variable equal to one if pre-recession OCCUPATIONAL_SIMILARITY is above the median, and zero otherwise. The coefficients of the interactions between these variables (KNOW, IO_SIM, and OCC_SIM) with $I_{08\text{-}09}$ and $I_{10\text{-}12}$ are omitted for brevity. The pre-recession control variables include Ln(SIZE), TANGIBILITY, Ln(AGE), NET_LEVERAGE, PROFITABILITY, TOBINS_Q, CR_EMP_GROWTH, CR_ESTAB_GROWTH, CR_BETA_EG, CR_BETA_SG, and CR_BETA_RET. All variables are defined in the Appendix. The *t*-statistics in parentheses are calculated from heteroscedasticity-robust standard errors clustered by BCD×Region. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	SALES_GROWTH							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln(DENSITY) × $I_{2008\text{-}09}$	0.008	0.009	0.006	-0.001	0.014	0.020*	0.003	-0.008
	(0.97)	(0.73)	(0.66)	(-0.07)	(1.54)	(1.66)	(0.21)	(-0.47)
Ln(DENSITY) × $I_{2010\text{-}12}$	0.011	0.001	0.007	0.010	0.012	0.003	-0.002	-0.015
	(1.43)	(0.07)	(0.73)	(0.72)	(1.32)	(0.26)	(-0.17)	(-1.04)
Ln(DENSITY) × $I_{2008\text{-}09}$ × KNOW	0.022	0.037*					0.027	0.032
	(1.49)	(1.91)					(1.62)	(1.33)
Ln(DENSITY) × $I_{2010\text{-}12}$ × KNOW	0.027*	0.057***					0.028*	0.041**
	(1.80)	(3.08)					(1.69)	(2.03)
Ln(DENSITY) × $I_{2008\text{-}09}$ × IO_SIM			0.020	0.042**			0.016	0.039*
			(1.57)	(2.18)			(1.26)	(1.92)
Ln(DENSITY) × $I_{2010\text{-}12}$ × IO_SIM			0.017	0.009			0.013	0.009
			(1.04)	(0.37)			(0.79)	(0.39)
Ln(DENSITY) × $I_{2008\text{-}09}$ × OCC_SIM					-0.008	-0.018	-0.018	-0.027
					(-0.58)	(-0.97)	(-1.42)	(-1.37)
Ln(DENSITY) × $I_{2010\text{-}12}$ × OCC_SIM					0.006	0.042**	-0.004	0.025
					(0.44)	(2.47)	(-0.28)	(1.56)
p-value ($\beta_1 + \beta_3 = 0$)	0.012	0.001	0.011	0.005	0.601	0.887		
p-value ($\beta_2 + \beta_4 = 0$)	0.031	<0.001	0.066	0.282	0.123	0.003		
Firm FEs	✓	✓	✓	✓	✓	✓	✓	✓
BCD & Region × Year FEs	✓		✓		✓		✓	
Controls × $I_{2008\text{-}09}$ & $I_{2010\text{-}12}$	✓	✓	✓	✓	✓	✓	✓	✓
NAICS6 & County × Year FEs		✓		✓		✓		✓
Observations	19,501	16,395	17,708	14,982	17,708	14,982	17,708	14,982
Adjusted R^2	0.191	0.124	0.186	0.122	0.186	0.122	0.187	0.124

TABLE 8
Regional Cluster Density and Sales Growth: Effect of Competition

The table reports the results from OLS regressions relating a firm's sales growth rate to regional cluster density estimated over the years 2005-2012 (the regression specification is analogous to Eq. (2) in the text). The dependent variable is a firm's sales growth rate (SALES_GROWTH). DENSITY is the density of a firm's BCD in its region. $I_{2008\text{-}09}$ equals one for the years 2008 and 2009, and zero otherwise. $I_{2010\text{-}12}$ equals one for the years 2010-2012, and zero otherwise. LOWC4 is an indicator variable equal to one if pre-recession FOUR-FIRM_CONCENTRATION is below the sample median, and zero otherwise. In columns (3)-(4), we focus exclusively on the subsample of firms in competitive industries (LOWC4=1). SMALL_FIRM is an indicator variable equal to one if pre-recession firm sales is below the sample median, and zero otherwise. The coefficients of the interactions between the variables (LOWC4 and SMALL_FIRM) with $I_{2008\text{-}09}$ and $I_{2010\text{-}12}$ are omitted for brevity. The pre-recession control variables include Ln(SIZE), TANGIBILITY, Ln(AGE), NET_LEVERAGE, PROFITABILITY, TOBINS_Q, CR_EMP_GROWTH, CR_ESTAB_GROWTH, CR_BETA_EG, CR_BETA_SG, and CR_BETA_RET. All variables are defined in the Appendix. The *t*-statistics in parentheses are calculated from heteroscedasticity-robust standard errors clustered by BCD×Region. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	SALES_GROWTH			
	(1)	(2)	(3)	(4)
Ln(DENSITY) × $I_{2008\text{-}09}$	0.003	0.022	0.027*	0.010
	(0.32)	(1.24)	(1.77)	(0.56)
Ln(DENSITY) × $I_{2010\text{-}12}$	0.010	0.013	0.010	0.034
	(0.95)	(0.78)	(0.60)	(1.29)
Ln(DENSITY) × $I_{2008\text{-}09}$ × LOWC4	0.032*	0.015		
	(1.94)	(0.56)		
Ln(DENSITY) × $I_{2010\text{-}12}$ × LOWC4	0.036**	0.061**		
	(2.34)	(2.33)		
Ln(DENSITY) × $I_{2008\text{-}09}$ × SMALL_FIRM			0.032	0.050*
			(1.34)	(1.93)
Ln(DENSITY) × $I_{2010\text{-}12}$ × SMALL_FIRM			0.088***	0.076
			(2.85)	(1.64)
p-value ($\beta_1 + \beta_3 = 0$)	0.003	0.029	0.004	0.016
p-value ($\beta_2 + \beta_4 = 0$)	<0.001	<0.001	<0.001	0.001
Firm FEs	✓	✓	✓	✓
BCD × Year FEs	✓		✓	
Region × Year FEs	✓		✓	
NAICS6 × Year FEs		✓		✓
County × Year FEs		✓		✓
Controls × $I_{2008\text{-}09}$	✓	✓	✓	✓
Controls × $I_{2010\text{-}12}$	✓	✓	✓	✓
Observations	17,958	15,027	8,871	7,205
Adjusted R^2	0.163	0.083	0.168	0.078

INTERNET APPENDIX

REGIONAL CLUSTERS AND PRODUCT MARKET OUTCOMES DURING TURBULENT TIMES

Sandy Klasa, Hernán Ortiz-Molina, and Matthew Serfling

FIGURE IA1
Density of Benchmark Cluster Definitions in Largest Regions

The figure shows the number of Benchmark Cluster Definitions (BCDs) with DENSITY between 0.0-0.4, 0.4-0.8, 0.8-1.2, 1.2-1.6, 1.6-2.0, and >2.0, respectively, in each of the 20 U.S. regions with the highest employment (from the County Business Patterns database). DENSITY is defined in the Appendix.

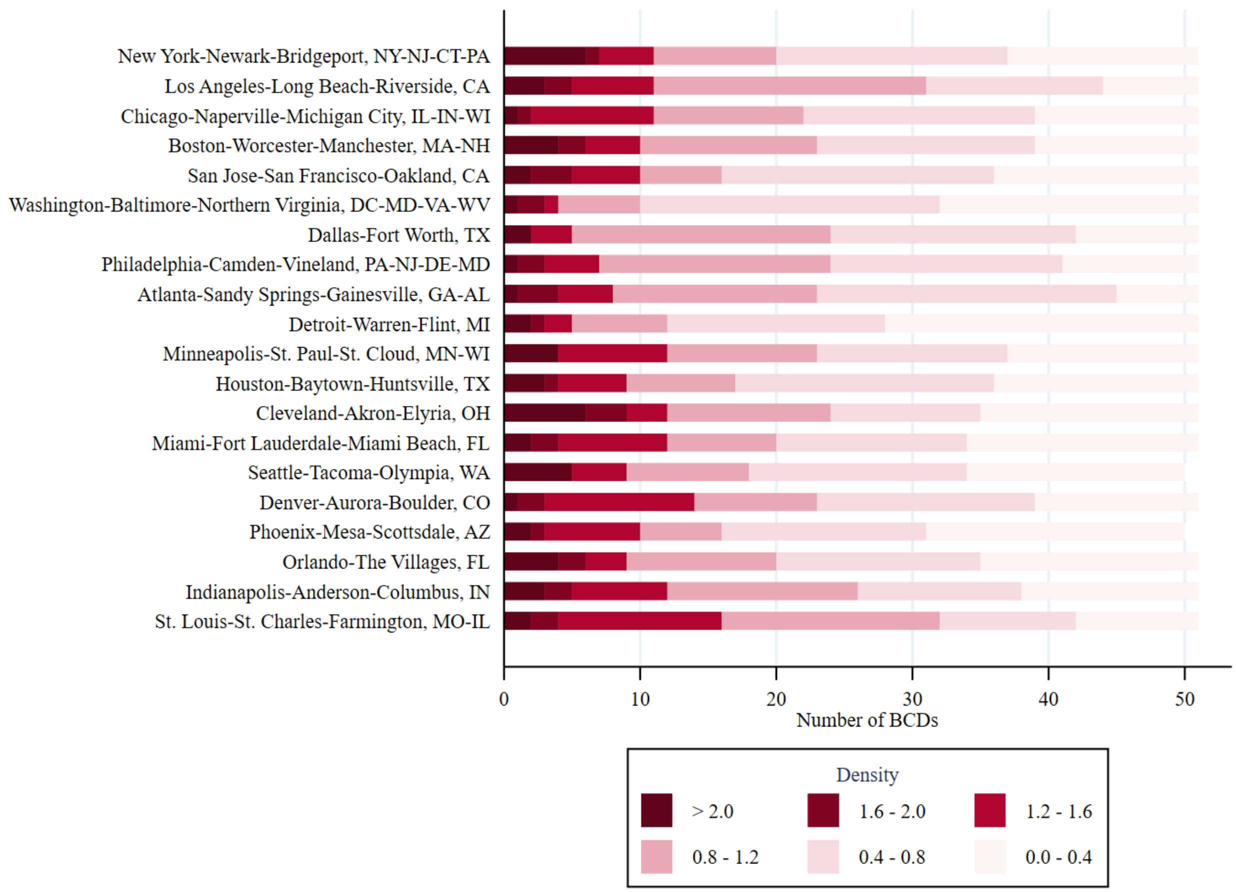

FIGURE IA2
Dynamic Effects of Regional Cluster Density on Firm Profitability

The figure plots the estimated impact of Ln(DENSITY) on OPERATING_PROFIT_MARGIN (operating income before depreciation and amortization scaled by sales) in Graph A and OPERATING_ROA (operating income before depreciation and amortization scaled by book value of assets) in Graph B in each of the individual years within the period 2003-2014 as well as the associated 90% confidence intervals based on standard errors clustered by BCD×Region. The estimated coefficients are based on a fully dynamic version of Eq. (1) that includes interactions of Ln(DENSITY) with year dummies (year 2006 is the left-out reference period), all control variables interacted with the year dummies, and firm fixed effects. The two alternative specifications further include either BCD-year and region-year fixed effects (solid line) or NAICS6-year and county-year fixed effects (dashed line).

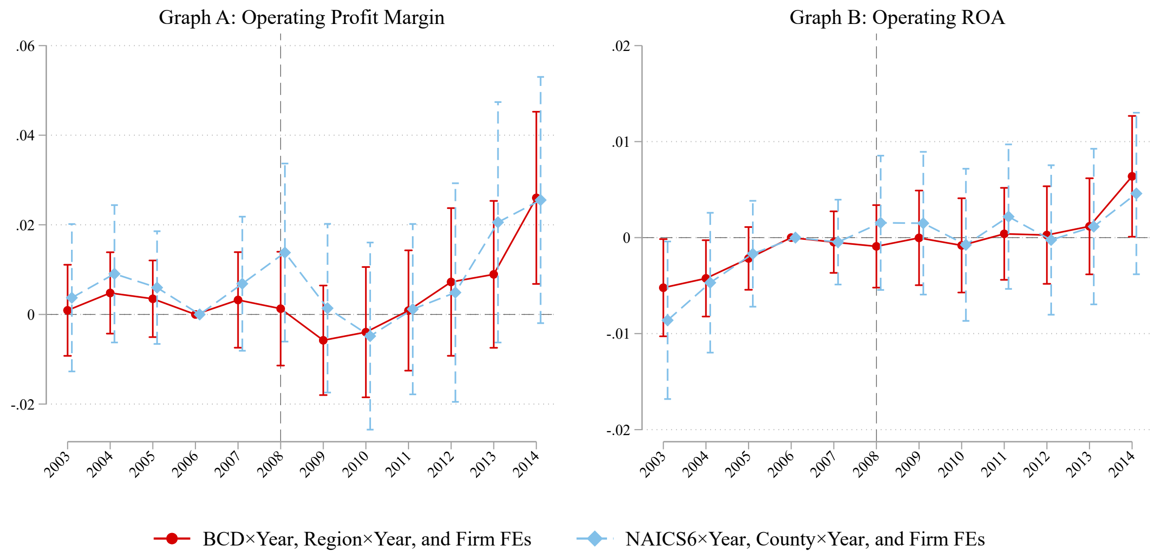

TABLE IA1
Benchmark Cluster Definitions

The table reports the 51 Benchmark Cluster Definitions (BCDs) and the number of six-digit NAICS industries based on the 2002 NAICS classification in each of them. Source: Delgado, Porter, and Stern (2016) and U.S. Cluster Mapping Project.

Code	BCD	# of NAICS	Code	BCD	# of NAICS
1	Aerospace Vehicles and Defense	7	27	Lighting and Electrical Equipment	15
2	Agricultural Inputs and Services	9	28	Livestock Processing	5
3	Apparel	21	29	Marketing, Design, and Publishing	22
4	Automotive	26	30	Medical Devices	5
5	Biopharmaceuticals	4	31	Metal Mining	8
6	Business Services	33	32	Metalworking Technology	17
7	Coal Mining	4	33	Music and Sound Recording	5
8	Communications Equipment and Services	8	34	Nonmetal Mining	13
9	Construction Products and Services	20	35	Oil and Gas Production and Transportation	12
10	Distribution and Electronic Commerce	62	36	Paper and Packaging	20
11	Downstream Chemical Products	13	37	Performing Arts	8
12	Downstream Metal Products	16	38	Plastics	15
13	Education and Knowledge Creation	15	39	Printing Services	13
14	Electric Power Generation and Transmission	5	40	Production Technology and Heavy Machinery	41
15	Environmental Services	7	41	Recreational and Small Electric Goods	15
16	Financial Services	26	42	Textile Manufacturing	23
17	Fishing and Fishing Products	5	43	Tobacco	3
18	Food Processing and Manufacturing	47	44	Trailers, Motor Homes, and Appliances	9
19	Footwear	6	45	Transportation and Logistics	17
20	Forestry	4	46	Upstream Chemical Products	12
21	Furniture	12	47	Upstream Metal Manufacturing	26
22	Hospitality and Tourism	31	48	Video Production and Distribution	6
23	Information Technology and Analytical Instruments	27	49	Vulcanized and Fired Materials	17
24	Insurance Services	8	50	Water Transportation	12
25	Jewelry and Precious Metals	4	51	Wood Products	13
26	Leather and Related Products	6			

TABLE IA2
Industry Composition of Selected Benchmark Cluster Definitions

The table gives the industry breakdown of BCD #8 "Communications Equipment and Services" and BCD #35 "Oil and Gas Production and Transportation". Source: Delgado, Porter, and Stern (2016) and U.S. Cluster Mapping Project.

Communications Equipment and Services		*Oil and Gas Production and Transportation*	
NAICS	NAICS Name	NAICS	NAICS Name
334210	Telephone Apparatus Manufacturing	211111	Crude Petroleum and Natural Gas Extraction
334220	Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing	211112	Natural Gas Liquid Extraction
334290	Other Communications Equipment Manufacturing	213111	Drilling Oil and Gas Wells
335912	Primary Battery Manufacturing	213112	Support Activities for Oil and Gas Operations
515210	Cable and Other Subscription Programming	324110	Petroleum Refineries
517211	Paging	324199	All Other Petroleum and Coal Products Manufacturing
517212	Cellular and Other Wireless Telecommunications	333132	Oil and Gas Field Machinery and Equipment Manufacturing
517410	Satellite Telecommunications	486110	Pipeline Transportation of Crude Oil
517910	Other Telecommunications	486210	Pipeline Transportation of Natural Gas
		486910	Pipeline Transportation of Refined Petroleum Products
		486990	All Other Pipeline Transportation
		541360	Geophysical Surveying and Mapping Services

TABLE IA3
Correlations of Regional Cluster Density with Predetermined Variables

The table reports the pairwise correlations of pre-GR DENSITY with pre-GR variables using one observation per firm. The variables in Panel A are defined in the Appendix and calculated by averaging over 2005-2007. The additional variables in Panel B are calculated analogously. CASH is cash and cash equivalents scaled by book assets (*che*/*at*); DIVIDEND_PAYER is equal to one if a firm pays a common dividend (*dvc*), and zero otherwise; WW_INDEX is the Whited-Wu (2006) index of financial constraints; HP_INDEX is the Hadlock-Pierce (2010) index of financial constraints; RATED is equal to one if a firm has a long-term credit rating (*splticrm* is not missing), and zero otherwise; INVESTMENT_GRADE is equal to one if a firm's long-term credit rating (*splticrm*) is investment grade, and zero otherwise. *p*-values correspond to standard two-tailed *t*-tests of the null hypothesis that each correlation is equal to zero and are based on heteroscedasticity-robust standard errors clustered by BCD×Region.

Panel A: Correlation of Density with Predetermined Control Variables

	Obs	Correlation	*p*-value
Ln(SIZE)	3,155	0.073	0.070
TANGIBILITY	3,155	0.103	0.342
Ln(AGE)	3,155	-0.035	0.220
NET_LEVERAGE	3,155	-0.048	0.451
PROFITABILITY	3,155	0.011	0.656
TOBINS_Q	3,155	-0.011	0.326
CR_ESTAB_GROWTH	3,155	0.098	0.309
CR_EMP_GROWTH	3,155	0.209	0.095
CR_BETA_EG	3,155	0.172	0.024
CR_BETA_SG	3,155	0.026	0.707
CR_BETA_RET	3,155	0.104	0.339

Panel B: Correlation of Density with Additional Proxies for Predetermined Financial Constraints

	Obs	Correlation	*p*-value
CASH	3,155	0.043	0.562
DIVIDEND_PAYER	3,155	-0.061	0.141
WW_INDEX	3,139	-0.046	0.309
HP_INDEX	3,155	-0.031	0.296
RATED	3,155	0.048	0.226
INVESTMENT_GRADE	3,155	-0.010	0.766

TABLE IA4
Regional Cluster Density and Sales Growth: Controlling for the Likelihood of Government Relief

The table reports the results from OLS regressions relating a firm's sales growth rate to regional cluster density estimated over the years 2005-2012. The dependent variable is a firm's sales growth rate (SALES_GROWTH). DENSITY is the density of a firm's BCD in its region. $I_{2008\text{-}09}$ equals one for the years 2008 and 2009, and zero otherwise. $I_{2010\text{-}12}$ equals one for the years 2010-2012, and zero otherwise. NAICS6_SHARE is the fraction of employees in a county belonging to a six-digit NAICS industry in the county. GOV_SUPPLIER_BCD-REGION is the fraction of firms in a BCD-region that report the government as a major customer in the Compustat-Segment files. LOBBY_BCD-REGION is the total lobbying expenditures of firms in a BCD-region (data from OpenSecrets.org). GOV_SUPPLIER is an indicator variable equal to one if a firm reports the government as a major customer. LOBBY is the total lobbying expenditures of a firm. All variables are calculated yearly over 2005 to 2007 and averaged to create single pre-recession measures. The pre-recession control variables include Ln(SIZE), TANGIBILITY, Ln(AGE), NET_LEVERAGE, PROFITABILITY, TOBINS_Q, CR_EMP_GROWTH, CR_ESTAB_GROWTH, CR_BETA_EG, CR_BETA_SG, and CR_BETA_RET. All variables are defined in the Appendix. The *t*-statistics in parentheses are calculated from heteroscedasticity-robust standard errors clustered by BCD×Region. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	SALES_GROWTH			
	(1)	(2)	(3)	(4)
Ln(DENSITY) × $I_{2008\text{-}09}$	0.018**	0.022**	0.018**	0.021**
	(2.38)	(2.06)	(2.40)	(2.06)
Ln(DENSITY) × $I_{2010\text{-}12}$	0.020***	0.021*	0.020***	0.021**
	(2.70)	(1.96)	(2.70)	(1.99)
NAICS6_SHARE × $I_{2008\text{-}09}$	-0.001	0.003	-0.001	0.003
	(-0.11)	(0.19)	(-0.18)	(0.19)
GOV_SUPPLIER_BCD-REGION × $I_{2008\text{-}09}$	0.003	0.013		
	(0.45)	(1.31)		
Ln(1+LOBBY_BCD-REGION) × $I_{2008\text{-}09}$	-0.001	-0.002		
	(-0.16)	(-0.19)		
NAICS6_SHARE × $I_{2010\text{-}12}$	0.004	0.009	0.004	0.010
	(0.83)	(0.51)	(0.79)	(0.55)
GOV_SUPPLIER_BCD-REGION × $I_{2010\text{-}12}$	-0.010	-0.002		
	(-1.64)	(-0.25)		
Ln(1+LOBBY_BCD-REGION) × $I_{2010\text{-}12}$	-0.003	-0.000		
	(-0.29)	(-0.03)		
GOV_SUPPLIER × $I_{2008\text{-}09}$			0.014**	0.025***
			(2.34)	(3.05)
Ln(1+LOBBY) × $I_{2008\text{-}09}$			-0.002	-0.003
			(-0.21)	(-0.25)
GOV_SUPPLIER × $I_{2010\text{-}12}$			-0.019**	-0.011
			(-2.58)	(-1.01)
Ln(1+LOBBY) × $I_{2010\text{-}12}$			-0.002	-0.001
			(-0.26)	(-0.05)
Firm FEs	✓	✓	✓	✓
BCD × Year FEs	✓		✓	
Region × Year FEs	✓		✓	
Controls × $I_{2008\text{-}09}$	✓	✓	✓	✓
Controls × $I_{2010\text{-}12}$	✓	✓	✓	✓
NAICS6 × Year FEs		✓		✓
County × Year FEs		✓		✓
Observations	18,337	15,405	18,337	15,405
Adjusted R^2	0.184	0.118	0.185	0.119

Table IA5
Robustness: Dispersed Operations and Minimum Number of Firms

The table reports the results from OLS regressions relating a firm's sales growth rate to regional cluster density estimated over the years 2005-2012. The dependent variable is a firm's sales growth rate (SALES_GROWTH). Columns (1) and (2) exclude firms that mention an above median number of states in their 10-K filings (data from Garcia and Norli (2012)). Columns (3) and (4) exclude firms in industries with dispersed operations. These industries are Retail Trade (NAICS2 of 44 and 45), Wholesale Trade (NAICS2 of 42), and Transportation (NAICS2 of 48 and 49). Columns (5) and (6) require each BCD and region to have at least four firms in a year to enter the sample. Columns (7) and (8) exclude firms that relocated to a different region at any point between 2002 and 2007. DENSITY is the density of a firm's BCD in its region. $I_{2008\text{-}09}$ equals one for the years 2008 and 2009, and zero otherwise. $I_{2010\text{-}12}$ equals one for the years 2010-2012, and zero otherwise. The pre-recession control variables include Ln(SIZE), TANGIBILITY, Ln(AGE), NET_LEVERAGE, PROFITABILITY, TOBINS_Q, CR_EMP_GROWTH, CR_ESTAB_GROWTH, CR_BETA_EG, CR_BETA_SG, and CR_BETA_RET. All variables are defined in the Appendix. The *t*-statistics in parentheses are calculated from heteroscedasticity-robust standard errors clustered by BCD×Region. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	SALES_GROWTH							
	Below Median # of States		Non-Dispersed Industries		At Least Four Firms in a BCD and Region Each Year		Location Did Not Change Between 2002 and 2007	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln(DENSITY) × $I_{2008\text{-}09}$	0.037***	0.033**	0.019***	0.023**	0.023***	0.025***	0.014**	0.021**
	(3.16)	(2.00)	(2.61)	(2.47)	(3.09)	(2.63)	(1.99)	(2.13)
Ln(DENSITY) × $I_{2010\text{-}12}$	0.043***	0.053***	0.022***	0.025**	0.022***	0.026***	0.014**	0.017**
	(3.72)	(3.13)	(3.13)	(2.58)	(3.01)	(2.64)	(2.09)	(2.00)
Firm FEs	✓	✓	✓	✓	✓	✓	✓	✓
BCD × Year FEs	✓		✓		✓		✓	
Region × Year FEs	✓		✓		✓		✓	
Controls × $I_{2008\text{-}09}$	✓	✓	✓	✓	✓	✓	✓	✓
Controls × $I_{2010\text{-}12}$	✓	✓	✓	✓	✓	✓	✓	✓
NAICS6 × Year FEs		✓		✓		✓		✓
County × Year FEs		✓		✓		✓		✓
Observations	8,782	6,971	17,849	15,023	17,339	14,815	18,714	15,718
Adjusted R^2	0.128	0.023	0.189	0.119	0.193	0.122	0.194	0.124

TABLE IA6
Regional Cluster Density and Sales Growth: Alternative Functional Forms

The table reports the results from OLS regressions relating a firm's sales growth rate to regional cluster density estimated over the years 2005-2012. The dependent variable is a firm's sales growth rate (SALES_GROWTH). Density is the density of a firm's BCD in its region. DENSITY>P50, DENSITY>P66, and DENSITY>P75 are indicator variables equal to one if Density is above the median, in the top tercile, or in the top quartile of the distribution, respectively, and zero otherwise. $I_{2008\text{-}09}$ equals one for the years 2008 and 2009, and zero otherwise. $I_{2010\text{-}12}$ equals one for the years 2010-2012, and zero otherwise. The pre-recession control variables include Ln(SIZE), TANGIBILITY, Ln(AGE), NET_LEVERAGE, PROFITABILITY, TOBINS_Q, CR_EMP_GROWTH, CR_ESTAB_GROWTH, CR_BETA_EG, CR_BETA_SG, and CR_BETA_RET. All variables are defined in the Appendix. The *t*-statistics in parentheses are calculated from heteroscedasticity-robust standard errors clustered by BCD×Region. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	SALES_GROWTH					
	(1)	(2)	(3)	(4)	(5)	(6)
DENSITY>P50 × $I_{2008\text{-}09}$	0.017	0.033**				
	(1.45)	(2.09)				
DENSITY>P50 × $I_{2010\text{-}12}$	0.029**	0.048***				
	(2.32)	(2.95)				
DENSITY>P66 × $I_{2008\text{-}09}$			0.022*	0.042**		
			(1.83)	(2.45)		
DENSITY>P66 × $I_{2010\text{-}12}$			0.025*	0.039*		
			(1.66)	(1.94)		
DENSITY>P75 × $I_{2008\text{-}09}$					0.026*	0.056**
					(1.81)	(2.32)
DENSITY>P75 × $I_{2010\text{-}12}$					0.054***	0.072***
					(3.21)	(3.05)
Firm FEs	✓	✓	✓	✓	✓	✓
BCD × Year FEs	✓		✓		✓	
Region × Year FEs	✓		✓		✓	
Controls × $I_{2008\text{-}09}$	✓	✓	✓	✓	✓	✓
Controls × $I_{2010\text{-}12}$	✓	✓	✓	✓	✓	✓
NAICS6 × Year FEs		✓		✓		✓
County × Year FEs		✓		✓		✓
Observations	19,501	16,395	19,501	16,395	19,501	16,395
Adjusted R^2	0.191	0.123	0.190	0.123	0.191	0.123

TABLE IA7
Regional Cluster Density and Sales Growth: Non-Linear Relation

The table reports the results from OLS regressions relating a firm's sales growth rate to regional cluster density estimated over the years 2005-2012. The dependent variable is a firm's sales growth rate (SALES_GROWTH). In columns (1) and (2), DENSITY is the density of a firm's BCD in its region. In columns (3) and (4), DENSITYT2 and DENSITYT3 are indicator variables that equal one if DENSITY is in the second or third terciles of the distribution, respectively, and zero otherwise. In columns (5) and (6), DENSITYQ2, DENSITYQ3, and DENSITYQ4 are indicator variables that equal one if DENSITY is in the second, third, or fourth quartiles of the distribution, respectively, and zero otherwise. $I_{2008\text{-}09}$ equals one for the years 2008 and 2009, and zero otherwise. $I_{2010\text{-}12}$ equals one for the years 2010-2012, and zero otherwise. The pre-recession control variables include Ln(SIZE), TANGIBILITY, Ln(AGE), NET_LEVERAGE, PROFITABILITY, TOBINS_Q, CR_EMP_GROWTH, CR_ESTAB_GROWTH, CR_BETA_EG, CR_BETA_SG, and CR_BETA_RET. All variables are defined in the Appendix. The *t*-statistics in parentheses are calculated from heteroscedasticity-robust standard errors clustered by BCD×Region. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	SALES_GROWTH					
	(1)	(2)	(3)	(4)	(5)	(6)
DENSITY × $I_{2008\text{-}09}$	0.026**	0.062***				
	(2.05)	(3.37)				
DENSITY × $I_{2010\text{-}12}$	0.030**	0.041**				
	(2.40)	(2.55)				
DENSITYT2 × $I_{2008\text{-}09}$			-0.001	0.005		
			(-0.07)	(0.24)		
DENSITYT3 × $I_{2008\text{-}09}$			0.022	0.044**		
			(1.58)	(2.29)		
DENSITYT2 × $I_{2010\text{-}12}$			0.012	0.012		
			(0.96)	(0.69)		
DENSITYT3 × $I_{2010\text{-}12}$			0.030*	0.044**		
			(1.85)	(2.05)		
DENSITYQ2 × $I_{2008\text{-}09}$					0.005	0.001
					(0.28)	(0.03)
DENSITYQ3 × $I_{2008\text{-}09}$					0.012	0.016
					(0.74)	(0.69)
DENSITYQ4 × $I_{2008\text{-}09}$					0.031*	0.061**
					(1.85)	(2.40)
DENSITYQ2 × $I_{2010\text{-}12}$					0.017	0.006
					(1.10)	(0.26)
DENSITYQ3 × $I_{2010\text{-}12}$					0.019	0.031
					(1.28)	(1.48)
DENSITYQ4 × $I_{2010\text{-}12}$					0.064***	0.083***
					(3.31)	(3.22)
Firm FEs	✓	✓	✓	✓	✓	✓
BCD × Year FEs	✓		✓		✓	
Region × Year FEs	✓		✓		✓	
Controls × $I_{2008\text{-}09}$	✓	✓	✓	✓	✓	✓
Controls × $I_{2010\text{-}12}$	✓	✓	✓	✓	✓	✓
NAICS6 × Year FEs		✓		✓		✓
County × Year FEs		✓		✓		✓
Observations	19,501	16,395	19,501	16,395	19,501	16,395
Adjusted R^2	0.191	0.123	0.190	0.122	0.191	0.123

TABLE IA8
Regional Cluster Share and Sales Growth

The table reports the results from OLS regressions relating a firm's sales growth rate to regional cluster density estimated over the years 2005-2012. The dependent variable is a firm's sales growth rate (SALES_GROWTH). REGSHARE is the number of employees in a BCD-region scaled by the total number of employees in a BCD nationwide. $I_{2008\text{-}09}$ equals one for the years 2008 and 2009, and zero otherwise. $I_{2010\text{-}12}$ equals one for the years 2010-2012, and zero otherwise. The pre-recession control variables include Ln(SIZE), TANGIBILITY, Ln(AGE), NET_LEVERAGE, PROFITABILITY, TOBINS_Q, CR_EMP_GROWTH, CR_ESTAB_GROWTH, CR_BETA_EG, CR_BETA_SG, and CR_BETA_RET. All variables are defined in the Appendix. The *t*-statistics in parentheses are calculated from heteroscedasticity-robust standard errors clustered by BCD×Region. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	SALES_GROWTH	
	(1)	(2)
REGSHARE × $I_{2008\text{-}09}$	0.019**	0.029**
	(2.41)	(2.51)
REGSHARE × $I_{2010\text{-}12}$	0.021***	0.028***
	(2.68)	(3.07)
Firm FEs	✓	✓
BCD × Year FEs	✓	
Region × Year FEs	✓	
Controls × $I_{2008\text{-}09}$	✓	✓
Controls × $I_{2010\text{-}12}$	✓	✓
NAICS6 × Year FEs		✓
County × Year FEs		✓
Observations	19,501	16,395
Adjusted R^2	0.191	0.123

TABLE IA9
Regional Cluster Density and Acquisition Activity

The table reports the results from OLS regressions relating M&A activity to regional cluster density estimated over the years 2005-2012 in columns (1)-(4) and (6)-(9) and 2003-2014 in columns (5) and (10). The dependent variable is an indicator variable equal to one if a firm makes an acquisition during the year, and zero otherwise (ACQUISITION_DUMMY) in columns (1)-(5) and the total value of the acquisitions it makes in a year scaled by lagged market value of assets ($VALUE_OF_ACQUISITIONS) in columns (6)-(10). We obtain deal announcements of U.S. targets from the SDC database and apply standard filters following Masulis, Wang, and Xie (2007). To be included in the sample, deals must satisfy the following criteria: (i) the acquirer owns less than 50% of the target before the deal and owns 100% after the deal, (ii) the deal value is at least $1 million, (iii) the deal amount scaled by the acquirer's market value of equity on the 11th trading day before the deal announcement is at least 1%, (iv) the deal form is "Merger", "Acq. of Assets", or "Acq. Maj. Int.", and (v) the deal is eventually completed. DENSITY is the density of a firm's BCD in its region. $I_{2008\text{-}09}$ equals one for the years 2008 and 2009, and zero otherwise. $I_{2010\text{-}12}$ equals one for the years 2010-2012, and zero otherwise. $I_{2013\text{-}14}$ equals one for the years 2013 and 2014, and zero otherwise. The pre-recession control variables include Ln(SIZE), TANGIBILITY, Ln(AGE), NET_LEVERAGE, PROFITABILITY, TOBINS_Q, CR_EMP_GROWTH, CR_ESTAB_GROWTH, CR_BETA_EG, CR_BETA_SG, and CR_BETA_RET. All variables are defined in the Appendix. The *t*-statistics in parentheses are calculated from heteroscedasticity-robust standard errors clustered by BCD×Region. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	ACQUISITION_DUMMY					$VALUE_OF_ACQUISITIONS				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$I_{2008\text{-}09}$	-0.050***					-0.012***				
	(-7.59)					(-7.67)				
$I_{2010\text{-}12}$	-0.032***					-0.008***				
	(-4.68)					(-4.43)				
Ln(DENSITY) × $I_{2008\text{-}09}$		-0.002	0.002	-0.001	-0.005		0.001	0.002	0.001	-0.000
		(-0.38)	(0.31)	(-0.12)	(-0.55)		(0.62)	(0.87)	(0.41)	(-0.04)
Ln(DENSITY) × $I_{2010\text{-}12}$		-0.008	-0.005	-0.003	-0.007		0.000	0.001	0.003	0.001
		(-1.23)	(-0.70)	(-0.31)	(-0.79)		(0.20)	(0.62)	(1.04)	(0.60)
Ln(DENSITY) × $I_{2013\text{-}14}$					-0.024**					-0.004
					(-2.30)					(-1.13)
Firm FEs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
BCD × Year FEs		✓	✓				✓	✓		
Region × Year FEs		✓	✓				✓	✓		
Controls × $I_{2008\text{-}09}$			✓	✓	✓			✓	✓	✓
Controls × $I_{2010\text{-}12}$			✓	✓	✓			✓	✓	✓
Controls × $I_{2013\text{-}14}$					✓					✓
NAICS6 × Year FEs				✓	✓				✓	✓
County × Year FEs				✓	✓				✓	✓
Observations	19,752	19,501	19,501	16,395	24,010	19,373	19,116	19,116	16,021	23,487
Adjusted R^2	0.198	0.186	0.188	0.162	0.157	0.080	0.065	0.072	0.025	0.033

Variable Definitions for Table AI10

DENSITY_BREADTH: breadth of BCD *c* in region *r*, defined as the fraction of industries in BCD *c* that have location quotients greater than 1.5 in region *r*, averaged over 2005-2007 (time invariant). As in Delgado and Porter (2021), for each NAICS6 industry *i* in BCD *c* and region *r*, using CBP data, we first calculate $D_{i,c,r} = \left(\frac{1+emp_{i,r}}{emp_{i,N}}\right) \Big/ \left(\frac{emp_r}{emp_N}\right)$, where $emp_{i,r}$ is employment of industry *i* in region *r*, $emp_{i,N}$ is employment of industry *i* in the nation, emp_r is employment in region *r*, emp_N is nationwide employment. We then calculate $DENSITY\_BREADTH_{c,r} = \frac{1}{N_c}\sum_{i\in c} I\left(D_{i,c,r} > 1.5\right)$, where N_c is the number of industries in BCD *c*, and *I* is an indicator function for whether the condition inside the parenthesis is met. The variable is calculated for each year using data from CBP and then averaged over 2005-2007.

DENSITY_CUS: density (location quotient) of related customer industries in BCD *c* located in region *r*, averaged over 2005-2007 (time invariant). As in Delgado and Porter (2021), for each NAICS6 industry *i* in BCD *c* and region *r*, we first calculate $D\_CUS_{i,c,r} = \left(\frac{1+\sum_{j\in c, j\neq i}\omega_{cus_{i,j}} \times emp_{j,r}}{\sum_{j\in c, j\neq i}\omega_{cus_{i,j}} \times emp_{j,N}}\right) \Big/ \left(\frac{emp_r}{emp_N}\right)$, where $emp_{j,r}$ is employment of industry *j* in region *r*, $emp_{j,N}$ is employment of industry *j* in the nation, emp_r is employment in region *r*, emp_N is nationwide employment, and $\omega\_cus_{i,j}$ is the percentage of industry *i*'s output sold to industry *j* based on the 2002 BEA Input-Output tables. Employment data from CBP. We then calculate $DENSITY\_CUS_{c,r}$ by averaging $D\_CUS_{i,c,r}$ across all industries in BCD *c* and region *r*. The variable is calculated for each year and then averaged over 2005-2007.

DENSITY_KNOW: density (location quotient) of BCD *c* in region *r* based on the stock of knowledge, averaged over 2005-2007 (time invariant). As in Delgado and Porter (2021), $DENSITY\_KNOW_{c,r} = \left(\frac{1+know_{c,r}}{know_{c,N}}\right) \Big/ \left(\frac{know_r}{know_N}\right)$, where $know_r$ is the stock of patents of BCD *c* in region *r*, $know_{c,N}$ is the stock of patents of BCD *c* in the nation, $know_r$ is the stock of patents in region *r*, and $know_N$ is the stock of patents in the nation. The variable is calculated for each year and then averaged over 2005-2007. The stock of patents is calculated using the perpetual inventory method with a depreciation rate of 30% (Bloom and Van Reenen, 2002) and data from the USPTO obtained through PatentsView.org. Beginning in 1976, we calculate the number of eventually granted patents in a BCD-region each year. We match patents to a region based on inventor location and attribute fractional patents to a region using equal weights when a patent has more than one inventor. We match USPC patent classifications to NAICS6 codes using the concordance file available at Nikolas Zolas' website (Goldschlag, Lybber, and Zolas, 2019). When a USPC code maps to more than one NAICS code, we attribute fractional patents to a NAICS using the provided probability weights.

DENSITY_OCC: density (location quotient) of industries with similar occupations in BCD *c* located in region *r*, averaged over 2005-2007 (time invariant). As in Delgado and Porter (2021), for each NAICS6 industry *i* in BCD *c* and region *r*, we first calculate $D\_OCC_{i,c,r} = \left(\frac{1+\sum_{j\in c, j\neq i}\omega_{occ_{i,j}} \times emp_{j,r}}{\sum_{j\in c, j\neq i}\omega_{occ_{i,j}} \times emp_{j,N}}\right) \Big/ \left(\frac{emp_r}{emp_N}\right)$, where $emp_{j,r}$ is employment of industry *j* in region *r*, $emp_{j,N}$ is employment of industry *j* in the nation, emp_r is employment in region *r*, emp_N is nationwide employment, and $\omega\_occ_{i,j}$ is the pairwise correlation between the occupation composition of industries *i* and *j* normalized to add to one within each BCD-region cell (based on 2009 OES data). We then calculate $DENSITY\_OCC_{c,r}$ by averaging $D\_OCC_{i,c,r}$ across all industries in BCD *c* and region *r*. The variable is calculated for each year and then averaged over 2005-2007.

DENSITY_SUP: density (location quotient) of related supplier industries in BCD *c* located in region *r*, averaged over 2005-2007 (time invariant). As in Delgado and Porter (2021), for each NAICS6 industry *i* in BCD *c* and region *r*, we first calculate $D\_SUP_{i,c,r} = \left(\frac{1+\sum_{j\in c, j\neq i}\omega\_sup_{i,j} \times emp_{j,r}}{\sum_{j\in c, j\neq i}\omega\_sup_{i,j} \times emp_{j,N}}\right) \Big/ \left(\frac{emp_r}{emp_N}\right)$, where $emp_{j,r}$ is employment of industry *j* in region *r*, $emp_{j,N}$ is employment of industry *j* in the nation, emp_r is employment in region *r*, emp_N is nationwide employment, and $\omega\_sup_{i,j}$ is the percentage of industry *i*'s intermediate purchases bought from industry *j* based on the 2002 BEA Input-Output tables. We then calculate $DENSITY\_SUP_{c,r}$ by averaging $D\_SUP_{i,c,r}$ across all industries in BCD *c* and region *r*. Employment data are from CBP. The variable is calculated for each year and then averaged over 2005-2007.

TABLE IA10
Regional Cluster Density and Sales Growth: Cluster Density Channels

The table reports the results from OLS regressions relating a firm's sales growth rate to regional cluster density estimated over the years 2005-2012. The dependent variable is a firm's sales growth rate (SALES_GROWTH). DENSITY_* in columns (1)-(8) is the density of a firm's BCD in its region in which weights are based on supplier links (DENSITY_SUP), customer links (DENSITY_CUS), occupation similarities (DENSITY_OCC), and stock of patents (DENSITY_KNOW), respectively. In columns (9) and (10), DENSITY_* is the cluster breadth in a BCD-region (DENSITY_BREADTH). $I_{2008\text{-}09}$ equals one for the years 2008 and 2009, and zero otherwise. $I_{2010\text{-}12}$ equals one for the years 2010-2012, and zero otherwise. The pre-recession control variables include Ln(SIZE), TANGIBILITY, Ln(AGE), NET_LEVERAGE, PROFITABILITY, TOBINS_Q, CR_EMP_GROWTH, CR_ESTAB_GROWTH, CR_BETA_EG, CR_BETA_SG, and CR_BETA_RET. All variables are defined in the Appendix. The *t*-statistics in parentheses are calculated from heteroscedasticity-robust standard errors clustered by BCD×Region. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Alternative Measures of Regional Cluster Density									
	DENSITY_SUP		DENSITY_CUS		DENSITY_OCC		DENSITY_KNOW		DENSITY_BREADTH	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ln(DENSITY_*) × $I_{2008\text{-}09}$	0.016**	0.019**	0.018***	0.023**	0.015**	0.025**	0.017**	0.028***	0.012*	0.019**
	(2.35)	(2.06)	(2.61)	(2.49)	(2.15)	(2.57)	(2.40)	(2.81)	(1.78)	(2.16)
Ln(DENSITY_*) × $I_{2010\text{-}12}$	0.020***	0.021**	0.020***	0.022**	0.020***	0.024**	0.013*	0.024**	0.016**	0.021**
	(2.85)	(2.30)	(2.97)	(2.37)	(2.98)	(2.57)	(1.73)	(2.33)	(2.30)	(2.21)
Firm FEs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
BCD × Year FEs	✓		✓		✓		✓		✓	
Region × Year FEs	✓		✓		✓		✓		✓	
Controls × $I_{2008\text{-}09}$	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls × $I_{2010\text{-}12}$	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
NAICS6 × Year FEs		✓		✓		✓		✓		✓
County × Year FEs		✓		✓		✓		✓		✓
Observations	19,501	16,395	19,501	16,395	19,501	16,395	19,501	16,395	19,501	16,395
Adjusted R^2	0.191	0.123	0.191	0.123	0.191	0.123	0.191	0.123	0.191	0.123