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Turbulence, Firm Decentralization, and Growth in Bad Times†

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What is the optimal form of firm organization during "bad times"? The greater turbulence following macro shocks may benefit decentralized firms because the value of local information increases (the "localist" view). On the other hand, the need to make tough decisions may favor centralized firms (the "centralist" view). Using two large micro datasets on decentralization in firms in ten OECD countries (WMS) and US establishments (MOPS administrative data), we find that firms that delegated more power from the central headquarters to local plant managers ***prior*** *to the Great Recession outperformed their centralized counterparts in sectors that were hardest hit by the subsequent crisis (as measured by export growth and product durability). Results based on measures of turbulence based on product churn and stock market volatility provide further support to the localist view. This conclusion is robust to alternative explanations such as managerial fears of bankruptcy and changing coordination costs. Although decentralization will be suboptimal in many environments, it does appear to be beneficial for the average firm during bad times.* (*JEL* D22, G12, G32, G34, L23)

What makes firms more resilient to large negative macro shocks? A recent literature has focused on firms' technological, financial, and governance structures as possible factors affecting their ability to cope with sudden negative

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changes in external conditions,[1] but much less is known about the role of the internal organization of the firm. This paper focuses on how a specific organizational aspect of a firm, namely the extent to which decision-making is decentralized down from headquarters to plant managers, affects a company's response to an economic crisis.

It is not a priori obvious what is the best organizational form in a crisis. One common argument (the "centralist" view) is that centralized firms are best equipped to survive a recession because of the importance of decisive and coordinated action, which, due to conflicting interests within the firm and the partial information available to local units, may be best directed from corporate headquarters. An alternative "localist" view is that recessions are periods of rapid change, and being decentralized provides firms with the necessary flexibility and local perceptiveness needed to respond to turbulent business conditions.

Chandler (1962) illustrates these conflicting views vividly in his account of how the depression of 1920–1921 affected Dupont—at the time one of the major US corporations. Dupont's managers had realized quickly that the company's centralized organizational structure—which allocated a great deal of authority to central functions at the expense of local product divisions—was a poor fit for the more volatile business environment that had emerged in the early 1920s, especially in its recently established lines of consumer-facing products, such as paints. However, it took several months, countless internal debates, and worsening financial outcomes for Dupont's executives to agree on what to do. Frederik W. Pickard, one of Dupont's key senior managers, called for the appointment of a "dictator," [...] a single man with "absolute jurisdiction over personnel and full authority to do what he could to meet the crisis." Another senior manager, H. Fletcher Brown, believed instead that decentralization would allow the company to better cope with the crisis and allow the business to "adjust itself to present conditions." Eventually, Brown's views prevailed, and in September 1921, Dupont finally moved to a decentralized organizational structure, which provided the [...] "head of each Industrial Department full authority and responsibility for the operation of his industry, subject only to the authority of the Executive Committee as a whole." This strategic choice eventually allowed the firm to reestablish its prominence in both its core and peripheral businesses.[2]

Similar contrasting views over how best to organize for "recovery and survival" have emerged following the Great Recession of 2008–2009 and the COVID-19 recession of 2020, with some proposing centralization as a way to respond in a coor-

[1] For example, see Aghion et al. (2012) on technology, Chodorow-Reich (2014) on financial structure, and Alfaro and Chen (2012) or D'Aurizio, Oliviero, and Romano (2015) on governance.

[2] The initial proposal to decentralize to product lines had been made originally by a committee of young managers early in 1920, based on the rationale that this move would allow each division to best adapt to each individual condition. However, this first proposal had been strongly objected to by senior management and the president, who were concerned about losing the efficiencies gained within each function over time. They instead proposed greater investments in better information and knowledge to be fed to central HQ. This internal debate continued—with some organizational compromises done in the meantime—until 1921, when the growing postwar recession of 1921 resulted in major losses on every product except explosives (their core business at the time). Wide disagreements persisted until the decision to move to a multidivisional form was finally made in 1921. The crisis of 1920–1921 also motivated the reorganization of General Motors under the guidance of Alfred Sloan, though in that case the efforts were aimed at the creation of more efficient integration and coordination systems to guide the activity of the already largely centralized business units (Chandler 1962).

dinated fashion to the crisis and others instead emphasizing the benefits of decentralization as a way to adapt to changing conditions more swiftly.[3]

To advance the study of these issues, we create two new panel datasets with explicit measures of decentralization measured prior to the Great Recession. One dataset, the World Management Survey (WMS), has firm-level data across ten OECD countries (France, Germany, Greece, Italy, Japan, Poland, Portugal, Sweden, the United Kingdom, and the United States). The other dataset, the Management and Organizational Practices Survey (MOPS), is a plant-level dataset which we constructed in partnership with the US Census Bureau. We combine these datasets with firm and plant performance data before and after the 2009–2008 crisis.

Theoretically, there are two countervailing effects of decentralization on firm performance during a crisis. On the one hand, a large negative shock is more likely to reduce the level of congruence between the CEO (headquarters) and the plant manager—for example, tough decisions on closing down projects and laying off staff may well be resisted by local managers. On the other hand, a crisis can also increase turbulence/uncertainty, thus making local information more valuable. In this case, decentralized firms suffer less in a crisis because local managers can better understand and respond more quickly to the turbulent business environment than the central headquarters. This result emerges from a wide class of models where higher turbulence and uncertainty increase the value of local knowledge and the benefits of decentralization. The net effect of decentralization on firm performance is thus theoretically ambiguous, a result which we discuss in more detail in the next section, in a model building on Aghion and Tirole (1997).

In our empirical analysis, we find compelling evidence that in sectors that were exogenously hit harder by the global financial crisis, decentralized firms outperformed their centralized rivals in terms of their growth of sales, productivity, profits, and market value. We use several measures of the shock, including the actual changes in trade patterns (exports in an establishment's industry-by-country cell) and alternative designs to isolate exogenous shifters, such as a prerecession measure of product durability (demand for durable goods falls more in recessions as consumers can postpone purchases).

Importantly, we show that our empirical results are driven by the fact that the industries which had the most severe downturns during the Great Recession also had the largest increase in turbulence.[4] To demonstrate this, we employ a novel

[3] Gulati, Nohria, and Wohlgezogen (2010), for example, discuss how firms frequently—though not always successfully—resort to centralization to implement faster and more extensive cost-cutting initiatives during recessions, but also emphasize the importance of "staying connected to customer need" during more turbulent times. The starkly conflicting advice that managers were getting in the depths of the Great Recession is best exemplified by two 2009 articles, both published by the Economist Intelligence Unit. In August 2009 (p. 12), they wrote in favor of decentralization during the crisis: "Companies have to deal with dramatically more uncertainty, complexity and ambiguity in the current recession. Success does not come from centralization. True flexibility arises when those who are closest to customers are empowered to respond to constant shifts in demand, preferences and attitudes" Yet a few months later, in December 2009 (p. 4), the same publication supported centralization: "Firms should be centralizing their decision-making processes. […] In a recession investments and other decisions are scrutinized more carefully by senior management and a greater emphasis is placed on projects that provide benefits across the enterprise rather than individual units."

[4] Bloom et al. (2018) show a large variety of datasets that suggest that turbulence and uncertainty rise in downturns.

industry-level measure of turbulence, the rate of new product additions and subtractions (product churn), which we built from the US Census of Manufactures ten-digit product data. As shown in Bernard and Okubo (2016), product churn rises sharply during recessions—in a crisis, establishments both destroy more existing products and also create more new products.[5] Using this measure on the US Census MOPS sample, we find that decentralization significantly protected establishments from the downturn in industries which had a bad shock and an increase in product churn. We validate these results using an alternative measure of turbulence based on stock market volatility for both the MOPS and the WMS. Alternative explanations of our results (e.g., reduced agency problems, financial conditions, lower coordination costs, and omitted variables) seem less consistent with the data. Finally, although organizational change is slow (we show evidence of large adjustment costs), firms subject to big negative shocks appear more likely to decentralize.

A drawback of this econometric approach is that it relies on weak exogeneity of lagged decentralization, an identification condition that could be violated if there was an omitted variable correlated with lagged decentralization that had a differential effect on future firm growth in those industries hardest hit by the Great Recession. We assess this issue in three ways. First, we use our rich micro data to include interactions of the negative shock with a large number of firm and industry observables. We can draw on existing work examining the determinants of decentralization in our data, as well as the wider empirical literature, when considering such confounders. Second, because MOPS has multiple plants belonging to the same firm, we can exploit the variation in growth across plants with different degrees of decentralization *within* the same firm. Third, we run placebo analysis in the pre–Great Recession period. Our results are robust to all three types of experiment.

Overall, our paper suggests that the internal organization of firms may serve as an important mediating factor through which macroeconomic shocks affect firm performance and, ultimately, economic growth. Importantly, we are *not* claiming that decentralization is always the "best" form of firm organization. Our findings are consistent with rational, forward-looking firms choosing their optimal degree of decentralization based on their expectations of the (stochastic) economic environment. Firms will choose different degrees of decentralization as they face different environments and will have different histories of past idiosyncratic shocks. When an unexpected large negative shock occurs, such as the global financial crisis or pandemic adjustment costs over decentralization prevent firms from immediately shifting to the new optimal organizational form.[6] Over time, if the shock has a permanent component, firms will adjust their organization to the new optimal structure. Hence, such unexpected shocks combined with nontrivial adjustment costs can help reveal if there is an empirical regularity that decentralization is an advantage in bad times.

[5] Contrary to Bernard and Okubo (2016), Broda and Weinstein (2010) report a procyclical product churn. However, they have a very different focus—looking at the net change in the product offering in retail stores (the number of new bar code products sold less current products no longer sold)—and a different time period (1994 and 1999–2003) spanning one mild recession. In contrast, our measure is gross product churn (new products plus dropped products), is built on manufacturing establishment production data, and spans 15 years from 1997 to 2012, exploiting aggregate and industry variation.

[6] For evidence of high organizational adjustment costs, see Cyert and March (1963); Gibbons and Henderson (2012); or Bloom, Sadun, and Van Reenen (2016).

Related Literature.—Our paper builds on an extensive prior literature. The benefits of exploiting local knowledge harks back to a classic economic debate over economic systems between Lange (1936) and Von Hayek (1945). Lange argued that a centralized socialist economy would outperform a decentralized market economy, partly because the central planner could coordinate better, for example by setting prices to internalize externalities. By contrast, Hayek argued that it was impossible to aggregate all the local knowledge of agents, and it was more efficient to allow individuals to make their decentralized choices based on their local information. Modern organizational economics builds upon these trade-offs *within* a firm rather than across the economy as a whole. On the theory side, our paper relates to the literature on decentralization within the firm (see Gibbons, Matouschek, and Roberts 2012 or Garicano and Rayo 2016 for recent surveys) and incomplete contracts (see Gibbons and Roberts 2012). In particular, Hart and Moore (2005) analyze the optimal allocation of authority in multilayer hierarchies. Dessein (2002) analyzes how the allocation of control can help incorporate the agent's information into decision-making in a situation where the agent has private information.

Our paper also relates to the existing empirical literature on the determinants and effects of decentralization. Rajan and Wulf (2006) and Blundell, Green, and Jin (2016) document a movement toward flatter organizations and decentralized firms in the United States and the United Kingdom, respectively. Caroli and Van Reenen (2001) and Bresnahan, Brynjolfsson, and Hitt (2002) point at positive correlations between decentralization and both human capital and information technology. Closest to our analysis is Acemoglu et al. (2007), whose model assumes firms can learn about the outcome of an investment decision from observing other firms. Hence, in sectors with more heterogeneity/turbulence or where the firm is closer to the technological frontier (so that learning is more limited), decision-making control should be more decentralized. In the contract literature, Prendergast (2002) suggested that the "puzzle" of performance pay in uncertain and turbulent environments (where higher risk should make the agent less willing to accept a high-powered contract) could be because of the need to exploit local information more effectively. Similarly, in the firm boundaries literature, Lafontaine and Slade (2007) also suggest that a similar puzzle over the lack of a negative impact of turbulence on franchising (versus direct control) could again be related to the need to exploit the franchiser's superior local knowledge, which is more important in such environments. None of these papers, however, look at the interplay between firm decentralization, shocks, and turbulence, which is the center of our analysis.[7]

There is also a growing literature on the empirical factors influencing decentralization within firms (see the survey by Aghion, Bloom, and Van Reenen 2014, for example), including contributions by Guadalupe and Wulf (2010); Katayama, Meagher, and Wait (2018); McElheran (2014); Bloom, Sadun, and Van Reenen (2012); Dessein, Lo, and Minami (2019); and others. To our knowledge, this is the

[7] Bradley et al. (2011) report a positive relationship between firm independence—which they interpret as a proxy for greater autonomy in resource-allocation decisions—and firm survival during downturns using Swedish data.

first paper to analyze how the impact of negative shocks affects the future performance of firms and plants with differential degrees of decentralization.

The rest of the paper is organized as follows. Section I presents a simple model to motivate the analysis. Section II presents the data and methodology, and Section III establishes our main empirical finding that in times of crisis, decentralized firms outperform their centralized counterparts. Section IV considers extensions, showing that volatility seems to matter rather than other mechanisms such as changing levels of congruence, and Section V concludes.

I. A Simple Model

To guide our empirical analysis of the relationship between firm performance and decentralization in bad times, we develop a simple model based upon Aghion and Tirole (1997). The key idea is that there is a trade-off between incentives and local information. Misalignment of interests between the CEO and the plant manager makes centralization seem natural. But the plant manager is likely to have better local information than the CEO, which is a force for decentralization. A negative shock that makes the environment more turbulent will affect the returns to decentralization in two opposing ways. First, it may heighten the costs of decentralization by increasing the misalignment of interests between the CEO and the plant manager. Second, it may boost the benefits of decentralization by increasing the informational asymmetry between the CEO and the plant manager and thus the value of local information.

A. *The Setup*

We consider a one-period model of a firm with a single principal (the CEO/central headquarters) and a single agent (the plant manager). The CEO cares about the profitability of the business, whereas the plant manager wants to maximize private benefits and is not responsive to monetary incentives.[8] Taking an uninformed action involves potentially disastrous outcomes; thus an action will be taken only if at least one of the two parties is informed. Also, the agent obtains private benefits only if the firm remains in business.

There are $n \geq 3$ possible actions (or projects), and at any point in time only two of them—call them a_1 and a_2—are "relevant," i.e., avoid negative payoffs to the parties. Among these two actions, one maximizes monetary profitability, and one maximizes the agent's private utility. Other actions lead to very negative payoffs to both parties. With ex ante probability α the agent's preferred action (conditional upon the firm remaining in business) will also be the action that maximizes profits. The variable α captures the degree of congruence between the principal's preferences and the agent's preferences. If preferences coincide, then the action that maximizes the private utility of the agent also yields monetary utility B to the principal.

[8] This insensitivity assumption is to rule out implementation of a performance pay contract to overcome the principal-agent problem. Obviously, we could allow some incentive contracts, and as long as these only partially deal with the agency problem, the mechanisms we describe here would still be at play.

If preferences do not coincide, the action that maximizes the agent's private utility yields monetary payoff $B - k$ to the principal.

We assume that only the agent is informed ex ante about the project's payoffs and therefore can choose a course of action. However, the principal can obtain an early signal of forthcoming performance, e.g., a current realization of income, at some cost C and then correct the choice of action if she believes that the signal is due to the agent choosing the non-profit-maximizing action. Further, suppose that in the absence of turbulence, the signal reveals the bad action choice perfectly. But the higher the degree of turbulence, the more difficult it is for the principal to infer action choice from performance. More formally, suppose that current performance is given by $y = a + \varepsilon$, where $a \in \{a_1, a_2\}$ denotes the agent's action choice (e.g., a decision whether or not to introduce a new product),[9] with $a_1 < a_2$, and ε is a noise term uniformly distributed on the interval $[-u, u]$.

B. *Analysis*

The CEO will infer the action choice from observing the signal realization if and only if $y \in [a_1 - u, a_2 - u) \cup (a_1 + u, a_2 + u]$. In this case, the principal can correct the action if she has control rights, i.e., the firm is centralized. By Bayes' rule, the probability of the CEO guessing the action choice is

$$(1) \qquad P(u) = \Pr\big(y \in [a_1 - u, a_2 - u) \cup (a_1 + u, a_2 + u]\big) = \min\left\{\frac{2(a_2 - a_1)}{a_2 - a_1 + 2u}, 1\right\}.$$

The probability of guessing the correct action is clearly declining in the amount of noise (u). Hence, the probability $\Omega(u)$ that the profit-maximizing action will be taken eventually under centralization is equal to $\Omega(u) = P(u) + (1 - P(u))\alpha$, where P is the probability that the principal acquires the information about projects' payoffs. The ex ante CEO's payoff under *decentralization* (Π^d) and centralization (Π^c) is

$$(2) \qquad \Pi^d = \alpha B + (1 - \alpha)(B - k),$$

$$\Pi^c = \Omega(u)B + [1 - \Omega(u)](B - k) - C.$$

Therefore, the net gain from centralization is then given by

$$(3) \qquad \Delta\Pi = \Pi^c - \Pi^d = P(u)(1 - \alpha)k - C.$$

[9] Equivalently, this could be whether to drop an existing product from the portfolio or to make an investment in marketing or sales that enhances the product's value to the consumer. The key thing is that the decision has to have some irreversibility.

C. *Two Counteracting Effects of a Bad Shock*

We think of a bad shock as reducing congruence between the principal and the agent, to the extent that the principal has invested her wealth in the project, whereas the agent is subject to limited liability. In other words, a bad shock increases k. For example, Gulati, Nohria, and Wohlgezogen (2010) mention that the threat of cost-cutting initiatives that often emerge in a recession end up building a sense of mistrust between local units and central headquarters, i.e., an increase in k in the model. For given level of uncertainty u, this will make centralization more attractive as

$$\frac{\partial \Delta \Pi}{\partial k} = P(u)(1-\alpha) > 0.$$

There is, however, also much evidence that negative macro shocks are usually associated with greater uncertainty (i.e., with a higher u); see Bloom et al. (2018) and citations therein. This makes centralization less attractive since

$$\frac{\partial \Delta \Pi}{\partial u} = (1-\alpha)kP'(u) \leq 0.$$

If the level of turbulence u does not change after the occurrence of a bad shock, then the overall effect of a bad shock is to make centralization unambiguously more attractive. However, if uncertainty increases with a bad shock and k does not change, the bad shock makes centralization less attractive. Hence, the impact of a bad shock is theoretically ambiguous. In the next sections, we will empirically investigate which of the two mechanisms dominates.

II. Data Description and Measurement

We start by describing in some detail our decentralization data. We then describe the accounting and administrative data matched with the survey-based measures of decentralization and the proxies measuring the severity of the Great Recession. We describe our measures of turbulence in Section III when we discuss theoretical mechanisms. More details on the data are in online Appendix A.

A. *Decentralization*

Cross-Country Data: World Management Survey.—Our international decentralization data were collected in the context of the World Management Survey, a large-scale project aimed at collecting high-quality data on management and organizational design across firms around the world (Bloom et al. 2016). The survey is conducted through an interview with a plant manager in medium-sized manufacturing firms.

We asked four questions on decentralization from the central headquarters to the local plant manager. First, we asked how much capital investment a plant manager could undertake without prior authorization from the corporate headquarters.

This is a continuous variable enumerated in national currency that we convert into dollars using PPPs.[10] We also inquired on where decisions were effectively made in three other dimensions: (i) the introduction of a new product, (ii) sales and marketing decisions, and (iii) hiring a new full-time permanent shop floor employee. These more qualitative variables were scaled from a score of 1, defined as all decisions taken at the corporate headquarters, to a score of 5, defined as complete power ("real authority") of the plant manager. In online Appendix Table A1, we detail the individual questions in the same order as they appeared in the survey. Since the scaling may vary across all these questions, we standardized the scores from the four decentralization questions to z-scores by normalizing each question to mean zero and standard deviation one. We then average across all four z-scores and then z-score the average again to have our primary measure of overall decentralization. In the same survey, we collected a large amount of additional data to use as controls, including management practice information following the methodology of Bloom and Van Reenen (2007) and human resource information (e.g., the proportion of the workforce with college degrees, average hours worked, the gender and age breakdown within the firm).

We attempt to achieve unbiased survey responses to our questions by taking a range of steps. First, the survey was conducted by telephone without telling the managers they were being scored on organizational or management practices. This enabled scoring to be based on the interviewer's evaluation of the firm's actual practices rather than their aspirations, the manager's perceptions, or the interviewer's impressions. To run this "blind scoring," we used open questions (i.e., "To introduce a new product, what agreement would your plant need from corporate headquarters?") rather than closed questions (e.g., "Can you introduce new products without authority from corporate headquarters?" [yes/no]). Second, the interviewers did not know anything about the firm's financial information or performance in advance of the interview.[11] Consequently, the survey tool is "double blind"—managers do not know they are being scored, and interviewers do not know the performance of the firm. These firms are mostly privately held and too small to attract coverage from the business media. Third, each interviewer ran 85 interviews on average, allowing us to remove interviewer fixed effects from all empirical specifications. Fourth, we collected information on the interview process itself (duration, day of the week), on the manager (seniority, job tenure, and location), and on the interviewer (for removing analyst fixed effects and subjective reliability score). These survey metrics are used as "noise controls" to help reduce residual variation. We decided to focus on the manufacturing sector, where productivity is easier to measure than in the nonmanufacturing sector. We also focused on medium-sized firms, selecting a sampling frame of firms with between 50 and 5,000 workers. We drew a sampling frame from each country to be representative of medium-sized manufacturing firms and then randomly chose the

[10] One reason that the main regressions control for size is that the value of this question might be mechanically greater for larger firms and plants.

[11] This was achieved by selecting medium-sized manufacturing firms and by providing only firm names and contact details to the interviewers (but no financial details).

order of which firms to contact. Each interview took an average of 48 minutes, and the main wave was run in the summer of 2006. We achieved a 45 percent response rate, which is very high for voluntary company surveys.

US Census Data: Management and Organizational Practices Survey.— The 2010 Management and Organizational Practices Survey was jointly funded by the Census Bureau and the National Science Foundation as a supplement to the Annual Survey of Manufactures (ASM). The design was based on the World Management Survey and was mailed to the establishment plant manager (see Brynjolfsson and McElheran 2016 and Bloom et al. 2019). The survey contained six questions on decentralization, with four of these covering the same domain as WMS—plant manager autonomy over (i) capital investments, (ii) hiring of full-time employees, (iii) product introduction, and (iv) sales and marketing—with two additional questions on (v) pay increases of at least 10 percent and (vi) product pricing decisions. For each question, respondents were asked to choose among three options capturing where the specific decisions were made: "only at this establishment" (coded as 3), "only at headquarters" (coded as 1), or "both at this establishment and at headquarters" (coded as 2). There were 5 choices for the question on autonomy in capital investments, starting with "Under $1,000" (coded as 1) up until "$1 million or more" (coded as 5). Each of these six questions was then z-scored, and then averaged, and then z-scored again. The survey also included management practice questions and some background questions on the establishment and respondent.[12] The respondent was asked about conditions in 2010 and 2005.

The MOPS survey was sent to all ASM establishments in the ASM mail-out sample. Overall, 49,782 MOPS surveys were successfully delivered, and 37,177 responses were received, yielding a response rate of 78 percent. The Organization Module of MOPS is only for plants where headquarters is off site—plants with headquarters on site are told to skip this section—which takes the sample to about 20,000 plants. We further require the sample to match to the 2006 ASM and 2009 ASM to calculate the main dependent variable (growth in sales), which brings the sample down to 8,800 plants.[13] Online Appendix Table A2 shows how our various samples are derived from the universe of establishments.

B. *Accounting Data*

Cross-Country WMS Data.—We build firm-level measures of sales, employment, capital, profits, market value, and materials using accounting data extracted from Bureau Van Dijk's ORBIS. These are digitized versions of company accounts covering very large samples (close to the population in most of our countries) of private and publicly listed firms. In our baseline specifications, we estimate in three-year

[12] The full questionnaire is available at https://www2.census.gov/programs-surveys/mops/technical-documentation/questionnaires/mop-2010.pdf.

[13] The ASM is a stratified randomly sampled rotating four-year panel, so many plants are not included across panels, which accounts for over 90 percent of this drop in sample size.

(annualized) growth rates. We are able to build firm-level measure of sales growth for at least 1 year for 1,330 out of the 2,351 firms with decentralization data in 2006.

US MOPS Data.—In addition to our decentralization data, we use data from other census and non-census datasets to create our measures of performance (growth in sales, productivity, and profitability). We use establishment-level data on sales, value-added, and labor inputs from the ASM to create measures of growth and labor productivity. We also combined the plant-level capital stock data from the Census of Manufactures with investment data from the ASM and applied the perpetual inventory method to construct annual capital stocks. Finally, we measure plant profitability using profits as a percent of capital stock, with plant-level profits defined as sales less total salaries and wages, material costs, and rental expenses.

C. *Measuring the Great Recession*

Our baseline measure of the intensity of impact of the Great Recession ("*SHOCK*") at an industry-by-country cell level comes from the UN Comtrade database of world trade. This is an international database of six-digit product-level information on all bilateral imports and exports between any given pairs of countries. We aggregate Comtrade data from their original six-digit product level to three-digit US SIC-1987 level using the Pierce and Schott (2012) concordance. We deflate the industry- and country-specific export value series by a country- and year-specific CPI from the OECD to measure "real exports."[14]

For the US MOPS data, we are able to construct a more detailed "*SHOCK*" variable which varies at the establishment level. Specifically, we use prerecession product-level revenue data from the 2006 ASM to measure each establishment's distribution of sales across seven-digit NAICS products before the onset of the Great Recession. We then aggregate the Longitudinal Firm Trade Transactions Database (LFTTD), which contains the universe of import and export transactions for US firms, to the product-year level. By matching each establishment's prerecession distribution of sales across products to product-level export growth, we are able to obtain a more precise measure of the intensity of the Great Recession that measures export growth in the *products* that the establishment produces. All results from the US MOPS data use this establishment-specific formulation of the "*SHOCK*" measure.[15] The plant-specific shock is advantageous in that it addresses an important potential bias arising from mismeasurement of the relevant economic shock for diversified plants. To the extent that diversification of product mix is correlated with decentralization, using an industry-level shock introduces nonrandom measurement error and may bias the results. Our plant-specific shock built from plant-product data addresses this concern.

[14] We find similar results using other measures of the shock (such as industry sales derived from aggregating firm-level data in ORBIS), but trade data are attractive as they have a large external component driven by demand in world markets and are available at a detailed level for every country and industry in our sample.

[15] All of the MOPS results are robust to using the same three-digit SIC "*SHOCK*" variable that is used in the cross-country WMS analysis.

Online Appendix Figure A1 shows the evolution of annualized export growth in the years preceding and during the Great Recession using industry-level data for all countries (for a total of 5,641 manufacturing sector by country cells). Exports were growing by about 13 percent in 2007 and 9 percent in 2008 and experienced a dramatic fall (−20 percent) in 2009 compared to 2008. Industry sales fell even faster than exports in 2008 and 2009. In the empirical analysis, we build empirical proxies for the Great Recession by averaging 2007 and 2006 (prerecession) and 2009 and 2008 (in-recession) levels and calculate log differences between the two subperiods for each three-digit, industry-by-country cell.[16]

Since recessions typically have a greater impact on reducing the expenditure on durable versus nondurable goods (e.g., King and Rebelo 1999), we use as an alternative variable to capture the intensity of the Great Recession shock the average durability of the goods produced in the industry, drawn from Nekarda and Ramey (2013).[17]

D. *Descriptive Statistics*

Panel A of Table 1 contains some descriptive statistics from the WMS. The median (average) firm has 250 (574) employees and \$67 million (\$184 million) in sales. Firm sales declined by about 6 percent per year over this time period (2011–2006). Panel B has the equivalent information from MOPS. Despite being a quite different sample, the values look broadly comparable—MOPS *firms* are a little larger in terms of jobs (423 versus 250 at the median). MOPS plants shrank by 7 percent a year, similar to the WMS average. Exports fell in 51 percent of the industries in the sample. While the median growth rate of real exports across the whole sample is about −0.4 percent and −0.8 percent in the WMS and MOPS samples, respectively, the data show considerable variation both within and across countries.

In Bloom, Sadun, and Van Reenen (2012), we show that the WMS decentralization measure is correlated with other decentralization indicators from different datasets at the country level. MOPS allows another sense check as it contains information across multiple plants of the same firms. If our decentralization measure is meaningful, we would expect managers to be making different decisions in different plants, and therefore there would be greater across-plant/within-firm variation of inputs (and outcomes). In online Appendix Table A15, we confirm that more decentralized *firms* do display a greater dispersion in input decisions (jobs and products) and outputs across their establishments. For example, regressing the standard deviation of plant-level jobs growth within a firm on the firm's average decentralization reveals a positive and significant correlation.

[16] We also run robustness checks using discrete measure of *SHOCK*, in which we code an industry-country cell to be unity if exports fell over this period, and zero otherwise.

[17] We also consider a discrete version using a dummy equal to 1 if the durability in the industry is greater than the median (and 0 otherwise).

TABLE 1—SUMMARY STATISTICS

Variable	Mean	Median	SD
Panel A. World Management Survey			
Sales levels ($Millions)	184.14	67.07	513.41
Sales growth (3 years annualized log change)	−6.38	−5.81	13.31
Employment (firm)	574.39	250.00	2,144.77
Employment (plant)	232.93	150.00	254.36
Percent of employees with a college degree	16.32	10.00	17.51
Decentralization score	0.00	−0.04	1.00
Exports (continuous, percent change in sector/country export in 2008/2009 relative to 2006/2007)	−1.96	−0.43	20.96
Durability (continuous, median years of service of goods produced in the industry)	13.03	10.00	19.50
Panel B. US Census Data—MOPS			
Sales levels (2009) ($Millions)	137.40	50.50	403.60
Sales growth (3 years annualized log change)	−7.09	−6.06	18.44
Employment (firm)	1,354	423.3	2,812
Employment (plant)	249.81	135.00	481.91
Percent of employees with a college degree	11.84	7.28	11.69
Decentralization score	0.00	−0.17	1.00
Exports (continuous, percent change in product exports in 2008/2009 relative to 2006/2007)	−1.51	2.83	29.94
Durability (continuous, median years of service of goods produced in the industry)	12.98	12.20	13.17

Notes: These are the regression samples used in Table 2. Panel A contains descriptive statistics from the WMS and panel B from the MOPS.

III. Main Results

A. *Descriptive Analysis of the Main Result*

Our main empirical finding is illustrated in Figure 1, in which panel A refers to the results using the cross-country WMS data and panel B uses the US MOPS data. Panel A shows the annualized average three-year growth rate in sales for all firms included in the WMS decentralization sample computed using data ending in the years 2011, 2010, and 2009 (hence, averaging across three different growth periods: 2011–2008, 2010–2007, and 2009–2006).[18] These are all years involving the Great Recession.[19] Panel B shows sales growth for all plants in the MOPS decentralization sample (2009–2006 growth rate). We exclude the 2011–2008 and 2010–2007 periods from the MOPS sample because the recession was over in the United States in 2010.[20]

[18] We use long differences to smooth over some of the transitory measurement error. The results are robust to choosing alternative methods of long differencing.

[19] We also test the robustness of the results to dropping the 2008–2011 period, in which the Recession was starting to taper off in Europe.

[20] In Europe (where most of our WMS data are from), the crisis persisted due to the eurozone currency crisis and fiscal austerity policies.

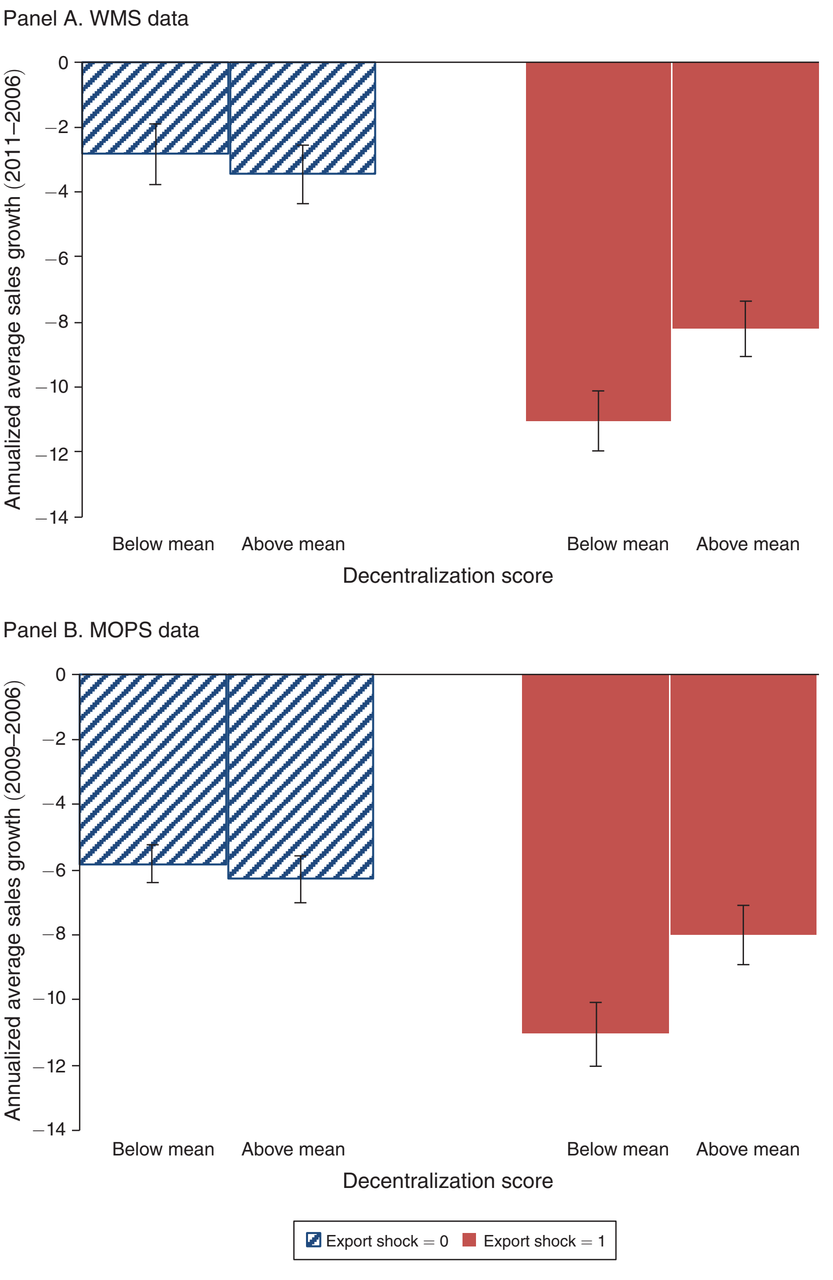


Figure 1. Changes in Sales by Shock and Decentralization

Notes: Panel A uses WMS firm data from ten OECD countries. In panel A, the bars plot annualized average of three-year, firm-level change in ln(sales) over 2011–2008, 2010–2007, and 2009–2006. Ninety-five percent confidence interval bands reported. "Export shock" is whether firms were in a country-industry cell that experienced a drop in the average level of exports in 2008 and 2009 (the main Great Recession years) compared to the average level in 2006 and 2007 (the latest pre-Recession years). Right-hand-side bars are industry-country cells where the shock was worst. Firms are split into whether they are decentralized (above the overall mean of decentralization in 2006) or centralized. Sample size in each bar in panel A (from left to right) is (i) 695 observations over 296 firms; (ii) 863 observations, 352 firms; (iii) 736 observations, 316 firms; and (iv) 857 observations, 367 firms. Panel B uses MOPS data on US plants and is the same as panel A except we just use one 2009–2006 long difference for plant sales growth and decentralization dated in 2005. The sample in panel B includes 8,800 US plants in 3,150 firms.

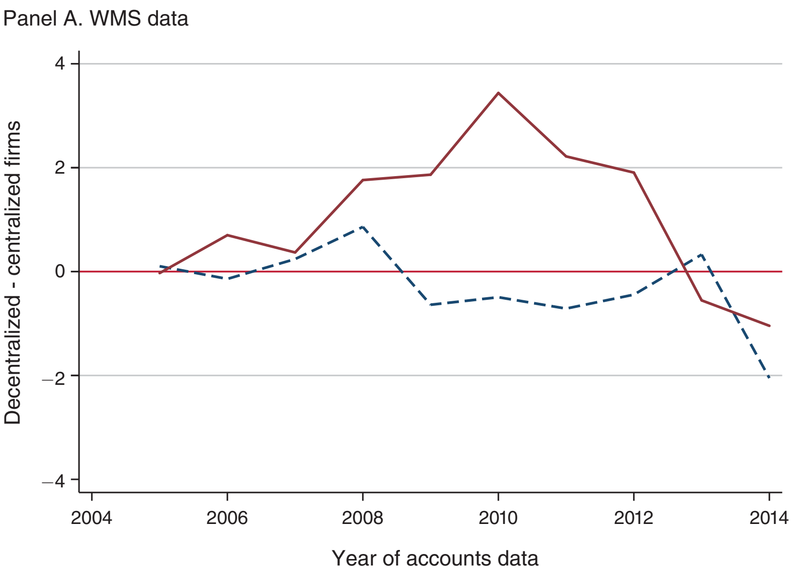
The sample in panel A of Figure 1 is subdivided into four categories of firms. First, we split firms according to whether they experienced a drop in exports in an industry-by-country cell in the main Great Recession years (the 2008 and 2009 average) compared to the latest prerecession years (2006 and 2007 average).[21] Second, we split firms by above/below the mean level of decentralization measured before the advent of the Great Recession. Not surprisingly, all our groupings of firms experienced a drop in average sales, and furthermore, the drop in sales is clearly (and significantly) larger for firms classified in industries experiencing a negative export shock (compare the two bars on the right with the two on the left). However, within the group of firms experiencing a negative shock (those on the right of the figure), the decline in sales was significantly larger for firms that were more centralized prior to the recession. In the WMS sample, for firms in an industry-country pair hit by a greater negative shock, decentralized firms had an 8.2 percent fall in sales compared to about 11.8 percent in the centralized firms, for a difference of 3.6 percentage points, which is significant at the 5 percent level (compared to an insignificant difference of −0.1 percent in industries that did not experience a shock). Panel B of Figure 1 performs the analogous exercise on the MOPS sample of US establishments. The difference-in-differences is very similar at 3.5 percentage points, also significant at the 5 percent level.

The performance differential between decentralized and centralized firms appears confined to the crisis period. Using the same four categories as in Figure 1, Figure 2 plots the difference in sales growth between decentralized and centralized firms (or plants), again distinguishing between those that experienced a drop in exports in an industry-by-country cell during the Great Recession years, including the years before and after the Great Recession. As before, the *y*-axis is the annualized three-year growth rate in sales, with the year 2010, for example, corresponding to the 2010–2007 growth rate. In both the WMS sample in panel A and the MOPS sample in panel B, decentralized firms (plants) and centralized firms (plants) have similar sales growth rates in the prerecession periods (before 2008), regardless of whether they subsequently experienced a decline in exports during the Great Recession (to see this, note that the two lines in each panel do not diverge until 2007). The performance differentials between decentralized and centralized firms (plants) in industries hit by the Great Recession start to emerge in 2008 and converge in both datasets after roughly five years.[22]

The basic finding emerging from the raw data is that decentralization was associated with relatively better performance for firms or establishments facing the toughest environment during the crisis. Moreover, the improved performance associated with decentralization is unique to the crisis period, as these firms (plants) did not outperform their peers before the crisis, and temporary, as these firms (plants) do

[21] To be precise, we first divide the value of nominal exports by a country- and time-specific CPI. We then construct average real exports in (i) 2009 and 2008 and (ii) 2007 and 2006. We then take the log difference between these two periods.

[22] In the US MOPS data, although not in the cross-country WMS, centralized plants in 2012 experience a more rapid recovery in the industries most affected by the Great Recession.



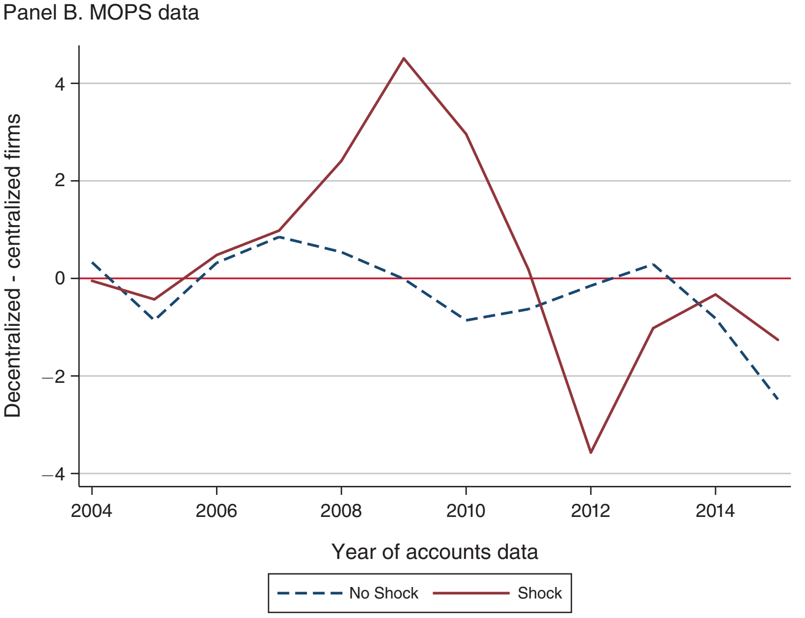


Figure 2. Changes in Sales by Shock, Difference between Decentralized versus Centralized Firms

Notes: Panel A uses WMS firm data from ten OECD countries. In panel A, the lines plot annualized average three-year, firm-level change in ln(sales) for decentralized firms minus annualized average three-year change in ln(sales) for centralized firms, distinguishing between firms that experienced an export shock during the Great Recession, versus those that did not. Growth rates are shown for each year, starting with the 2005–2002 growth rate, through the 2014–2011 growth rate. "Shock" is whether firms were in a country-industry cell that experienced a drop in exports in 2008 and 2009 (the main Great Recession years) compared to 2006 and 2007 (the latest pre-Great Recession years). Panel B uses MOPS plant data from the United States. In panel B, the lines plot annualized average three-year, plant-level change in ln(sales) for decentralized plants minus annualized average three-year change in ln(sales) for centralized plants, distinguishing between plants that experienced an export shock during the Great Recession, versus those that did not. Growth rates are shown for each year, starting with the 2004–2001 growth rate, through the 2015–2012 growth rate. "Shock" is whether plants produced products (measured before the crisis) which on average experienced a drop in exports in 2008 and 2009 (the main Great Recession years) compared to 2006 and 2007 (the latest pre-Recession years).

not appear to be systematically outperforming their centralized counterparts after the crisis.[23]

We now turn to more formal tests of this basic result using alternative measurement strategies and controls for many other possible confounders.

B. *Baseline Regression Equation*

Our baseline specification is

$$\Delta \ln Y_{ijct} = \alpha DEC_{i0} + \beta \big(DEC_{i0} \times SHOCK_{jc}\big) + \gamma SHOCK_{jc} + \delta x_{i0} + \theta_c + \phi_j + \tau_t + \varepsilon_{ijct}, \tag{4}$$

where $\Delta \ln Y_{ijct}$ is the sales growth rate: the three-year annualized change in ln(real sales) for firm (or plant) i in industry j in country c in end-year t.[24] The term DEC_{i0} is firm (or plant) i's level of decentralization (measured in the initial year of 2006 for WMS and 2005 for MOPS); $SHOCK_{jc}$ is our measure of the severity of the shock of recession in the industry-country cell; x_{i0} is a set of controls also measured prerecession (firm and plant size, survey noise, and the proportion of college-educated employees); θ_c are country dummies, ϕ_j are industry dummies, τ_t are year dummies, and ε_{ijct} is an error term. Standard errors are clustered at the industry-by-country level or just industry level depending on the variables used to proxy for the Great Recession and the specific sample used. When we use export growth as a measure of the shock, the key hypothesis we examine is whether $\beta < 0$, i.e., whether decentralized firms and plants do relatively better in bad times. When we use product durability as a measure of the magnitude of the shock, the equivalent hypothesis is that $\beta > 0$ as the more durable goods industries are expected to have (and do have) the largest fall in demand.

Our underlying identification assumption in equation (4) is that in the pre–Great Recession period, firms were in an initial equilibrium where they had adapted their degree of decentralization (DEC_{i0}) based on their current and expected environment.[25] The $SHOCK_{jc}$ associated with the Great Recession was largely unexpected, and since organizational form is likely subject to large adjustment costs, firms could not immediately respond by changing to the optimal form of organization (i.e., becoming more decentralized) in the new environment. Thus, DEC_{i0} can be considered weakly exogenous in equation (4). We investigate the adjustment

[23] One might ask why should centralized firms not systematically *outperform* their decentralized counterparts in "good times"? One reason related to the model in online Appendix A is that although turbulence/uncertainty spikes in deep recessions (albeit to different degrees in different industries) it does not do so in other times (see Bloom et al. 2016, especially table 2). A second reason is that although the Great Recession is a plausibly unexpected shock to which a firm's optimal decentralization did not reflect prerecession, industry growth trends were less unusual in the precrisis period, so firm decentralization had already been chosen endogenously to reflect these trends.

[24] As discussed above, for the long differences we are using the three overlapping time periods for WMS, but for MOPS we can only use one of these long differences, 2009–2006. Hence, for MOPS the time dummy is absorbed by the constant in the regression.

[25] Formally, we do not need to assume fully optimizing behavior in the preperiod, only that DEC_{i0} is weakly exogenous.

costs assumption by using repeat observations on decentralization for the same firms or plants over time. We find decentralization to be highly persistent over the time in both the WMS and MOPS samples.[26] Note that our identification assumption does not require decentralized firms to have the same observable and unobservable characteristics as centralized firms (they do not), but it *does* require that such characteristics correlated with DEC_{i0} are not solely responsible for generating better performance in those industry-country pairs worst hit by the Great Recession. We present a battery of tests consistent with this assumption, including (i) running placebo analysis in the pre–Great Recession period, (ii) using our rich micro data to include interactions of the negative shock with a large number of firm and industry observables, and (iii) exploiting only the variation in decentralization and growth across plants within the same firm.

C. *Baseline Results*

Sales Growth as an Outcome.—Column 1 of Table 2 shows the results from estimating a simple specification including export growth as our recession shock indicator and a full set of country, year, and three-digit SIC industry dummies. A 1 percent increase in industry exports is associated with a significant 0.07 percentage point increase in sales growth. We also find a positive and weakly significant association between sales growth and lagged initial decentralization (in 2006). A one standard deviation increase in our decentralization index is associated with a 0.58 percentage point increase in sales growth (e.g., growth increases from say 2.0 percent a year to 2.6 percent a year).[27] In column 2, we introduce an interaction term between decentralization and the export shock variable. The interaction term is negative and significant (0.042 with a standard error of 0.013), which indicates that decentralized firms shrank much less than their centralized counterparts when they were hit by a negative export shock. Note that the coefficient on the linear decentralization term is insignificant when the interaction term is added to the specification, which indicates that decentralized firms did not grow significantly faster or slower in those sectors that had zero export growth.

The magnitudes of the coefficients are nontrivial. Consider a macro shock causing a 1 percent fall in exports. The coefficients in column 2 of Table 2 suggest that the sales of an average firm (with mean decentralization score of zero) will shrink three times as much as those of a decentralized firm (with a score one standard deviation above the mean).[28] Panel A of Figure 3 shows the implied marginal effect of decentralization on sales growth as a function of export growth. These

[26] We estimate the annual AR(1) coefficient on decentralization as 0.965 in MOPS and 0.707 in WMS. The true persistence parameter is likely to lie between these as the MOPS estimate is likely to be an overestimate because of recall bias, and the WMS estimate is likely to be an underestimate because of classical measurement error. See Bloom, Sadun, and Van Reenen (2016) for more structural estimation of adjustment costs in WMS also showing high degrees of persistence of organizational form.

[27] Note that the growth rates of both firm sales and industry exports used throughout all regressions are multiplied by 100 (i.e., 1 percent is 1, not 0.01)

[28] Assuming the effects were causal for illustrative purposes, the average firm will see a drop in sales of 0.062 percent (the coefficient on export growth), whereas the decentralized firm will see a fall in sales of just 0.020 percent (0.062 minus 0.042, the coefficient on the interaction).

Table 2—Decentralization and Sales Growth: Main Results

Dependent variable = sales growth	World Management Survey (WMS)				US Census data (MOPS)	
	(1)	(2)	(3)	(4)	(5)	(6)
Decentralization	0.579	0.363	0.041	−0.460	0.583	−0.182
	(0.302)	(0.302)	(0.417)	(0.572)	(0.230)	(0.234)
EXPORT Growth	0.069	0.062			0.027	
	(0.029)	(0.029)			(0.021)	
Decent. × EXPORT Growth		−0.042	−0.047		−0.023	
		(0.013)	(0.018)		(0.009)	
Decent. × DURABILITY				0.502		0.381
				(0.194)		(0.091)
Firms	1,330	1,330	1,330	1,330	3,150	3,150
Observations	3,151	3,151	3,151	3,151	8,800	8,800
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes		Yes	Yes	Yes
Industry by country dummies			Yes			
Firm and plant employment, skills			Yes	Yes	Yes	Yes
Cluster	SIC3×Cty	SIC3×Cty	SIC3×Cty	SIC4	SIC3	SIC3

Notes: Estimated by OLS with standard errors clustered at three-digit industry-by-country level in columns 1–3 and just industry in columns 4–6. The dependent variable is the annualized three-year change of firm ln(sales). The periods 2011–2008, 2010–2007, and 2009–2006 are pooled in WMS (columns 1–4) and just 2009–2006 in MOPS (columns 5 and 6). Decentralization is measured in 2006 for WMS and 2005 for MOPS. "EXPORT Growth" is change in ln(exports) in country by three-digit industry cell between the 2008 and 2009 average (the main Great Recession years) compared to the 2006 and 2007 average (the latest pre-Recession years) in columns 1–4 and is the average change (2008/2009 average compared to 2006/2007) in ln(exports) at the product level (HS7) for the products the plant produced just prior to the Great Recession in 2006 for column 5. "DURABILITY" is the average durability of the goods produced in the four-digit industry (in years), drawn from Nekarda and Ramey (2013). Baseline controls are country and year dummies and "noise controls" (plant manager's tenure and hierarchical seniority and the interview's reliability score, day of the week and duration; WMS also includes analyst dummies and MOPS whether the survey was answered online or by mail). Industry dummies are at the three-digit SIC level (four digits in column 4). Firm and plant employment are measured as log(employment), and skills are measured as ln(percent of employees with a college degree).

plots are obtained using the coefficients reported in column 2 of Table 2. According to these estimates, decentralization has a positive association with sales growth in all industries experiencing country-industry export growth below 8 percent. This corresponds to two-thirds of the WMS sample in the postrecession period but only 12 percent of firms in the prerecession periods (this is shown in panel B of Figure 3). In other words, the positive association between decentralization and firm growth appears to be contingent on the wider demand conditions in the aggregate environment facing the firm, which in turn may be one of the possible reasons for the heterogeneous levels of decentralization observed in 2006.[29]

[29] In other work done using the WMS decentralization data (Bloom, Sadun, and Van Reenen 2012), we discuss other influences on firm decentralization, such as scale, human capital, complexity, and culture. We exploit one source of this variation (culture, as proxied by trust) in an instrumental variable approach discussed below (footnote 43). We show robustness to the inclusion of proxies for scale, human capital, and firm complexity in online Appendix Tables A5 to A8.

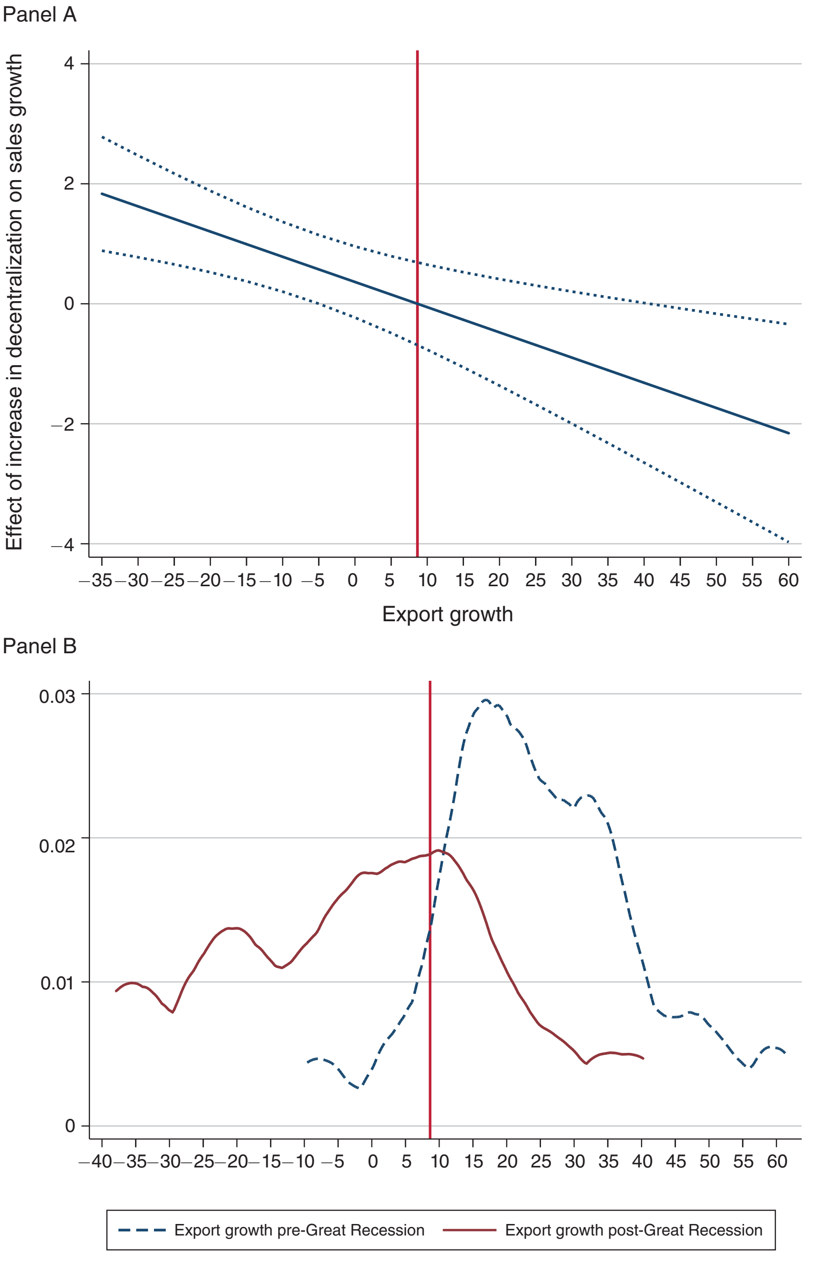


Figure 3. Effect of Increase in Decentralization on Sales Growth

Notes: WMS data. Panel A plots the implied marginal effect of decentralization on firm sales growth using the coefficients in Table 2, column 2 as a function of the shock (export growth in cell). Panel B shows the distribution of firms in industry-country cells with different levels in cell. Panel B shows the distribution of firms in industry-country cells with different levels of export growth before and after the Great Recession.

The recession shock measure is industry- and country-specific. Therefore, in column 3 of Table 2, we include a full set of industry dummies interacted with country dummies, as well as a set of other firm controls (measured in 2006). The linear export shock is absorbed by the industry-by-country dummies, but we can still identify the interaction of the shock with initial firm decentralization. Even in this demanding specification, the interaction between decentralization and the shock remains negative and significant.[30]

A possible concern with the estimates is that the *SHOCK* variable uses information dated over the same period as the dependent variable, which may give rise to an endogeneity bias. Consequently, we test for the robustness of the main results, using as a proxy for the intensity of the Great Recession a measure of the durability of the products in the four-digit industry calculated prior to the recession. We include a full set of four-digit industry dummies to absorb the linear effects in column 4 of Table 2. Consistent with the earlier results, the interaction between decentralization and the *SHOCK* is positive (since more durable industries experienced greater drops in demand during the recession) and significant.[31]

Columns 5 and 6 of Table 2 repeat the specifications of columns 3 and 4 using the MOPS sample.[32] Remarkably, although drawn from a distinct dataset, a single country (United States), and different survey methodology, the results in this larger sample of plants are extremely similar to the ones reported using the cross-country WMS data. The coefficients on the interaction terms are of the same sign, statistically significant, and of a broadly comparable magnitude.

Other Performance Measures as Outcomes.—The results discussed so far suggest the presence of a positive relationship between firm and establishment sales growth and decentralization in the industries most affected by the Great Recession. In Table 3, we explore whether this relationship persists even when we examine total factor productivity (TFP), i.e., we estimate the most general econometric model of Table 2, column 3 but also control for increases in other inputs such as employment, capital, and materials on the right-hand side of the equation. As discussed in the introduction, some have argued that firms need to centralize during crises so tough cost controls and efficiency-enhancing measures can be driven down throughout the company. This would imply that although decentralized firms (or plants) may fare better on protecting sales revenue during downturns, they will do worse in terms of productivity.

Column 1 of Table 3 reports the baseline results for sales growth on the subsample of firms with data on factor inputs, while column 2 reports the productivity results.[33]

[30] Other measures of the demand shock give similar qualitative results to using exports. For example, using industry output built from aggregating the ORBIS population data in the same way as exports (across the three-digit industry-by-country cell between the 2009–2008 and 2007–2006 periods) generates a coefficient (standard error) on the interaction term of -0.060 (0.015).

[31] The specification in column 4 of Table 2 can be regarded as the reduced form of an IV regression where we use durability as an instrumental variable for the shock. When we use decentralization $\times$ durability to instrument for *Decentralization* $\times$ *SHOCK* in an IV specification on the sample in column 3, we obtain a coefficient (standard error) of -0.165 (0.052) on the *Decentralization* $\times$ *SHOCK* interaction.

[32] Note that the linear export shock in column 5 is not absorbed by the industry fixed effects as the MOPS export shock varies at the plant level.

[33] The sample for the TFP regression is smaller due to missing data on some of the additional inputs needed for the production functions specification (in many countries, revenues are a mandatory item on company accounts, but other inputs such as capital are not).

Table 3—Alternative Firm-Level Outcomes

	World Management Survey (WMS)				US Census data (MOPS)			
Dependent variable	Sales growth (1)	TFP growth (2)	Profit growth (3)	Tobin's Q growth (4)	Sales growth (5)	TFP growth (6)	Profit growth (7)	Tobin's Q growth (8)
Decentralization	−0.017	−0.263	−0.396	−0.673	0.583	−0.358	−0.027	−0.062
	(0.400)	(0.357)	(1.597)	(1.309)	(0.230)	(0.508)	(0.761)	(0.667)
Decentralization × EXPORT Growth	−0.048	−0.033	−0.068	−0.072	−0.023	−0.054	−0.064	−0.053
	(0.017)	(0.013)	(0.065)	(0.056)	(0.009)	(0.022)	(0.031)	(0.019)
Firms	1,211	1,211	1,192	1,024	3,150	3,150	3,150	150
Observations	2,839	2,839	2,712	866	8,800	8,800	8,800	1,800
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm and plant employment, skills	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies					Yes	Yes	Yes	Yes
Industry by country dummies	Yes	Yes	Yes	Yes				
Cluster	SIC3×Cty	SIC3×Cty	SIC3×Cty	SIC3×Cty	SIC3	SIC3	SIC3	SIC3

Notes: Estimated by OLS with standard errors clustered at three-digit industry-by-country level in columns 1–4 and just industry in columns 5–8. Sales growth is the annualized three-year change of firm ln(sales). TFP growth is the same as sales growth except we include the growth of employment, capital, and materials on the right-hand side of the regression. Profit growth is EBIT/capital for WMS and gross profits/capital for MOPS (profits measured as plant sales − wage bill − materials − rental expenses). Tobin's Q is market value divided by the capital stock. For all these dependent variables, we pool the long difference 2011–2008, 2010–2007, and 2009–2006 in WMS and just 2009–2006 in MOPS. Decentralization is measured in 2006 for WMS and 2005 for MOPS. "EXPORT Growth" is change in ln(exports) in country by three-digit industry cell between the 2008 and 2009 average (the main Great Recession years) compared to the 2006 and 2007 average (the latest pre-Recession years) in columns 1–4 and is the average change (2008/2009 average compared to 2006/2007) in ln(exports) at the product level (HS7) for the products the plant produced just prior to the Great Recession in 2006 in columns 5–8. Baseline controls are year dummies and "noise controls" (plant manager's tenure and hierarchical seniority and the interview's reliability score, day of the week and duration; WMS also includes analyst dummies and MOPS whether the survey was answered online or by mail). Firm and plant employment are measured as log(employment), and skills are measured as ln(percent of employees with a college degree).

Decentralization is also significantly and positively associated with an increase in TFP during a crisis.[34] Column 3 uses the growth of profitability (Earnings Before Interest and Tax divided by the capital stock) as the dependent variable, and column 4 uses the growth in Tobin's Q (the ratio of the firm's stock market value to the capital stock) as a more forward-looking, market-based indicator of firm performance. In both columns, there is a negative coefficient on the interaction, although it is not significant at conventional levels. Columns 5 through 8 repeat the analysis using the MOPS data and show even stronger results. The key coefficient on the interaction term between decentralization and the shock is negative and significant for sales, productivity, profits, and Tobin's Q growth.

It is reassuring that Table 3, which uses more refined measures of firm performance that take inputs into account, is consistent with Table 2, which uses sales growth. We continue to focus on sales growth as our baseline outcome as it is the

[34] The sum of the unreported coefficients on employment, capital, and materials growth is about 0.9, suggesting decreasing returns to scale (and/or market power). Measurement error may also be responsible for attenuating the coefficients on factor inputs toward zero. Note that if we calculate TFP as a residual using cost shares as weights on the factor inputs and use this as the dependent variable (dropping the factor shares from the right-hand side), our results are similar to those from the estimated production function.

simplest measure and is nonmissing for most firms (TFP, for example, also requires data on capital and employment) but note that our results are robust to these alternative firm performance outcomes.

D. *Turbulence: Product Churn and Stock Market Volatility*

Our empirical findings strongly suggest that decentralization becomes more valuable in bad times. The model in Section I suggests that one reason for this was that negative shocks may be associated with greater turbulence (a higher u), which increases the benefits of local information. We now study whether there is any direct evidence to support this idea.

Product Churn.—Our main measure of turbulence is changes in product churn in recession versus nonrecession years as a proxy. Product churn is measured using data from the US Census of Manufactures (CM). The CM, which is conducted in years ending in 2 and 7, asks manufacturing plants to list the value of annual shipments by 10-digit product code. Plants receive a list of all the product codes typically produced in their industry along with corresponding descriptions of each code. Plants that produce products not listed on the form are instructed to write in the appropriate product code.[35] We then measure the amount of product churn at the plant level as the number of products added or dropped between the previous census and the current census, divided by the average number of products produced in both censuses. That is, product churn for establishment i in year t is defined as

$$(5) \quad Product\ Churn_{i,t} = \frac{\#Products\ Added_{i,t} + \#Products\ Dropped_{i,t}}{0.5\left(\#Products_{i,t} + \#Products_{i,t-5}\right)} \in [0,2].$$

Our measure of industry product churn is the average plant-level product churn among all plants within an industry (three-digit US SIC-1987) which produce at least three products. We restrict attention to plants with at least three products in order to reduce measurement error from product code misreporting.[36] Finally, in order to measure the *change* in product churn by industry during the Great Recession, we calculate the change in product churn from 2007 to 2012 as industry-level product churn in 2012 minus industry-level product churn in 2007 (constructed from the 2007 and 2002 censuses). [37]

Before examining the relationship between sales growth, decentralization, and turbulence (as measured by product churn), we first examined whether decentralization really was greater in industries where turbulence was higher. Online

[35] The ASM also has a 10-digit product trailer, but the question is formulated in a way that results in less detailed responses than the five-yearly CM question, so we use the CM to measure churn.

[36] Establishments which produce the same portfolio of products in consecutive censuses but misreport a product code in one year will be incorrectly measured as having switched products. Product code misreporting is particularly problematic for establishments with one or two products, for which a single reporting mistake would result in very high measured product churn. Our results are robust to using industries with plants with a lower cutoff of two or more products or a higher cutoff of five or more products.

[37] Note that the measure is based on plants that survived between census years. We also constructed an alternative measure that included plants which died and entered between census years in the construction of equation (5). This broader measure led to similar results.

Appendix Figure A2 shows that this is indeed the case: plants in the top quintile of product churn industries had a decentralization index about 0.2 standard deviations higher than those in the bottom quintile. More formally, online Appendix Table A11 finds a positive and significant relationship between decentralization (the dependent variable) and product churn, particularly for decentralization of decisions regarding product introduction and sales and marketing as the theory would suggest. Furthermore, we checked whether product churn had indeed increased more in (i) industries that experienced a larger drop in exports during the Great Recession or (ii) operated in industries that produced in more durable goods industries. This is also the case in the data as shown in online Appendix Figure A3.

To investigate the empirical validity of the turbulence-based theoretical mechanism, we extend our basic equation (4) to include both the change in *CHURN* and also its interaction with decentralization:

$$(6) \quad \Delta \ln Y_{ij} = \alpha DEC_{i0} + \beta\left(DEC_{i0} \times SHOCK_j\right) + \gamma SHOCK_j + \eta \Delta CHURN_j + \mu\left(DEC_{i0} \times \Delta CHURN_j\right) + \delta x_{i0} + \phi_j + \tau_t + \varepsilon_{ij},$$

where $\Delta CHURN_j$ is the change in churn in industry j (since we estimate this regression model only in the US MOPS sample, we omit the country subscript). According to the model, $\mu > 0$ since churn increases the value of decentralization. Moreover, to the extent that our export shock variable is proxying for rising turbulence during recessions, we would also expect β to drop in magnitude in equation (6) compared to equation (4).

Table 4 shows the results of this exercise.[38] In column 1, we estimate the specification in column 3 of Table 2 for the subset of establishments for which an industry-level measure of product churn could be built. This has similar results to the overall sample, i.e., the coefficient on the interaction $DEC_{i0} \times SHOCK_j$ is negative and statistically significant. Column 2 includes the $DEC_{i0} \times \Delta CHURN_j$ interaction instead of the $DEC_{i0} \times SHOCK_j$ interaction. In line with the model's prediction, the coefficient on the interaction with changes in product churn is positive and significant, i.e., sales growth appears to have a positive association with decentralization in industries that experienced a greater increase in turbulence, as proxied by product churn. Column 3 includes both interactions. The coefficient on the interaction between decentralization and product churn remains positive and significant, while the coefficient on the interaction between decentralization and growth in industry exports drops by a quarter in magnitude compared to column 1 and is statistically insignificant.

One concern with Table 4 is that we are assuming that an increase in product churn causes all establishments to experience an increase in turbulence. It may be that churn matters much less for some firms than for others as churn is a weaker signal of the true increase in uncertainty (which our theory suggests increases the benefits of delegation) for some firms than for others. In online Appendix Table A3, we

[38] Since we are measuring churn 2012–2007 (our Census of Manufactures years), we use as our dependent variable the change in ln(sales) between 2012 and 2007, which is why the sample is slightly smaller.

Table 4—Decentralization and Turbulence (as Measured by Product Churn)

Dependent variable: Sales growth (2007–2012)	Exports			Durability		
	(1)	(2)	(3)	(4)	(5)	(6)
Decentralization	1.026	1.524	1.854	−0.019	1.524	1.611
	(0.713)	(0.681)	(0.686)	(1.043)	(0.681)	(1.004)
Decentralization × Change in Product Churn		4.722	4.330		4.722	4.649
		(1.43)	(1.524)		(1.43)	(1.492)
Decentralization × Export Growth (2007–2012)	−0.040		−0.031			
	(0.019)		(0.019)			
Decentralization × Durability				0.734		0.409
				(0.430)		(0.405)
Observations	8,200	8,200	8,200	8,200	8,200	8,200
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm and plant employment, skills	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	SIC3	SIC3	SIC3	SIC3	SIC3	SIC3

Notes: Estimated by OLS with standard errors clustered at three-digit industry level. The dependent variable is the annualized five-year change of firm ln(sales) 2012–2007. Decentralization is measured in 2005. "Export Growth" is average change (2008/2009 average compared to 2006/2007 average) in ln(exports) at the product level (HS7) for the products the plant produced just prior to the Great Recession in 2006. All columns include three-digit industry dummies, firm and plant size, skills, and "noise controls" (plant manager's tenure and hierarchical seniority and the interview's reliability score, day of the week, and duration, and whether the survey was answered online or by mail). "Product Churn" is the three-digit industry-level value of the average change in the (number of products added between t and $t-5$ plus the number of products dropped between t and $t-5$)/(average number of products between t and $t-5$). Baseline controls are year dummies and "noise controls" (plant manager's tenure and hierarchical seniority and the interview's reliability score, day of the week and duration, and whether the survey was answered online or by mail). Firm and plant employment are measured as log(employment), and skills are measured as ln(percent of employees with a college degree).

investigate this by showing that product churn matters more for decentralized firms when they operate in more product-differentiated industries (as measured by Rauch 1999)[39] or less mature markets, and (to some extent) when they are smaller. This seems consistent with theoretical intuition.

An alternative measure of the shock is product durability. Columns 4 to 6 of Table 4 repeat the same specifications as the first three columns, only this time using durability as an alternative industry-level proxy for the Great Recession. The coefficient on the interaction between decentralization and product churn is positive and significant, and its inclusion again reduces the magnitude of the coefficient on the interaction between decentralization and durability to insignificance.

Stock Market Volatility.—Stock-returns volatility is a useful alternative measure of turbulence in that it captures all changes in outcomes (or expectations) that impact the firm weighted by their impact of total discounted profits. As such, for firms hit by a huge variety of shocks, stock-returns volatility is a useful average measure of overall turbulence across a wide variety of sources. We measure the standard

[39] We use the concordance in Salas (2015) to map Rauch's measures to the US manufacturing codes we use in the census data.

deviation in monthly firm-level stock market returns in an industry-by-year cell over the population of publicly listed firms in each country. This stock-returns measure of volatility is similar to those used by Leahy and Whited (1996), for example, as a measure of uncertainty.[40] These measures are then used in changes as an alternative proxy for the increase in turbulence. In the United States, we pool at the three-digit SIC level as there are about 2,000 publicly listed firms. In the other OECD countries, there are fewer publicly listed firms, so we construct the measure at the SIC two-digit level. An advantage of this measure is that it is available for the WMS as well as the MOPS, but a disadvantage is that it is constructed only from firms listed on the stock market (in the same industry).

Table 5 shows the results. In column 1, we reproduce the specification in column 2 of Table 2.[41] In column 2, we use the interaction between decentralization and the change in the standard deviation of stock market returns instead of our usual interaction. As expected from the theory, the coefficient is positive and significant, suggesting that decentralized firms outperform their centralized counterparts in industries where stock market volatility has increased by most. In column 3, we include both interactions. The stock market volatility interaction remains positive and significant, whereas the coefficient on the export growth interaction falls by a third in magnitude and is now only significant at the 10 percent level. The next three columns reproduce the same specifications using the MOPS data, showing a roughly similar pattern.

Summary on Turbulence.—Taking Tables 4 and 5 together, it appears that decentralized firms did relatively better in industries where turbulence increased. At least part of the reason why decentralized firms do better in bad times appears to be because the industries worse hit by the Great Recession were also those where turbulence also increased.

E. *Magnitudes*

In online Appendix Table A16, we consider some simple calculations of cross-country magnitudes. Our thought experiment is to consider the Great Recession as a global shock as reflected by a fall in trade. We use the US value of the shock from COMTRADE of a fall in exports of 7.7 percent. This is the empirical difference between 2009–2008 versus 2007–2006 that we use as our industry-country-specific shock measure elsewhere in the paper.

We take the 2006 average levels of cross-country decentralization by country (column 1 of online Appendix Table A16) and the empirical estimates in column 2 of Table 2 to estimate the average annual implied effect of GDP of the shock (column 2 of online Appendix Table A16). We express this relative to the United States in column 3. For all countries except Sweden, there is a negative relative

[40] Indeed, in a stochastic volatility model based on Dixit and Pindyck (1994), the variance of stock returns is monotonically (indeed almost linearly) related to the volatility of the underlying driving process.

[41] The only difference is that we are using two-digit dummies instead of three-digit dummies to match the level of aggregation for the stock market volatility measures.

Table 5—Decentralization and Turbulence (as Measured by Stock Market Volatility)

Dependent variable = Sales growth	World Management Survey			US Census data (MOPS)		
	(1)	(2)	(3)	(4)	(5)	(6)
Decentralization	0.208	0.421	0.289	0.583	0.3179	0.283
	(0.331)	(0.329)	(0.321)	(0.230)	(0.216)	(0.206)
EXPORT Growth	0.088		0.090	0.027		1.190
	(0.032)		(0.027)	(0.021)		(1.633)
Decent. × EXPORT Growth	−0.034		−0.024	−0.023		−0.019
	(0.017)		(0.014)	(0.009)		(0.007)
Decent. × Change in SD (stock returns)		7.142	6.304		1.208	1.285
		(1.341)	(2.354)		(0.402)	(0.374)
Firms	1,330	1,330	1,330	3,150	3,150	3,150
Observations	3,151	3,151	3,151	8,800	8,800	8,800
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes (SIC2)	Yes (SIC2)	Yes (SIC2)	Yes	Yes	Yes
Firm and plant employment, skills	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	SIC2×Cty	SIC2×Cty	SIC2×Cty	SIC3	SIC3	SIC3

Notes: The dependent variable is the annualized three-year change of firm ln(sales) in 2009–2006. "EXPORT Growth" is change in ln(exports) in country-by-three-digit-industry cell between the 2008 and 2009 average (the main Great Recession years) compared to the 2006 and 2007 average (the latest pre-Recession years) in columns 1–3 and is the average change (2008/2009 average compared to 2006/2007) in ln(exports) at the product level (HS7) for the products the plant produced just prior to the Great Recession in 2006 in columns 4–6. Columns 1–3: estimated by OLS with standard errors clustered at two-digit industry-by-country level. "Change in SD (stock returns)" is the change in standard deviation of stock returns in two-digit industry-by-country cell between 2008 and 2009 average compared to 2006. These columns include two-digit industry-by-country dummies. Columns 4–6 estimated by OLS with standard errors clustered at three-digit industry level. "Change in SD (stock returns)" is the change in standard deviation of stock returns in three-digit industry cell between 2008 and 2009 average compared to 2006. These columns include three-digit industry dummies. Baseline controls are country and year dummies and "noise controls" (plant manager's tenure and hierarchical seniority and the interview's reliability score, day of the week and duration; WMS also includes analyst dummies and MOPS whether the survey was answered online or by mail). Industry dummies are at the three-digit SIC level (four digits in column 4). Firm and plant employment are measured as log(employment), and skills are measured as ln(percent of employees with a college degree).

implied effect because decentralization in the United States is greater than in every other country except Sweden. Column 4 displays the actual annual change in GDP growth since the start of the global financial crisis (from World Bank data) for each of our countries, and then again expresses these relative to the US base in column 5. Every country except Poland (which is still in a strong catch-up phase of development) experienced a slower growth performance than the United States over this period, averaging just over a third of a percentage point (base of column). Column 6 divides column 3 into column 5, which is the fraction of relative economic performance accounted for by decentralization (note that since we are assuming a common shock, none of this difference is due to the magnitude of the crisis being worse in some countries than others).

Overall, column 6 of online Appendix Table A16 suggests that an average of 15 percent of the postcrisis growth experience between countries is accounted for by decentralization. This is nontrivial, but it is worth noting that there is a large degree of heterogeneity between countries underlying this average. Almost all of the differential growth experience of France and Japan compared to the United States can be accounted for by decentralization (96 percent and 95 percent, respectively), whereas decentralization accounts for virtually none of Britain's performance. In particular, as noted above, because Sweden is more decentralized than the United States, we should expect it to have outperformed the United States, whereas it grew about half a percentage point more slowly. If we drop Sweden, the importance of decentralization doubles to accounting for almost a third of the difference (32 percent). Note that the contribution is also negative for Poland, because although Poland is more centralized than the United States, it grew more quickly over this time period.

IV. Alternative Mechanisms: Identification and Robustness

We have emphasized that decentralized organizations appear more resilient to negative shocks and our interpretation that this is because they are able to respond more flexibly to turbulent environments. We turn next to various challenges to our conclusions from a theoretical perspective.

A. *Do Bad Times Reduce the Costs of Decentralization? Evidence from Financial Shocks*

Our theory suggested that congruence could fall in recessions (the "centralist" view), leading to an increase in the value of centralization. Our main result rejected this as decentralized firms performed better in bad times. There may, however, be alternative rationalizations of these results. Imagine, for example, that bad times reduce the *costs* of decentralization because plant managers fear that performing the non-profit-maximizing action might cause the firm to go bankrupt, and this will be *more* costly to the manager than to the CEO, as he will take a larger hit to his income (e.g., through longer unemployment). To test this idea, we examine environments where the firm-specific risk of bankruptcy rose rapidly in the Great Recession. We constructed several indicators of increased bankruptcy risk. In particular, we used the measures of exogenous increases in exposure to financial crisis exploited by Chodorow-Reich (2014), such as exposure to mortgage-backed securities (affected by the subprime crisis) and a firm's preexisting relationship with Lehman Brothers or similar "at-risk" banks. These are pre–Great Recession conditions relating to the supply of finance rather than product demand. We also used more conventional measures such as leverage ratios.

We found that these measures do predict negative performance in sales and other outcomes (see online Appendix Table A4) as in Chodorow-Reich (2014). However, in no case did including these bankruptcy risk variables (and their interactions with *SHOCK* or other covariates) materially alter the coefficient on the key interaction of *Decentralization* $\times$ *SHOCK* when included in equation (4).[42] This led us

[42] The coefficients on the Lehman Brothers variable cannot be reported due to census disclosure rules. Note, because of the need to match our data with the Chodorow-Reich (2014) data, our sample size falls to 2,000 observations, so many of our results are not statistically significant, but point estimates are similar and unaffected by the controls for financial conditions.

to conclude that the crisis was not leading to greater decentralization by fostering greater alignment between the central headquarters and plant manager.

B. *Does Decentralization Reflect Other Establishment Characteristics?*

We investigated whether the *Decentralization* × *SHOCK* interaction actually reflects other firm-level characteristics correlated with decentralization, exploiting the very rich data we have compiled.[43] Specifically, in online Appendix Tables A5 and A6, we augment the baseline specification of column 3 in Table 2 with interactions terms between the Great Recession indicator and a series of additional firm and plant controls.

First, it may be that decentralized firms are more resilient to negative shocks because they have better management quality. To test this, we include interactions with the overall management quality of the firm (in the WMS measured as in Bloom and Van Reenen 2007) or the plant (in the MOPS). We also have rich information on plant manager characteristics (age, immigrant status, and gender). We also have measures of human capital in general (the proportion of employees with college degrees).

Second, we know that smaller, less profitable firms may be more vulnerable to downturns. For example, firms in low profit margin industries with relatively homogeneous products may be more likely to exit. The concern is that these more marginal firms may also be more centralized, so that more decentralization simply reflects more efficient plants. To address this we include interactions between the *SHOCK* and (i) prerecession profit margins, (ii) firm and plant size, (iii) technology adoption (data-driven decision-making), and (iv) union strength.

In online Appendix Tables A7 and A8, we also tested the robustness of the results to the inclusion of measures of scale (size of the plant and/or the firm), decentralization from the plant manager to production workers, technology adoption (data-driven decision-making), and union strength. Throughout these experiments, the coefficient on our key *Decentralization* × *SHOCK* interaction remained significant, even when all variables were simultaneously included in the final column.[44]

[43] Ideally, we would have an instrumental variable for decentralization, but there is no obvious candidate. We did try looking at whether the regional variation in generalized trust in the population around the firm's headquarters is strongly correlated with decentralization (see Bloom, Sadun, and Van Reenen 2012). We found that firms in high-trust areas outperform others in downturns—an interaction between regional trust and our export shock variable is significantly negative in the performance regressions of Table 2. This reduced form is consistent with a mechanism whereby trust causes greater firm decentralization and therefore fosters resilience in bad times. However, there may also be other mechanisms through which higher trust helps firms outperform others during downturns, so trust cannot be reliably excluded from the second stage.

[44] Although the additional variables were usually insignificant, there are exceptions. In online Appendix Table A5, decentralization from plant manager to workers exhibits a similar pattern to our main decentralization measure of power between the central headquarters and plant manager. This suggests that decentralizing decision-making throughout the hierarchy is beneficial during times of crisis. The management interaction is also weakly significant, although in this case the coefficient is positive. In other words, well-managed firms perform relatively better in good times than in bad times.

C. *Coordination Costs*

When there are large externalities between different plants belonging to the same firm, decentralization is likely to be more costly (e.g., Alonso, Dessein, and Matouschek 2008). For example, coordinating prices and product decisions from the central headquarters is important if the sales of one establishment's products cannibalize those of another establishment belonging to the same firm. If coordination became less important in a downturn, this could be an alternative rationalization of our results. However, Bolton and Farrell (1990) have argued that coordination is more likely to be important when urgency increases, which is more likely in crisis situations. Nonetheless, to examine whether our results may reflect the changing importance of coordination in bad times, in online Appendix Tables A7 and A8, we included interactions with many measurable characteristics reflecting environments where coordination costs should be more important, such as firm and/or plant size and whether a firm was multiplant (so more need for coordination) and, if so, whether these plants are located in different countries or different states. Similarly, we looked at whether a firm was producing goods across multiple sectors ("diversification" dummy) or whether it was part of a foreign multinational enterprise. We also considered the degree of outsourcing (a direct question in WMS) and alternatively as measured by the ratio of intermediate goods inputs to total sales. In all cases, the main interaction between decentralization and export growth remained significant, and in only 1 of the 17 cases was 1 of the other interactions significant at the 5 percent level.[45] Although coordination costs matter in general for centralization, they do not seem to account for the better performance of decentralized firms during downturns.

D. *Types of Decentralization*

As a related experiment, to shed light on the model, we looked at the different subquestions which form the overall decentralization index, as shown in online Appendix Table A9. Since the Great Recession was associated with a decrease in output demand, we would expect that decentralization capturing managerial discretion over outputs (sales and new products) would be more important than delegation over inputs (like labor and capital). We start in column 1 by showing the baseline result of Table 2, column 3. In columns 2 and 3, we repeat the estimation using as the decentralization index a *z*-scored average of the two questions capturing plant manager decentralization for hiring and investment decisions in column 2 and for sales and marketing and product introduction in column 3. In columns 4 to 6, we repeat the same exercise for the US MOPS sample.[46] In both cases, the positive effect

[45] This is the materials share in column 9 in the WMS regressions of Table A7. Two other interactions with decentralization—firm size and the number of manufacturing industries in columns 4 and 8 of the MOPS regressions in Table A8—are significant at the 10 percent level. This could be taken as (weak) evidence that firms with more coordination issues with supply chains, scale, or industry diversification do worse during downturns when presumably lack of coordination becomes more costly.

[46] In the US sample we have three questions capturing plant manager decentralization for hiring and investment decisions in column 5 of online Appendix Table A9 and three capturing plant manager decentralization for sales and marketing and product introduction in column 6.

of decentralization in a crisis is driven primarily by the output-related questions. This finding provides additional insight on the possible mechanism through which decentralization may positively affect performance during a downturn, namely the ability to better adapt to more turbulent demand conditions.[47]

One concern with these findings is the belief that in practice, plant managers do not have meaningful autonomy in decisions regarding sales and marketing and product introduction. and that these decisions are typically undertaken in the marketing department of firm headquarters. It is worth recalling that while this may be the case in business-to-consumer firms, which sell their goods to households directly or through retail establishments, it is less obvious in business-to-business firms, which sell their manufacturing output to other firms. The latter scenario encompasses a significant share of US and EU manufacturing activity.[48] Moreover, our firms are not so large—a median of 250 employees in WMS and 423 in MOPS—so few of them are likely to have stand-alone marketing divisions.

E. *Changes in Decentralization over Time*

Recall that our identification assumption is that prerecession decentralization is weakly exogenous and that there are some adjustment costs which mean that after the Great Recession shock, firms do not immediately adopt the new optimal (more decentralized) organizational form. A corollary of our theory, however, is that firms will start moving to a more decentralized form (to the extent that they believe the shock is likely to be long lasting). Hence, we should expect to see some increase in decentralization for firms and establishments more exposed to the shock. Online Appendix Table A14 examines this by using the change in decentralization as a dependent variable. This is a demanding specification, especially for WMS where the panel element of decentralization is limited (we have data in 2009 and 2010 for a subsample of the 2006 wave). Nevertheless, in both WMS and MOPS, we do see that firms facing larger negative shocks are more likely to decentralize.

F. *Further Robustness Exercises*

A concern with the results is that our decentralization interaction is simply picking up longer-term trends or proxying for some unobserved variable. To address these issues, we took several steps.

Placebo Test in a Precrisis Period.—First, we address the concern that the *Decentralization* $\times$ *SHOCK* interaction may simply be picking up some other time-invariant industry characteristic associated with the magnitude of the recession

[47] Consistent with the previous subsection, online Appendix Table A11 shows that the positive interaction between decentralization and product churn is driven primarily by the sales and marketing and product introduction questions.

[48] According to the Bureau of Economic Analysis, over 90 percent of US manufacturing output goes to the manufacturing sector, which will be primarily business-to-business transactions. This will be similar in Europe, which like the United States has a higher-end manufacturing sector focused more at business consumers (Chinese manufacturing output, in contrast, is more consumer focused).

Table 6—Placebo Test

Dependent Variable:	Sales Growth			TFP Growth		
Sample	Year $\leq$ 2005 (1)	Year $\geq$ 2006 (2)	All (3)	Year $\leq$ 2005 (4)	Year $\geq$ 2006 (5)	All (6)
Decentralization	0.221	0.041	0.365	−0.117	−0.263	0.038
	(0.334)	(0.417)	(0.310)	(0.306)	(0.357)	(0.262)
Decentralization × EXPORT Growth	0.005	−0.047	0.004	0.004	−0.033	0.004
	(0.017)	(0.018)	(0.015)	(0.015)	(0.013)	(0.012)
POST × EXPORT Growth			0.089			0.115
			(0.024)			(0.021)
POST × Decentralization			−0.389			−0.387
			(0.427)			(0.350)
POST × Decentralization × EXPORT Growth			−0.052			−0.036
			(0.019)			(0.016)
Firms	1,080	1,330	1,330	991	1,211	1,211
Observations	3,664	3,151	6,815	3,265	2,839	6,104
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm and plant employment, skills	Yes	Yes	Yes	Yes	Yes	Yes
Industry-by-country dummies	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	SIC3×Cty	SIC3×Cty	SIC3×Cty	SIC3×Cty	SIC3×Cty	SIC3×Cty

Notes: WMS sample. Estimated by OLS with standard errors clustered at three-digit industry-by-country level. Sales growth is the annualized three-year change of firm ln(sales). TFP growth is the same as sales growth except we include the growth of employment, capital, and materials on the right-hand side of the regression. For columns 2 and 5, we use long differences 2011–2008, 2010–2007, and 2009–2006, and in columns 1 and 4 we use long differences 2008–2005, 2007–2004, 2006–2003, and 2005–2002. Columns 3 and 6 pool all these long differences together. "POST" is a dummy taking value 1 in all years after 2006 included. Firm and plant employment are measured in 2006. "EXPORT Growth" is change in ln(exports) in country-by-three-digit-industry cell between the 2008 and 2009 average (the main Great Recession years) compared to the 2006 and 2007 average (the latest pre-Recession years). Baseline controls are year dummies and "noise controls" (plant manager's tenure and hierarchical seniority and the interview's reliability score, day of the week and duration, and analyst dummies). Firm and plant employment are measured as log(employment), and skills are measured as ln(percent of employees with a college degree).

and firm decentralization. As shown in Figure 2, the raw data suggest that the differentials in performance between decentralized and centralized firms are confined to the Great Recession. To further probe this result, we examine the relationship between sales growth and the *Decentralization* × *SHOCK* interaction in a sample including years *preceding* the Great Recession in Table 6. Finding the same results in this period would raise the concern that the *SHOCK* dummy captures unobserved industry heterogeneity unrelated to the Great Recession such that decentralized firms always did better in certain sectors. Thus, we regard this as a placebo test. We look again at three-year differences in growth but instead pool across the three-year differences 2008–2005, 2007–2004, 2006–2003, and 2005–2002 to define the prerecession growth rates (in column 1 labeled "year $\leq$ 2005") and 2011–2008, 2010–2007, and 2009–2006 (as in the earlier tables) to define the postrecession years (column 2). Column 1 shows that the coefficient on *Decentralization* × *SHOCK* is actually positive, although insignificant, in the years preceding the Great Recession. Column 2 repeats the results of the specification of Table 2, column 3. Column 3 repeats the regression on the pooled precrisis and postcrisis samples of the first two columns and includes a full set of interactions with a dummy indicator taking a value of one for all crisis years (the three-year differences from 2009–2006 and later) to estimate a "differences in differences in differences" specification. The coefficient on the triple interaction $POST2006 \times Decentralization \times SHOCK$ interaction is negative and significant, which implies that the effect of decentralization in industries hit by the Great Recession is arising entirely from the Great Recession years. We repeated the same analysis on productivity with very similar results in the last three columns.[49]

Validity of Exports as a Shock Measure.—We have argued that trade changes are an attractive indicator of the Great Recession shock as they are more likely to reflect what is happening to demand in world markets than to be a reflection of country- and industry-specific supply factors. As a further check, we estimated our models separately for exporting establishments versus nonexporting establishments, using the MOPS data (export data are not items required in the company accounts data). As expected, the results are driven by the exporting plants who are most directly exposed to trade shocks.[50]

Asymmetries.—We investigated whether a negative shock differed from a positive shock by allowing different coefficients on positive than negative shocks (defined either as positive export growth or export growth above/below the median value). In all cases, we found we could not reject symmetry. This is unsurprising since in the Great Recession period, most firms were experiencing various degrees of a negative shock.

An Alternative Instrumental Variable.—An alternative exogenous shifter of the shock measure is to construct a Bartik-style IV where we predict the change in exports from an industry-country pair (see Mayer, Melitz, and Ottaviano 2016). We constructed this for every HS six-digit commodity in a country by interacting the lagged (i.e., built using 2006/2007 data) export share of the commodity from country r to a partner country p with the partner country's growth in imports (of that commodity) between 2006/2007 and 2008/2009 from all countries except country r. Summing this across all partner countries and then aggregating to the three-digit industry level gives an IV for the export shock. The results from using this Bartik IV are very similar to those shown in Table 2.[51]

Including Firm Fixed Effects.—In the MOPS data, we can implement a particularly tough test. Since we measure decentralization in multiple plants *within* the same firm, for multiplant firms, we are able to include an interaction between the

[49] We also checked that the results presented in online Appendix Tables A5 and A7 using the WMS sample are robust to using the placebo specification presented in Table 6. Furthermore, the results in the DDD specification are robust to the inclusion of firm fixed effects (results available upon request).

[50] For example, using the baseline MOPS specification in Table 2, column 5, we estimate a coefficient (standard error) of −0.036 (0.012) on the $Decentralization \times SHOCK$ variable for the exporters (4,200 observations) and −0.011 (0.012) for the nonexporters. These results are shown in online Appendix Table A13.

[51] For example, the IV coefficient (standard error) on the interaction of export growth and decentralization is −0.065 (0.029) using the Bartik IV. This is similar with the OLS estimate of −0.047 (0.018) in column 3 of Table 2. The first stage is strong, with an F-statistic of 29.5.

Great Recession indicator and average *firm* decentralization.[52] This means that the coefficient on the *Decentralization* $\times$ *SHOCK* interaction is identified solely off differences in decentralization across plants within the same firm. Remarkably, the results remain significant even in the presence of the firm level of decentralization and its interaction with export growth (coefficient of -0.023 and standard error of 0.010).

Other Industry Characteristics.—A further concern is that the *SHOCK* measure could be reflecting other industry characteristics rather than the demand fall. In online Appendix Table A10, we show that our key interaction is robust to including interactions of decentralization with a number of other industry characteristics such as asset tangibility, inventories, dependency on external finance, and labor costs. The key interaction is also robust to including other interactions such as firm age, plant age, and the financial health.

V. Conclusion

Are decentralized firms more resilient to large negative shocks? On the one hand, a shock like the Great Recession or the Pandemic may reduce the congruence between the CEO and the plant manager, thus making centralized firms more resilient (the "centralist" view). On the other hand, recessions are associated with greater turbulence, making the plant manager's local information more valuable, which would imply that decentralized firms will perform relatively better in unexpected downturns (the "localist" view).

To investigate these issues empirically, we collected new data on a panel of firms in ten OECD countries (WMS), and plants in the United States (MOPS) and exploited the negative shock of the Great Recession, which reduced demand across industries and countries in heterogeneous ways. Using our prerecession data on decentralization, we find that negative shocks hurt growth in centralized firms and establishments significantly more than in their decentralized counterparts. This is true whether we use export shocks which vary at the industry-by-country (WMS) or establishment (MOPS) level, or exogenous predictors of these negative shocks such as product durability. Further, as the localist view suggests, this effect is driven by the industries which experienced a greater increase in the turbulence (as measured by product churn and stock market volatility) that accompanied the crisis. Potentially, the fact that the United States has relatively more decentralized (and therefore flexible) firms meant that it could weather the global economic storm better than many more centralized countries (e.g., in Southern Europe).

We see our paper as a first attempt to unravel the relationship between growth and the internal organization of firms using micro data with observable measures of decentralization. There are many directions to take the research. First, we need to look at the ways in which, in the longer run, firms change their organizational forms. For example, as the effects of the Great Recession receded, how did the

[52] Bloom et al. (2019) show there is considerable variation in organization within firms across plants at a point in time.

growth effects and degree of decentralization change? Second, we would like to go deeper into the relation between the debt structure of companies (and so their bankruptcy risk) and the incentives for firms to change. Finally, it would be valuable to examine the macroeconomic implications of our modeling framework in more detail. Do the effects we identify matter in terms of thinking about business cycles and how economies and companies can be resilient to these adverse events?

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