Turbulence and Decentralization in Bad Times (Preliminary and Incomplete)

Philippe Aghion*, Nicholas Bloom†, Brian Lucking‡, Raffaella Sadun§and John Van Reenen¶

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Abstract

What is the optimal form of firm organization in "bad times"? Using original international datasets we find that firms that decentralized power from the Central Head Quarters to local plant managers prior to the Great Recession out-performed their centralized counterparts in sectors that were hardest hit by the subsequent crisis. We present a model where higher turbulence benefits decentralized firms because the value of local information and urgent action increases. Since turbulence is higher in downturns, decentralized firms do relatively better. Measuring turbulence by a new measure of product churn built from the Economic Census, we show that the data support our model over alternative explanations (such as recession-induced reduction in agency costs and co-ordination costs).

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*Harvard University, NBER and CEPR

†Stanford University, Center for Economic Performance, NBER and CEPR

‡Stanford University.

§Harvard University, Center for Economic Performance, CEPR and NBER

¶London School of Economics, Centre for Economic Performance, NBER and CEPR

1 Introduction

A long-standing question in economics is how does the internal organization of firms influence their response to macro shocks? A large recent literature has focused on firms' financial conditions and technology, but much less is know about the role of firm organization. This paper focuses on how a specific organizational aspect of a firm - the extent to which decision making is decentralized down from head quarters to plant managers - affects performance during a crisis. This has particular relevance following the Great Recession, which generated a debate over how best to "organize for recovery and survival". One common argument was that centralized firms were best equipped to survive the recession because of the importance of cost cutting which, because of conflicting interests within the firm, is best directed from corporate headquarters.[1] An alternative view is that recessions are periods of rapid change, and being decentralized allows the necessary flexibility to respond to turbulent business.[2]

To investigate these issues, we build two new panel datasets with explicit measure of decentralization measured prior to the Great Recession. One has firm-level data across ten countries (France, Germany, Greece, Italy, Japan, Poland, Portugal Sweden, the UK and US), the World Management Survey (WMS). The other is a larger plant-level dataset we constructed in partnership with the US Census, the Management and Organizational Practices Survey (MOPS). We combine these with performance data pre and post the 2008-2009 crisis.

We find compelling evidence that in sectors that were exogenously hit harder by the crisis decentralized firms outperform their centralized rivals in terms of survival, sales, TFP and profits growth. We use both export data in the industry by country cell and a pre-recession measure of product durability to measure the shock (as consumers can postpone purchases, durable industries suffer more in recessions). These findings are robust to placebo tests, a wide range of controls and an IV strategy exploiting the fact that trust around the headquarters predicts whether a firm decentralizes (see Bloom, Sadun and Van Reenen, 2012).

[1] For example, the Economist Intelligence Unit (June 2009) wrote: "Firms should be centralising 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." See also http://www.cimaglobal.com/Thought-leadership/Newsletters/Regional/The-CIMA-Edge-South-Asia-and-Middle-East/20111/May–June-2011/Centralised-decentralised-and-shared-services-a-comparison/.

[2] For example, the Economist Intelligence Unit in August 2009 wrote: "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." See also http://graphics.eiu.com/marketing/pdf/SAS_DecisionMaking.pdf

In order to understand this stylized empirical fact we develop a model of firm decision making building on the Aghion and Tirole (1997) paradigm. The model generates the prediction that recessions make decentralization more efficient by enabling firms to better adapt to the turbulent business environment. It is part of a wide class of models where higher turbulence and uncertainty increase the value of local knowledge and increase the benefits of decentralization.

Consistent with our model, we show that the empirical results are driven by the fact that the industries which had the most severe downturns during the Great Recessions also had the largest increase in turbulence, as measured by product churn. This novel industry level measure of product churn is the rate of new product additions and subtractions built from the Census of Manufacturing micro-data. As shown in Bernard and Okubo (2015), product churn rises sharply during recessions - in a crisis firms both destroy more existing products and also create more new products.[3] Decentralization did not significantly protect firms from the downturn in industries which had a bad shock, but no increase in product churn. Alternative explanations of our results based on reduced agency problems, lower coordination costs, omitted variables and other factors do not seem so consistent with our findings.

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, growth.

Our paper builds on an extensive prior literature. On the theory side, our paper relates to the literature on decentralization (see Gibbons, Matouscheck and Roberts, 2013 for a survey) and incomplete contracts (see Aghion, Bloom and Van Reenen, 2014, for a survey). In particular, Hart and Moore (2005) analyze the optimal allocation of authority in multi-layer hierarchies. More recently, 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.[4]

Our paper also relates to the existing empirical literature on decentralization and its determinants. For example, Rajan and Wulf (2006) document the evolution towards flatter organizations in the US between 1986 and 1999. Caroli and Van Reenen (2001) and also Bresnahan, Brynjolfsson

[3] Bloom et al (2014) show a large variety of datasets that suggest that turbulence and uncertainty rise in downturns.

[4] In contrast to Aghion and Tirole (1997), there is no information acquisition effort by the agent or the principal, therefore in Dessein's model the allocation of authority is not so much a tool to motivate the agent (as in Aghion and Tirole) or give a supplier incentives to make relationship specific investments (as in Grossman and Hart, 1986). The main insight in Dessein (2002) is that in a world with asymmetric information and contractual incompleteness, the delegation of authority from a Principal to an Agent is often the best way to elicit the agent's private information.

and Hitt (2002) point at positive correlations between decentralization and both human capital and information technology. Guadalupe and Wulf (2009) argue that the Canadian-US Free Trade Agreement (FTA) in 1989 constitutes an exogenous increase in competition for US firms in the industries where tariffs were removed. Exploiting this policy experiment they find that competition is associated with delayering (increasing span for CEO) and that this is likely to also reflect increased delegation. 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 or where the firm is closer to the performance frontier - so that learning is more limited - decision making control should be more decentralized. This prediction is confirmed in French and British firm level panel data. But none of these papers looks at the interplay between firm decentralization, negative shocks and turbulence.

The paper is organized as follows. Section 2 presents the data and methodology. Section 3 establishes our main empirical finding that in times of crisis decentralized firms out-perform their centralized counterparts. Section 4 develops a theoretical model which is consistent with this finding and Section 5 tests the additional predictions of the model. Section 6 explores the validity of the main results to alternative explanations and Section 7 concludes.

2 Data description and measurement

We start by describing in some detail our decentralization data since this involved an extensive new survey process. We then describe the accounting data matched with the survey-based measures of decentralization and the proxies measuring the severity of the Great Recession and the novel industry level measures of product churn.

2.1 Decentralization

2.1.1 Cross-country data - World Management Survey

The cross country decentralization data was collected in the context of the World Management Survey (WMS), a large scale project aimed at collecting high quality data on management and organizational design across firms around the world. The survey is conducted through an in-depth interview with a plant manager in medium sized manufacturing firms, excluding those where the CEO and the plant manager is the same person (this occurred in under 5% of our interviews).

We asked four questions on decentralization from the Central Head Quarters 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. We also inquired on where decisions were effectively made in three other dimensions: (a) the introduction of a new product, (b) sales and marketing decisions and (c) 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 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 converted 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).

To achieve unbiased survey responses to our questions we took 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]) (see question is Table A1). Second, the interviewers did not know anything about the firm's financial information or performance in advance of the interview. 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). 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 manufacturing firms (the median size was 250 employees) are too small to attract much coverage from the business media. Third, each interviewer ran 85 interviews on average, allowing us to remove interviewer fixed effects from all empirical specifications. This helps to ad-

dress concerns over inconsistent interpretation of categorical responses, standardizing the scoring system. Fourth, we collected a detailed set of information on the interview process itself (number and type of prior contacts before obtaining the interviews, duration, local time-of-day, date and day-of-the week), on the manager (gender, seniority, nationality, company and job tenure, internal and external employment experience, and location), and on the interviewer (we can include individual interviewer-fixed effects, time-of-day, and subjective reliability score). These survey metrics are used as "noise controls" to help reduce residual variation.

In analyzing organizational and management surveys across countries we also have to be extremely careful to ensure comparability of responses. One step was the team all operated from two large survey rooms in the London School of Economics. Every interviewer also had the same initial three days of interview training, which provided three "calibration" exercises, where the group would all score a role-played interview and then discuss scoring together of each question. This continued throughout the survey, with one calibration exercise every Friday afternoon as part of the weekly group training sessions. Finally, the analysts interviewed firms in multiple countries since they all spoke their native language plus English, so interviewers were able to interview firms from their own country plus the UK and US, enabling us to remove interviewer fixed effects.

Since our aim is to compare across countries, we decided to focus on the manufacturing sector where productivity is easier to measure than in the non-manufacturing sector. We also focused on medium sized firms, selecting a sample of firms with between 100 and 5,000 workers. Very small firms have little publicly available data. Very large firms are likely to be more heterogeneous across plants. We drew a sampling frame from each country to be representative of medium sized manufacturing firms and then randomly chose the order of which firms to contact (see Appendix B for details).

Each interview took on average 48 minutes and was run in the summer of 2006. We achieved a 45% response rate, which is very high for company surveys because the interview did not discuss firm's finances (we can obtain these externally), we had the written endorsement of many official institutions like the Bundesbank, Treasury and World Bank, and we hired high quality MBA-type students.[5]

[5] As a check of potential survey bias and measurement error we performed repeat interviews on 72 firms, contacting different managers in different plants at the same firm, using different interviewers. To the extent that our organizational measure is truly picking up company-wide practices these two scores should be correlated, while to the extent the measure is driven by noise the measures should be independent. The correlation of the first interview against the second interviews was 0.513 (p-value of 0.000), with no obvious (or statistically significant) relationship

Table 1, panel I contains some descriptive statistics from our WMS data, including that our average firm has 570 employees and about $180m of sales.

2.1.2 U.S. Census data - MOPS

The 2010 Management and Organizational Practices Survey (MOPS) was jointly funded by the Census Bureau and the National Science Foundation as a supplement to the Annual Survey of Manufactures (ASM). It was designed based on the World Management Survey and was mailed to the establishment plant manager (see Bloom et al. 2016). The survey contained six questions on organizational practices modeled on the World Management Survey. Four of these MOPs questions cover the same domains - autonomy in: (a) capital investments, (b) hiring of full time employees, (c) product introduction and (d) sales and marketing - with two additional question in MOPS on autonomy in: (e) pay increases of at least 10%, and (f) 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 five choices for the question on autonomy in capital investments, starting with "Under 1000" (coded as 1) up until "1 million or more" (coded as 5). Each of these six questions was then z-scored[6], and then averaged, and then z-scored again. The survey also included the management questions described in Bloom and Van Reenen (2007), and some background questions on the establishment and respondent.[7]

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%. The Organization Module of MOPS is only for plants where headquarters in not on site - plants with HQ 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 about 8,700 plants. Table A2 shows how our various samples are derived from the universe of establishments, while Table 1, Panel II provides some descriptive statistics on the data and the sample (which has a mean

between the degree of measurement error and the decentralization score. That is to say, firms that reported very low or high decentralization scores in one plant appeared to be genuinely very centralized or decentralized in their other plants, rather than extreme draws of sampling measurement error.

[6] Normalized to mean 0 and standard-deviation 1.

[7] The full questionnaire is available on http://www.census.gov/mcd/mops/how_the_data_are_collected/MP-10002_16NOV10.pdf.

employment size of 250 which is very similar to the WMS sample).

2.2 Accounting data

2.2.1 Cross-country WMS data

We build firm level measures of sales, employment, capital, profits and materials using accounting data extracted from Bureau Van Dijk's ORBIS. These are electronic versions of company accounts covering close to the population of private and publicly listed firms. In our baseline specifications we estimate in three-year (annualized) growth rates. We are able to build firm level measure of sales growth for at least one year for 1,330 out of the 2,351 firms with decentralization data in 2006.[8] Table 1 shows the basic summary statistics for the accounting data of the firms included in our sample. On average, firm level sales declined by 6% in the time period 2006-2011 for the firms included in our sample.

2.2.2 U.S. MOPS data

In addition to our decentralization data we also use data from other Census and non-Census data sets 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. As described in detail in the Appendix, we also combine capital stock data from the Census of Manufactures (CM) with investment data from the ASM and apply perpetual inventory method to construct capital stocks at the establishment level which we use to create measures of total factor productivity. Finally, for profitability, we use profits as a percent of capital stock, with profits defined as sales less total salaries and wages, material costs, and rental expenses.

2.3 Measuring the Great Recession

Our baseline measure of the intensity of impact of the Great Recession ("SHOCK") on an industry-by-country cell 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 its original six-digit product level

[8] The vast majority of firms without any sales data are located in the US (348 firms) and India (369 firms), where the reporting requirements for privately listed firms are weak.

to three-digit US SIC-1987 level using the Pierce and Schott (2010) concordance.[9] We deflate the industry and country specific export value series by a country and year specific CPI from the OECD to measure "real exports."

Figure A1 shows the evolution of annualized export growth in the years preceding and during Great Recession using industry level data for all countries (for a total of 5,641 manufacturing sectors by country cells). Exports were growing by about 13% in 2007 and 9% in 2008, and experienced a dramatic fall (-20%) 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 2006/2007 (pre-recession) and 2008/09 (in-recession) levels and calculating log growth rates between the two sub-periods for each 3-digit industry by country cell.[10]

Since recessions typically have a greater impact on reducing the expenditure on durable versus non-durable goods (e.g. King and Rebelo, 1989) we use as an alternative variable to capture the intensity of the Great Recession shock which is the average durability of the goods produced in the industry, drawn from Ramey and Nekarta (2013). As a cross-sectional measure this is simply used at the 4-digit industry level, and is a continuous measure.[11]

Table 1, Panels I and II shows the basic summary statistics of these shock measures for the cross country and the U.S. only sample. On average, exports fell in 51% of the industries in the sample. While the average growth rate of real exports across the whole sample is 0.4%, the data shows considerable variation both within and across countries.

2.4 Measuring changes in product churn

In the latter part of our empirical analysis, we also include changes in product churn in recession versus non recession years as a proxy for increases in market turbulence. Product churn is measured using data from the US Census Bureau's Census of Manufactures (CM). The CM, which is conducted in years ending in 2 and 7, asks establishments to list the dollar value of annual shipments by 10-digit product code. Establishments receive a list of all the product codes typically produced by establishments in their industry, along with corresponding descriptions of each code. There is

[9] A second proxy is the change in industry by country sales derived from the aggregating firm accounts extracted from ORBIS, since ORBIS represents a close to a full coverage of the population of firms in each country (see Appendix A).

[10] We also show 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.

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

also space on the form in which establishments which produce products not listed on the form are instructed to write in the appropriate product code.

We then measure the amount of product churn at the establishment 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:

$$\text{Product Churn}_{i,t} = \frac{\#\text{ Products Added}_{i,t} + \#\text{ Products Dropped}_{i,t}}{0.5\,(\#\text{ Products}_{i,t} + \#\text{ Products}_{i,t-5})} \tag{1}$$

Our measure of industry product churn is the average establishment-level product churn amongst establishments within an industry (three digit US SIC-1987) which produce at least 3 products. We restrict attention to establishments with at least 3 products in order to reduce measurement error from product code misreporting.[12] 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).

Note that the measure is based on establishments who survived between Census years. We also constructed an alternative measure that included establishments who died and entered between Census years in the construction of equation (1). In the robustness tests we report how this broader measure led to similar results.

3 Main results

3.1 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 U.S. MOPS data. Panel A shows the average 3 year growth rate in sales for all firms included in the WMS decentralization sample computed using data from 2006, 2007 and 2008 (hence, averaging across three different growth rates: 2006-2009,

[12] 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 1 or 2 products, for whom a single reporting mistake would result in very high measured product churn. Our results are robust to using industries with plants with a lower cut-off of 2 or more products or a higher cut-off of 5 or more products.

2007-2010 and 2008-2011). These are all years covering the Great Recession.[13] Panel B shows the average 3 year growth rate in sales for all firms included in the MOPS decentralization sample computed using data only from 2006 (the 2006-2009 growth rate). We exclude the 2007-2010 and 2008-2011 periods from the MOPS sample because the recession was over in the US in 2010.

The sample is subdivided in four categories of firms. First, we split firms according to whether they experienced a drop in exports in an industry by country cell in 2008/09 (the main Great Recession years) compared to 2006/07 (the latest pre-recession years). Second, we split firms by above/below the median level of decentralization measured before the advent of the Great Recession.[14] Not surprisingly, all our groupings of firms experienced a drop in average sales after the Great Recession. Furthermore, the drop in sales is clearly (and significantly) larger for firms classified in industries experiencing a decline in exports (compare the two bars on the right with the two on the left). However, within the 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, within firms experiencing a decline in industry exports, decentralized firms had a 8.2% fall in sales compared to about 11.8% in the centralized firms, for a difference of 3.6 percentage points which is significant at the 5% level (compared to an insignificant difference of -0.1% in industries that did not experienced a shock). In the MOPS sample, the difference in differences is even larger at 9 percentage points, also significant at the 5% level.

The basic finding emerging from the raw data is that in the decentralization was associated with better performance for firms facing the toughest environment during the crisis. We now turn to more formal tests of this basic result using alternative measurement strategies and controls for many other firm and industry factors.

3.2 Baseline regression equation

Our baseline specification is:

$$\Delta \ln Y_{ijct} = \alpha DEC_{i0} + \beta(DEC_{i0} * SHOCK_{jc}) + \gamma SHOCK_{jc} + \delta x_{i0} + \theta_c + \phi_j + \tau_t + \varepsilon_{icjt} \quad (2)$$

[13] Arguably, the recession began in 2008 and was over by 2011, so we also test the robustness of the results to dropping the 2008-2011 period. One could argue that the 2007-2010 period should also be dropped as the recession was officially over in the US in 2010. However, in Europe (where most of our WMS data is from) the recession remained severe due to the Eurozone crisis and tough austerity policies.

[14] The precise pre-recession year is 2006 for WMS firms and 2005 for MOPS firms.

where $\Delta \ln Y_{ijct}$ is the growth rate: the three year change in real ln(sales) for firm (or plant) i in industry j in country c in end-year t (for the long differences we are using the three overlapping time periods as discussed above). DEC_{i0} is firm i's level of decentralization (measured in the initial year of 2006 for WMS and 2005 for MOPS); $SHOCK_{jk}$ is our measure of the severity of the shock of recession in the industry-country cell; x_{i0} is a set of firm level controls also measured pre-recession (such as firm size and the proportion of college-educated employees); θ_c are country dummies, ϕ_j are industry dummies, τ_t are year dummies and ε_{icjt} and 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 do relatively better in bad times. When we use durability as a measure of the magnitude of the shock the hypothesis is that $\beta > 0$, as the more durable goods industries are expected to have the largest fall in demand.

The underlying identification assumption in equation (2) is that in the pre-Great Recession period firms were in an equilibrium where they had adopted their optimal degree of decentralization (DEC_{i0}) based on their environment. The $SHOCK_{jk}$ associated with the Great Recession was unexpected and since organizational form is subject to large adjustment costs (see Bloom, Sadun and Van Reenen, 2016, for evidence of this), firms cannot immediately respond by changing to the optimal form of organization (i.e. more decentralized) in the new environment. Thus, DEC_{i0} can be considered weakly exogenous in equation (2) and we would expect decentralized firms to be at a relative advantage to their more centralized counterparts. We consider potential violations of these assumptions below (e.g. in sub-section 3.4), such as the presence of other unobservable correlated with DEC_{i0} that could cause firms to out-perform in bad times.

3.3 Baseline results

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 industry dummies. A one percent increase in industry exports is associated with a weakly significant 0.07 percentage point increase in sales growth. We also find a positive and significant association between sales growth and 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% a year to 2.6% a year). In column (2) we introduce an interaction term between decentralization and the export shock variable. The interaction term is negative and significant (0.041 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 grew no faster or slower in those sectors that had zero export growth.

Panel A of Figure 2 shows the implied marginal effect of decentralization on sales growth as a function of export growth. These 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 a growth in industry exports below 8%. This corresponds to two-thirds of the WMS sample in the post recession period, but only 12% of firms in the pre-recession periods (see Panel B of Figure 2). In other words, the positive association between decentralization and growth appear to be contingent on the macroeconomic context, which may be one of the possible reasons for the heterogeneous levels of decentralization observed in 2006.[15]

The recession measure is industry and country specific. Therefore, in column (3) of Table 2 we include a full set of industry by country dummies, as well as a set of other firm controls (dated in 2006). The linear export shock is absorbed by the industry dummies, but we can still identify the interaction of the shock with firm decentralization. Even in this demanding specification, the interaction remains negative and significant, with a very similar magnitude to the previous column.

A possible concern with the estimates is that the SHOCK variable uses information dates over the same period as the dependent variable (2008 and 2009), which may give raise 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). Consistent with the earlier results, the interaction between decentralization and the SHOCK is positive (since more durable industries experienced greater drops in demand after during the recession) and significant.[16] Columns (5) and (6) repeat the specifications of

[15] In other work done using the WMS data (Bloom, Sadun and Van Reenen, 2012) we discuss other drivers of cross country and cross regional differences in decentralization across firms, focusing in particular on cultural factors. We exploit this source of variation in an instrumental variable approach discussed below.

[16] The specification in column (4) 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*durability to instrument for SHOCK*durability

columns (3) and (4) using the MOPS sample. The results obtained in this larger cross section of US plants are qualitatively similar to the ones reported using the cross country WMS data.[17]

The results discussed so far suggest the presence of a positive relationship between firm sales growth and decentralization in the aftermath of the Great Recession. In Table 3 we explore whether this relationship persists even when we examine a "Total Factor Productivity specification", i.e. we estimate our baseline econometric model 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 may fare better on protecting revenue during downturns, they will do worse in terms of productivity. 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). Column (1) reports the baseline results on the subsample of firms with TFP data, while column (2) reports the TFP results. Column (2) shows that, in fact, decentralization is also significantly and positively associated with an increase in TFP during a crisis.[18] Column (3) uses profits as the dependent variable and also finds a negative coefficient on the interaction although it is not significant at conventional levels. Column (4) investigates whether the positive association also extends to the extensive margin of adjustment, using an exit regression. The dependent variable is a dummy taking the value of one if the firm exited the sample between 2007 and 2011 and zero otherwise (the regression is estimated by OLS as a linear probability model). This shows that more decentralized firms also had a significantly lower probability of exit in industries worse hit by the crisis. Columns (5) though (7) repeat the analysis using the MOPS data, and finds a negative and significant coefficient on the interaction term between decentralization and the shock for sales, TFP and profits growth.[19]

in a 2SLS specification on the sample sample of column (4), we obtain a coefficient on the SHOCK*durability measure of 9.39, standard error 3.86.

[17] The marginal effects on the interaction term is larger in MOPS than WMS, but the difference is not so great as a standard deviation increase in export growth in MOPS is smaller (14) than in WMS (21). For example in column (5) the marginal effect of a one standard devation increase in decentralization (1 in both samples) and a one standard devation increase in exports is 0.94 (= 0.047*20) in WMS compared to 1.35 (= 0.0966*14) in MOPS.

[18] 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 towards zero.

[19] We have no exit data for MOPS as the survey was run in 2010 after the Great Recession, with our results using

3.4 Identification and robustness

One major concern with the results is that our decentralization results are picking up reverse causality, long-run trends or proxying for some unobserved variable. To address these concerns we take several steps.

Triple Differences First, we address the concern that the decentralization*SHOCK interaction may simply be picking up some other time-invariant industry characteristics associated with the magnitude of the recession and firm organization. To allay this concern, we examine the relationship between sales growth and the decentralization*SHOCK interactions in a sample including years *preceding* the Great Recession in Table 4. Finding the same results in this period would raise the concern that the SHOCK dummy could capture unobserved industry heterogeneity unrelated to the Great Recession, so we regard this as a placebo test. We look again at three year differences in growth but use the periods 2002-2005, 2003-2006, 2004-2007 and 2005-2008, all non-recession years, to define the pre-recession growth rates, and 2006-2009, 2007-2010 and 2008-2011 (as in the earlier tables) to define the post-recession years. Column (1) shows that the decentralization*SHOCK coefficient is actually positive, although insignificant, in the years preceding the Great Recession. Column (2) repeats the results of the specification of Table 2, column (4). Column (3) repeats the regression on the pooled pre and post crisis sample, and includes a full set of interactions with a dummy indicator taking value one for all crisis years (the three differences beginning in 2006 and afterward) to estimate a kind of "differences in differences in differences" specification. The coefficient on the triple interaction POST2006*decentralization*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 TFP with very similar results (see columns (4) to (6)).

Instrumental variables As a second way approach to investigating whether it is really decentralization (or a correlated unobservable) responsible for superior performance in bad times we considered an instrumental variable (IV) strategy. A potential IV is regional variations in trust around the firm's Head Quarters. Bloom, Sadun and Van Reenen (2012) showing that variations in trust is strongly predictive for decentralization and this relationship is likely to be causal. Trust

the 2005 recall question on decentralization.

is measured from the World Values Survey and is calculated as the share of individuals agreeing with the statement that "Generally speaking, people can be trusted". Trust can have a direct effect on performance in our context, but we require a stronger assumption than in Bloom et al (2012) such that trust only influences a firm's performance differentially in bad times through a firm's organizational structure. In column (1) of Table 5 we report the OLS results in the IV subsample, showing the standard negative interaction between decentralization and the shock. In column (2) we report the reduced form showing a strong negative interaction - high trust (and hence high decentralization) regions have firms that are less impacts by export shocks. Finally, in columns (3) to (5) we report the two first-stages and the second stage, finding in our familiar result that decentralization reduces the impact of export shocks on firms, protecting them from negative export shocks.

Other factors We also explored the robustness of our results to a series of tests related to unobserved firm and industry level heterogeneity. First, in Tables A3 and A4 we investigated whether the decentralization*SHOCK interaction captures the relevance of other firm level characteristics different from decentralization, augmenting the specification of column (3) in Table 2 with interactions terms between the Great Recession indicator and a series of additional firm level controls. These included the overall management quality of the firm, the pre-recession size of the firm, skills, and various other firm-level and plant manager characteristics. In all instances, these additional interaction terms were usually insignificant and did not alter the overall magnitude and significance of the decentralization*SHOCK interaction in both the WMS and the MOPS data. We also tested whether the SHOCK measure could be reflecting other industry characteristics rather than the demand fall. In Appendix Table A5 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.

4 A simple model

To understand what might underlie the stylized empirical finding that decentralized firms do better 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 information. Since there are agency problems between the CEO and plant manager, centralization may seem natural. But the plant manager is likely

to have better local information than the CEO which is a force for decentralization. When the environment becomes more turbulent, the CEO is even less well informed than in normal times. Therefore, the value of local information increases and decentralization becomes more valuable.

4.1 Basic set up

We consider a one-period model of a firm with one principal (the CEO/ Central Head Quarters) and one agent (the plant manager).[20] 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.[21] Taking an uninformed action involves potentially disastrous outcomes, thus only if at least one of the two parties is informed an action can be taken. 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 are "relevant", i.e. avoid negative payoffs to the parties. Among these two actions, one maximizes monetary profitability (or efficiency), one maximizes the agent's private utility. Other actions leads 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 (or monetary efficiency); this variable α captures the degree of congruence between the principal's 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; if preferences do not coincide, the action that maximizes the agent's private utility yields monetary payoff $B - k$ to the principal.

Informational assumptions: We assume that the principal acquires information about project payoffs with probability $p < 1$. On the other hand, the agent is assumed to be perfectly informed about the project payoffs.

Turbulence: Suppose that the principal gets an early signal of forthcoming performance, e.g. a current realization of income, and can then possibly decide to fire the agent if she believes that the signal is due to the agent's choosing a non-profit maximizing action. In the absence of turbulence,

[20] In the Appendix we also derive a continuous time version of the model. The two variants are very similar, except that in the basic model, uncertainty makes it harder for the principal to find out about the agent's action choice, whereas in the continuous time version of the model uncertainty makes it harder (it takes longer) for the principal to acquire the information about projects payoffs.

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

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.

Thus, suppose that current performance is given by

$$y = a + \varepsilon,$$

where $a \in \{a_1, a_2\}$ denotes the agent's action choice (think of the decision whether or not to introduce a new product[22]), with $a_1 < a_2$, and ε is a noise term uniformly distributed on the interval $[-u, u]$.

4.2 Solving the model

Suppose that the plant manager takes the non-profit maximizing action a_1 (think of it as a decision which delays the introduction of a new product). The CEO will infer the action choice from observing the signal realization:

$$y = a_1 + \varepsilon,$$

if and only if $y \in [a_1 - u, a_2 - u)$ and then can correct it if she has control rights, i.e. under centralization.

The probability of the CEO guessing the action choice is:

$$P(u) = \min\{\frac{a_2 - a_1}{2u}, 1\}. \tag{3}$$

Hence the probability that the profit-maximizing action will be taken eventually under centralization, is equal to:

$$\Omega(u) = \alpha + (1 - \alpha)P(u). \tag{4}$$

4.3 Centralization versus decentralization

The *ex ante* CEO's payoff under decentralization, is equal to:

$$\Pi^d = \alpha B.$$

The *ex ante* CEO's payoff under centralization (i.e. if the CEO delegates no authority to the plant manager), is equal to:

$$\Pi^c = \Omega(u)B + [1 - \Omega(u)](B - k) \tag{5}$$

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

Letting the relative value of decentralization be defined as:

$$\Delta\Pi = \Pi^d - \Pi^c,$$

our key result is that:

Proposition 1: $\frac{\partial \Delta\Pi}{\partial u} > 0$. *An increase in turbulence u will make decentralization more profitable,*

Proof.

$$\frac{\partial \Delta\Pi}{\partial u} = -\Omega'(u)B + \Omega'(u)(B-k) = -\Omega'(u)k$$

From equation (4) $\Omega'(u)k = (1-\alpha)kP'(u)$.So:

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

As equation (3) shows $P'(u) < 0$.

5 Testing the additional predictions of the model

5.1 Product churn and turbulence

We now examine the empirical validity of the additional predictions of the model by using cross-industry variations in the change in product churn after the Great Recession as a proxy for the increase in turbulence.

Before examining the relationship between sales growth, decentralization and turbolence (as measured by product churn), we first examined whether decentralization was greater in industries where turbulence was higher. Appendix Table A6 shows that this is indeed the case, and that the positive and significant relationship between decentralization and churn is stronger for decentralization specifically of decisions regarding product introduction and sales and marketing, as the theory would suggest. Furthermore, we checked whether product churn had indeed increased in industries that experienced a larger drop in exports during the Great Recession. This is also the case in the data, as shown in Appendix Figure A3.

To investigate the empirical validity of Proposition 1, we extend our basic equation (2) to include both the change in $CHURN$ and also its interaction with decentralization

$$\begin{aligned}\Delta \ln Y_{ijt} &= \alpha DEC_{i0} + \beta(DEC_{i0} * SHOCK_j) + \gamma SHOCK_j \\ &\quad + \eta \Delta CHURN_j + \mu\left(DEC_{i0} * \Delta CHURN_j\right) + \delta x_{i0} + \theta_c + \phi_j + \tau_t + \varepsilon_{icjt}\end{aligned} \tag{6}$$

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

Table 6 shows the results of estimating equation (6).[23] We begin in column (1), by estimating the specification in column (4) of Table 2 for the subset of firms 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 $DEC_{i0} * SHOCK_j$ is negative and statistically significant. Column (2) includes the $DEC_{io} * \Delta CHURN_j$ interaction instead of the $DEC_{i0} * SHOCK_j$ interaction. In line with the model's prediction, the coefficient on the interaction with changes in product churn is positive and significant, i.e. decentralization appears to have a positive association with sales growth 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 half in magnitude and is insignificant. Columns (4) to (6) repeat the same specifications, this time using durability as an alternative industry level proxy for the Great Recession. Even in this case, the interaction between decentralization and product churn appears with a positive and significant coefficient, and its inclusion reduces the magnitude of the coefficient on decentralization and average industry durability, driving it to insignificance.

5.2 Types of decentralization

As a second test of the model we looked at the different subquestions which form the overall decentralization index, as shown in Table 7. We start in column (1) by showing the baseline result of Table 2, column (4). In column (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

[23] Since we are measuring churn between 2007-2012 (our Manufacturing Census years) we use as our dependent variable the change in sales between 2007 and 2012, delivering a slightly smaller sample.

and budgetary 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 U.S. sample.[24] In both cases, the positive effect of decentralization in a crisis is primarily driven by the output related questions. This finding provides additional insight on the possible mechanism through which decentralization may positively affect firm performance during a downturn, namely the ability to better adapt to more turbulent demand conditions.

6 Alternative models and channels

6.1 Do bad times reduce the costs of decentralization?

The model in Section 4 suggests that bad times foster decentralization as the benefits have increased due to the greater importance of local information. We can extend the model to allow for another possible effect of bad times through reducing the costs of decentralization. The most straightforward way of doing this is to think of a bad shock is one which increases the opportunity cost k of not choosing the action which maximizes the principal's utility. We then immediately have from equation (5):

Proposition 2. $\frac{\partial \Delta \Pi}{\partial k} > 0$. *A bad shock which increases k, also increases the benefit from decentralization.*

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

The intuition behind proposition 2 is that the risk of bankruptcy rise in bad times, so the plant manager is more fearful of taking actions that give him private benefits but cost the firm some profits, as he may lose her job. Hence, bad times may effectively reduce the agency problem and so make decentralization less costly. For firms facing increased bankruptcy risk, we would expect the benefits of decentralization to be higher.[25]

The results of Table 7 are not so easy to rationalize in this type of model, but we consider some direct tests. In particular we examine environments where the risk of bankruptcy was higher.

[24] In the U.S. sample we have 3 questions capturing plant manager decentralization for hiring and budgetary decisions in column (5) and 3 capturing plant manager decentralization for sales and marketing and product introduction in column (6).

[25] Moreover, note that an increase in turbulence u will make $\frac{\partial \Delta \Pi}{\partial k}$ become more positive since $\Omega'(u) < 0$. In contrast, an increase in congruence between the principal's and the agent's preferences will make $\frac{\partial \Delta \Pi}{\partial k}$ become less positive since:

$$\frac{d\Omega(u)}{d\alpha} = 1 - P(u) > 0.$$

We constructed a large number of indicators of increased bankruptcy risk, but we found that when we interacted these with decentralization these were not significant in the firm performance regression. For example, we used the measures of exogenous increases in exposure to financial crisis exploited by Chodorow-Reich (2014) such as a firm's pre-existing relationship with Lehman Brothers, similar "at-risk" banks and exposure to Mortgage-backed securities. We also used more conventional measures such as leverage ratios. In no case were interactions of decentralization with changes (or levels) of bankruptcy risk significant when included in equation (2),

6.2 The role of coordination

When there are large externalities between different plants belonging to the same firm, decentralization is likely to be more costly. For example, coordinating prices and product decisions from the central headquarters is important if one plant's products cannibalize those of other plants. To examine whether our results may reflect the importance of differences in co-ordination in bad times, in Tables 8a and 8b we included interactions with many measures of co-ordination such as whether the firm was single plant (less need for co-ordination) or multi-plant; whether is was domestic or part of a multinational, whether the plants where in the same state, it's size and other proxies. In all cases the interactions were insignificant and the main interaction between decentralization and export growth remained significant.

6.3 Endogenizing decentralization

Recall that our identification assumption is that pre-recession 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 firm. A corollary of our theory, however, is that firms will start moving to a more decentralized form (to the extent that they have lower adjustment costs, higher costs from centralization and/or believe the shock is likely to be long-lasting). Hence, we should expect to see some increase in decentralization for firms more exposed to the shock.

Table A7 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. Nevertheless, in both WMS and MOPS we do see a significant and positive relationship between the size of negative shock and decentralization.

7 Conclusion

When does decentralizing power from the CEO to plant managers increase growth? We examine the responses of a panel of 1,300 firms in 10 OECD countries (WMS), and 8,700 US plants (MOPS) to the Great Recession which reduced demand across industries and countries in heterogeneous ways. Using pre-recession data on decentralization we find that negative demand shocks hurt firm growth in centralized firms significantly more than in their decentralized counterparts. This is true whether we use industry by country export shocks, or exogenous predictors of these like product durability. We consider a model where the CEO considers decentralizing product portfolio decisions to the plant manager. The increased turbulence that comes with bad times makes the importance of the plant manager's local information more valuable and so means decentralized firms will perform relatively better in unexpected downturns. Consistent with this model we show that the correlation between decentralization and performance during the crisis is stronger in industries which registered a greater increase in product churn, which is consistent with the idea that decentralization mattered the most in industries with greater increase in turbulence.

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. Many papers have speculated on this issue without a systematic theory linked to rich survey data. 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 recede, how will the 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 macro-economic implications of our modelling framework. 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?

8 References: Incomplete

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9 Appendix A: Data

[**** TO BE COMPLETED ****]

10 Appendix B: Model in continuous time

In this Appendix we derive the same predictions as in Section X using a continuous time delegation model. As in the model in the text, there are $n \geq 3$ possible actions (or projects) and at any point in time only two of them are "relevant", i.e. avoid highly negative payoffs to the parties. Among these two actions, one maximizes monetary profitability (or efficiency) and if that action is taken the principal gets current (ex post) utility B; on the other hand, if the agent's preferred action is taken and this action does not coincide with the principal's preferred action, the principal gets monetary payoff $B - k$. 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 (or monetary efficiency).

We denote by T the time horizon over which the payoff matrix - which describes the monetary and private payoffs from the n actions- remains constant. A lower T corresponds to a higher degree of "urgency". The agent has an informational advantage over the agent which we capture as follows. Once the payoff matrix changes the agent is informed at once about it (and information is soft). However, the principal takes time to learn the matrix: we denote by $F(\tau)$ the probability that the principal learn the payoff matrix by time $m\tau$, and $f(\tau)$ is the corresponding density distribution, where a higher m corresponds to higher uncertainty.

If the principal has control and gets the information about the payoff matrix at date t then the principal gets utility B flow from date t and until the termination date T. On the other hand at any time where the agent has control the principal gets an expected utility flow equal to αB.

The principal's problem consists in choosing an optimal stopping time $S \in [0, T]$ beyond which he will give up on acquiring the information about the payoff matrix and will instead defer the decision making process to the agent: as of time S production will start under the agent's control if by then the principal's investigation efforts have not paid out.

Thus, for given stopping rule S:

1. If the principal learns the payoff matrix before time S, then he gets flow utility B over the time interval $[t, T]$;

2. If by time S the principal has not learnt the payoff matrix, then the agent is in control and therefore the principal gets flow expected utility αB over the time interval $[S, T]$.

10.1 Solving the model

The optimal stopping rule maximizes firm profitability (i.e. firm performance) as measured by the expected monetary benefits:

$$\begin{aligned} EB &= B\int_0^{S/m}(\frac{e^{-rt}-e^{-rT}}{r})f(t)dt \\ &\quad +[B-(1-\alpha)k](1-F(S/m))(\frac{e^{-rS/m}-e^{-rT}}{r}) \end{aligned}$$

and therefore the interacted effects of a bad shock (an increase in k) and of higher volatility on firm performance are described by the following partial and cross derivatives:

$$\frac{\partial^2 EB}{\partial k \partial S} \propto F'(S/m)(\frac{e^{-rSm}-e^{-rT}}{r}) + (1-F(S/m))e^{-rS/m} > 0;$$

and therefore

$$\begin{aligned} \frac{\partial^3 EB}{\partial k \partial S \partial m} &\propto -F"(S/m)(\frac{e^{-rS/m}-e^{-rT}}{r}) \\ &\quad +2F'(S/m)e^{-rSm} + rS(1-F(S/m))e^{-rS/m} \end{aligned}$$

which is positive for r sufficiently large.

Finally the derivative

$$\begin{aligned} \frac{\partial^2 EB}{\partial S \partial m} &\propto -[(\frac{e^{-rS}-e^{-rT}}{r})F'(S/m)(1-\alpha)(1-q) \\ &\quad -\Omega(q)F(S/m)e^{-rS/m}] \end{aligned}$$

is negative for r sufficiently large. That more uncertainty per se should encourage delegation, is intuitive: the higher the degree of uncertainty, the longer it takes for the principal to learn and therefore the higher the principal's incentives to delegate sooner, especially when the principal is more impatient.

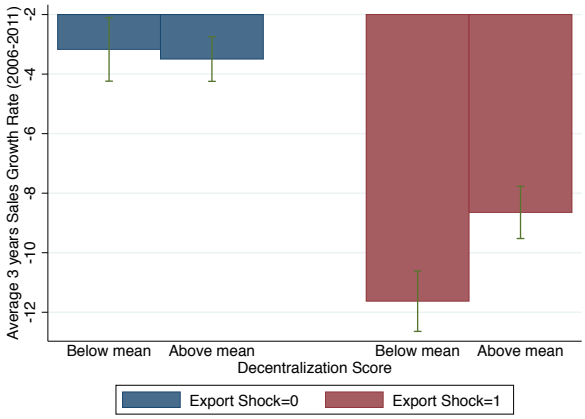
This yields:

Proposition 1: *We have: (i)* $\frac{\partial^2 EB}{\partial k \partial S} < 0$*: that is, the occurrence of a bad shock makes it more performance-enhancing to delegate more (i.e. to reduce* S*); (ii) for* r *sufficiently large and/or* α *sufficiently small,* $\frac{\partial^2 EB}{\partial S \partial m} < 0$*: that is, the higher the level of uncertainty as measured by* m*, the more profitable it is to delegate; (iii) for* r *sufficiently large and/or* α *sufficiently small,* $\frac{\partial^3 EB}{\partial k \partial S \partial m} < 0$*: that is, the higher the level of uncertainty as measured by* m*, the more performance-enhancing it is to delegate more in response to a bad shock.*

11 Appendix C: Additional results

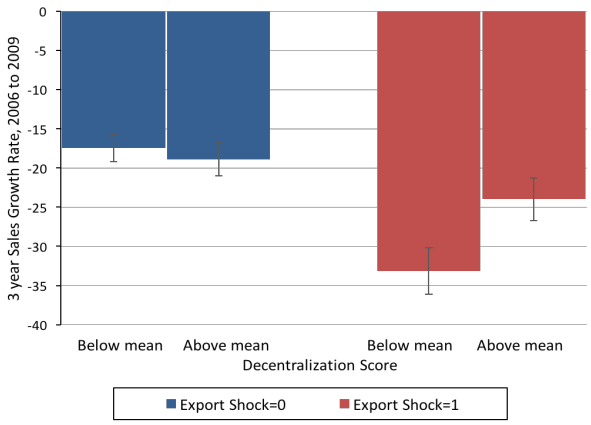
[**** TO BE COMPLETED ****]

Figure 1 - Change in Sales by Shock and Decentralization
Panel A - WMS data



Notes: Each bar plots the average of the 3-year log change in sales for the firms included in the decentralization sample computed pooling data from 2006, 2007 and 2008 (5% confidence interval bands reported). The sample is subdivided in four categories. First, we split firms according to whether they experienced a drop in exports in an industry by country cell in 2008/09 (the main Great Recession years) compared to 2006/07 (the latest pre-Recession years). Second, we split firms by above/below the median level of decentralization measured in 2006 (before the advent of the Great Recession). The countries included in the sample are France, Germany, Greece, Italy, Japan, Poland, Portugal, Sweden, UK, US. Sample size (from left to right): 1); 819 obs, 317 firms 2); 1572 obs, 583 firms 3); 755 obs, 331 firms 4) 1180 obs, 497 firms.

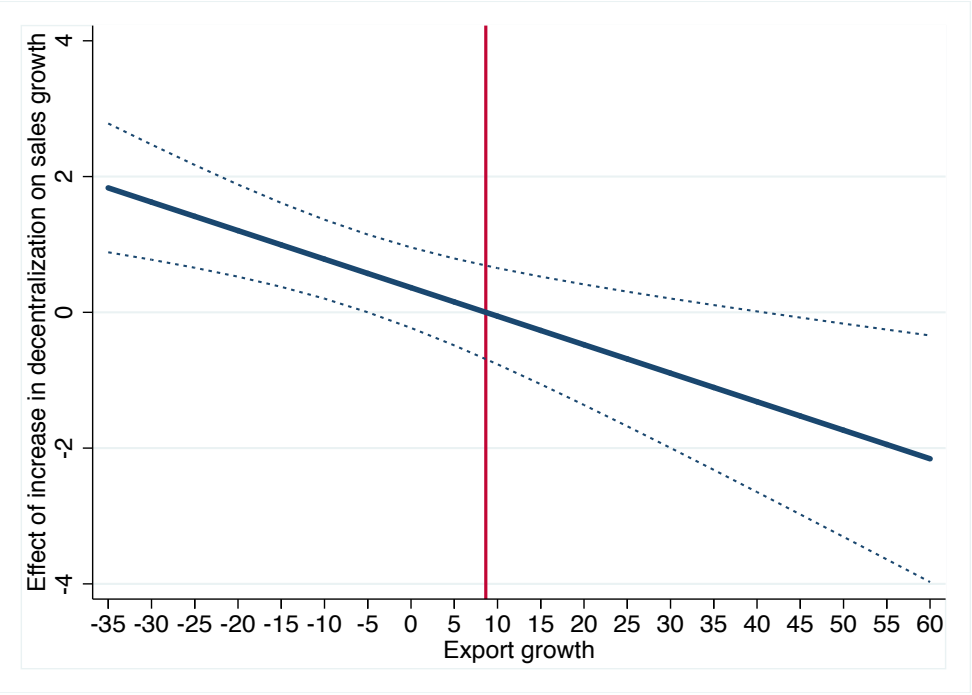
Figure 1 - Change in Sales by Shock and Decentralization
Panel B - MOPS data



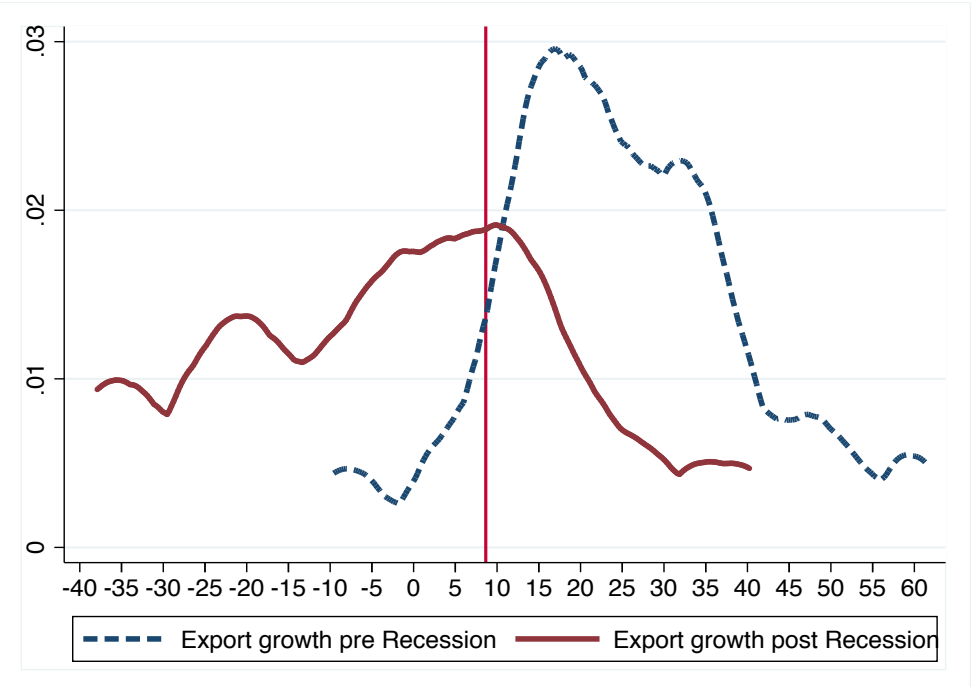
Notes: Each bar plots the average of the 3-year log change in sales for the establishments included in the MOPS decentralization sample (5% confidence interval bands reported). The sample is subdivided in four categories. First, we split establishments according to whether they are in an industry which experienced a drop in exports in 2008/09 (the main Great Recession years) compared to 2006/07 (the latest pre-Recession years). Second, we split establishments by above/below the median level of decentralization in 2005 (before the advent of the Great Recession). The sample includes 8774 US establishments in 3147 firms.

Figure 2 - Effect of increase in decentralization on sales growth (using coefficents from Table 2, col 2)

Panel A



Panel B



Note: Fraction of firms below 8% export growth before the Great Recession = 12%
Fraction of firms below 8% export growth after the Great Recession = 65%

Table 2 - Decentralization and Sales Growth - Main Results

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable = Sales Growth	**World Management Survey (WMS)**				**U.S. Census Data (MOPS)**	
Decentralization	0.579*	0.363	0.041	-0.460	1.709**	-0.545
	(0.302)	(0.302)	(0.417)	(0.539)	(0.674)	(0.702)
EXPORT Growth	0.069**	0.062**				
	(0.029)	(0.029)				
Decent.*EXPORT Growth		-0.042***	-0.047**		-0.105**	
		(0.013)	(0.018)		(0.044)	
Decent.*DURABILITY				0.502***		1.143***
				(0.184)		(0.364)
Firms	1330	1330	1330	1330	3147	3147
Observations	3151	3151	3151	3151	8774	8774
Controls						
Country + Year	**y**	**y**	**y**	**y**		
Industry	**y**	**y**		**y**	**y**	**y**
Industry by country			**y**			
Noise	**y**	**y**	**y**	**y**	**y**	**y**
Firm & plant employment, skills			**y**	**y**	**y**	**y**
Cluster	SIC3*Cty	SIC3*Cty	SIC3*Cty	SIC4	SIC3	SIC3

Notes: *significant at 10%; ** significant at 5%; *** significant at 1%. All columns estimated by OLS. **Columns (1)-(4)**: Standard errors under coefficient are clustered at the country/industry (SIC3) level in all columns, except for column (4), clustered by SIC4. The dependent variable is the three years log growth rate of firm sales starting in 2006, 2007 and 2008. The variable "Decentralization" is the z-scored average of four different z-scored measures of plant manager autonomy in a) hiring; b) capital investments; c) product introduction; d) marketing and sales decisions, all measured in 2006. The sample includes only firms in which the plant manager is not the CEO of the firm, and is within 4 hierarchical levels from the CEO. Firm and plant employment are measured in 2006. Skills is the log of % of firm employees with a college degree measured in 2006. Noise controls include: the tenure of the plant manager in the company, the hierarchical seniority of the plant manager, analyst dummies, an interview reliability score assigned by the interviewer at the end of the interview, dummies for the day of the week in which the interview was conducted, the duration of the interview. **Columns (4)-(5)** Standard errors under coefficient are clustered at the industry (SIC3) level. The dependent variable is the three years log growth rate of establishment sales starting in 2006. The variable "EXPORT Growth" is the log change in exports in the SIC3 industry 2008/09 (the main Great Recession years) compared to 2006/07 (the latest pre-Recession years). The variable "DURABILITY" is the log of the average durability of the goods produced in the SIC 3 industry (durability data is aggregated from SIC4 to SIC3 to avoid dropping observations). The variable "Decentralization" is the z-scored average of six different z-scored measures of plant manager autonomy in 2005 in a) hiring; b) pay increases; c) capital investments; d) product introduction; e) product pricing; f) product advertising, all measured in 2010. The sample excludes plants whose firm headquarters are on-site. Skills is the log of % of plant employees with a college degree measured in 2010. Noise controls include: the tenure and hierarchical seniority of the survey respondent, whether the survey was submitted online or through the mail, a reliability score based on the difference between 2005 employment as measured in the 2010 MOPS and 2005 employment as measured in the 2005 ASM, and dummies for the day of the week in which the survey was submitted.

Table 3 - Decentralization and Other Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		World Management Survey			U.S. Census Data		
Dependent Variable	**Sales growth**	**TFP growth**	**Profit growth**	**Exit**	**Sales growth**	**TFP growth**	**Profit growth**
Decentralization	-0.017	-0.263	-0.396	-0.017*	1.709**	-0.079	0.576
	(0.400)	(0.357)	(1.597)	(0.010)	(0.674)	(0.484)	(0.811)
Decent.*EXPORT Growth	-0.048***	-0.033**	-0.068	0.001*	-0.105**	-0.065**	-0.125**
	(0.017)	(0.013)	(0.065)	(0.000)	(0.044)	(0.032)	(0.058)
Firms	1211	1211	1192	2662	3147	3147	3147
Observations	2839	2839	2712	2662	8774	8774	8774
Controls							
Country + year	**y**	**y**	**y**	**y**			
Industry (SIC3) by Country	**y**	**y**	**y**	**y**			
Noise	**y**	**y**	**y**	**y**	**y**	**y**	**y**
Firm & plant employment, skills	**y**	**y**	**y**	**y**	**y**	**y**	**y**
Industry (SIC3)					**y**	**y**	**y**
Cluster	SIC3*Cty	SIC3*Cty	SIC3*Cty	SIC3*Cty	SIC3	SIC3	SIC3

Notes: *significant at 10%; ** significant at 5%; *** significant at 1%. All columns estimated by OLS. **Columns (1)-(4)**: Standard errors under coefficient are clustered at the country/industry (SIC3) level. The dependent variable in column 1 is the three years log growth rate of firm sales measured in 2006, 2007 and 2008. The dependent variable in column 2 the three years log growth rate of firm TFP measured in 2006, 2007 and 2008 (TFP obtained by regressing the 3 years log growth in sales against the 3 years log growth in capital, employment and materials). The variable "Decentralization" is the z-scored average of four different z-scored measures of plant manager autonomy in a) hiring; b) capital investiments; c) product introduction; d) marketing and sales decisions, all measured in 2006. The sample includes only firms in which the plant manager is not the CEO of the firm, and is within 4 hierarchical levels from the CEO.Firm and plant employment are measured in 2006. Skills is the log of % of firm employees with a college degree measured in 2006. Noise controls include: the tenure of the plant manager in the company, the hierarchical seniority of the plant manager, analyst dummies, an interview reliability score assigned by the interviewer at the end of the interview, dummies for the day of the week in which the interview was conducted, the duration of the interview. **Columns (5)-(7):** Standard errors under coefficient are clustered at the industry (SIC3) level. The dependent variable in column 5 is the three years log growth rate of plant sales starting in 2006. The dependent variable in column 6 is the three years log growth rate of plant TFP measured in 2006 (TFP obtained by regressing the 3 years log growth in sales against the 3 years log growth in capital, employment and materials). The dependent variable in column 7 is the three years difference in profits as a percent of capital (profits measured as plant sales minus total salaries and wages, materials cost, and rental expenses). The variable "EXPORT Growth" is the log change in exports in the SIC3 industry 2008/09 (the main Great Recession years) compared to 2006/07 (the latest pre-Recession years). The variable "Decentralization" is the z-scored average of six different z-scored measures of plant manager autonomy in 2005 in a) hiring; b) pay increases; c) capital investments; d) product introduction; e) product pricing; f) product advertising, all measured in 2010. The sample excludes plants whose firm headquarters are on-site. Skills is the log of % of plant employees with a college degree measured in 2010. Noise controls include: the tenure and hierarchical seniority of the survey respondent, whether the survey was submitted online or through the mail, a reliability score based on the difference between 2005 employment as measured in the 2010 MOPS and 2005 employment as measured in the 2005 ASM, and dummies for the day of the week in which the survey was submitted.

Table 4 - Triple Differences

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	**Sales Growth (3 years log change)**			**TFP Growth (3 years log change)**		
Sample	**Year<=2005**	**Year>=2006**	**All**	**Year<=2005**	**Year>=2006**	**All**
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			-26.197***			-16.317***
			(3.405)			(3.484)
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	1080	1330	1330	991	1211	1211
Observations	3664	3151	6815	3265	2839	6104
Controls						
Country + Year	**y**	**y**	**y**	**y**	**y**	**y**
Industry by Country (SIC3)	**y**	**y**	**y**	**y**	**y**	**y**
Noise	**y**	**y**	**y**	**y**	**y**	**y**
Firm & plant employment, skills	**y**	**y**	**y**	**y**	**y**	**y**
Cluster	SIC3*Cty	SIC3*Cty	SIC3*Cty	SIC3*Cty	SIC3*Cty	SIC3*Cty

Notes: *significant at 10%; ** significant at 5%; *** significant at 1%. All columns estimated by OLS. Standard errors under coefficient are clustered at the country/industry (SIC3) level in all columns. The dependent variable is the three years growth rate of firm sales measured in 2002, 2003, 2004 and 2005 in columns 1 and 4, and in 2006, 2007 and 2008 in columns 2 and 5. Columns 3 and 6 pool data across all years. The variable "Decentralization" is the z-scored average of four different z-scored measures of plant manager autonomy in a) hiring; b) capital investiments; c) product introduction; d) marketing and sales decisions, all measured in 2006. The sample includes only firms in which the plant manager is not the CEO of the firm, and is within 4 hierarchical levels from the CEO. The variable "EXPORT Growth" is is the log change in exports in the SIC3 industry/country cell in 2008/09 (the main Great Recession years) compared to 2006/07 (the latest pre-Recession years). The variable "POST" is a dummy taking value 1 in all years after 2006 included. Firm and plant employment are measured in 2006. Skills is the log of % of firm employees with a college degree. Noise controls include: the tenure of the plant manager in the company, the hierarchical seniority of the plant manager, analyst dummies, an interview reliability score assigned by the interviewer at the end of the interview, dummies for the day of the week in which the interview was conducted, the duration of the interview.

Table 5 - Instrumental Variables

	(1) Baseline on subsample	(2) Reduced form	(3) First Stage	(4) First Stage	(5) Second Stage
Dependent Variable	**Sales growth**	**Sales growth**	**Decentralization**	**Decentralization* Export Growth**	**Sales growth**
Decentralization	0.042				0.076
	(0.339)				(3.023)
Decentralization*EXPORT Growth	-0.042**				-0.298**
	(0.017)				(0.125)
Trust (HQ)		-2.926	1.374***	7.448	
		(4.066)	(0.394)	(8.709)	
Trust (HQ)*EXPORT Growth		-0.470***	0.015	1.408**	
		(0.164)	(0.022)	(0.529)	
Observations	2990	2990	2990	2990	2990
Angrist Pischke Test (Weak identification)			8.53	5.52	
Cragg-Donald Wald F statistic					16.72
Controls					
Country	**y**	**y**	**y**	**y**	**y**
Year	**y**	**y**	**y**	**y**	**y**
Industry by Country (SIC3)	**y**	**y**	**y**	**y**	**y**
Log firm and plant employment	**y**	**y**	**y**	**y**	**y**
Noise	**y**	**y**	**y**	**y**	**y**
Skills	**y**	**y**	**y**	**y**	**y**
Cluster	HQ Region	HQ Region	HQ Region	HQ Region	HQ Region

Table 6 - Decentralization and Product Churn

	(1)	(2)	(3)	(4)	(5)	(6)
		Exports			Durability	
Dependent Variable: Sales growth ('07-'12)						
Decentralization	2.401***	2.456***	2.882***	-0.019	2.456***	1.611
	(0.71)	(0.65)	(0.664)	(1.043)	(0.65)	(1.004)
Decent*Change in Product Churn		4.969***	4.430***		4.969***	4.649***
		(1.5)	(1.598)		(1.5)	(1.492)
Decent*Export Growth ('07-'12)	-0.072**		-0.038			
	(0.035)		(0.036)			
Decent*Durability				0.734*		0.409
				(0.43)		(0.405)
Observations	8243	8243	8243	8243	8243	8243
R-squared	0.116	0.116	0.116	0.115	0.116	0.116
Controls						
Industry (SIC3)	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
Noise	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
Firm and plant employment, skills	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
Cluster	SIC3	SIC3	SIC3	SIC3	SIC3	SIC3

NOTES: Standard errors under coefficient are clustered at the industry (SIC3) level. The dependent variable is the five years log growth rate of establishment sales starting in 2007. The variable "CHANGE IN PRODUCT CHURN" is measured by subtracting industry product churn from 2002 to 2007, average over all multiproduct plants within an industry of (# products added between 2002 and 2007 + # products dropped between 2002 and 2007)/(0.5*number of products in 2002 + 0.5*number of products in 2007), from industry product churn from 2007 to 2012, average over all multiproduct plants within an industry of (# products added between 2007 and 2012 + # products dropped between 2007 and 2012)/(0.5*number of products in 2007 + 0.5*number of products in 2012).The variable "EXPORT Growth" is the log change in exports in the SIC3 industry 2012 compared to 2007. The variable "DURABILITY" is the log of the average durability of the goods produced in the SIC 3 industry (durability data is aggregated from SIC4 to SIC3 to avoid dropping observations). The variable "Decentralization" is the z-scored average of six different z-scored measures of plant manager autonomy in 2005 in a) hiring; b) pay increases; c) capital investments; d) product introduction; e) product pricing; f) product advertising, all measured in 2010. The sample excludes plants whose firm headquarters are on-site. Skills is the log of % of plant employees with a college degree measured in 2010. Noise controls include: the tenure and hierarchical seniority of the survey respondent, whether the survey was submitted online or through the mail, a reliability score based on the difference between 2005 employment as measured in the 2010 MOPS and 2005 employment as measured in the 2005 ASM, and dummies for the day of the week in which the survey was submitted.

Table 7 - Differences across decentralization questions

	(1)	(2)	(3)	(4)	(5)	(6)
	World Management Survey			U.S. Census Data - MOPS		
Dependent Variable: Sales Growth (3 years log change)						
Decentralization	0.041			1.709**		
	(0.417)			(0.674)		
Decentralization*EXPORT Growth	-0.047**			-0.105**		
	(0.018)			(0.0438)		
Decentralization - Hiring & Investment		0.063			2.49***	
		(0.396)			(0.773)	
Decent. - Hiring & Investment*EXPORT Growth		-0.002			-0.014	
		(0.019)			(0.046)	
Decentralization - Sales, Marketing & New Products			-0.135			1.16
			(0.379)			(0.719)
Decent. - Sales, Marketing & New Products*EXPORT Growth			-0.060***			-0.135***
			(0.017)			(0.048)
Firms	1330	1330	1330	3147	3147	3147
Observations	3151	3151	3151	8774	8774	8774
Controls						
Country + Year	**y**	**y**	**y**			
Industry by Country (SIC3)	**y**	**y**	**y**			
Noise	**y**	**y**	**y**	**y**	**y**	**y**
Firm & plant employment, skills	**y**	**y**	**y**	**y**	**y**	**y**
Industry (SIC3)				**y**	**y**	**y**
Cluster	SIC3*Cty	SIC3*Cty	SIC3*Cty	SIC3	SIC3	SIC3

Notes: *significant at 10%; ** significant at 5%; *** significant at 1%. All columns estimated by OLS. **Columns (1)-(3**): Standard errors under coefficient are clustered at the country/industry (SIC3) level. The dependent variable in all columns is the three years log growth rate of firm sales starting in 2006, 2007 and 2008. The variable "Decentralization" is the z-scored average of four different z-scored measures of plant manager autonomy in a) hiring; b) capital investiments; c) product introduction; d) marketing and sales decisions, all measured in 2006. The sample includes only firms in which the plant manager is not the CEO of the firm, and is within 4 hierarchical levels from the CEO. Firm and plant employment are measured in 2006. Skills is the log of % of firm employees with a college degree. Noise controls include: the tenure of the plant manager in the company, the hierarchical seniority of the plant manager, analyst dummies, an interview reliability score assigned by the interviewer at the end of the interview, dummies for the day of the week in which the interview was conducted, the duration of the interview. **Columns (4)-(6):** Standard errors under coefficient are clustered at the industry (SIC3) level. The dependent variable is the three years log growth rate of establishment sales starting in 2006. The variable "EXPORT Growth" is the log change in exports in the SIC3 industry 2008/09 (the main Great Recession years) compared to 2006/07 (the latest pre-Recession years). The variable "DURABILITY" is the log of the average durability of the goods produced in the SIC 3 industry. The variable "Decentralization" is the z-scored average of six different z-scored measures of plant manager autonomy in 2005 in a) hiring; b) pay increases; c) capital investments; d) product introduction; e) product pricing; f) product advertising, all measured in 2010. The variable "Decentralization - Hiring & Investment" is the z-scored average of the z-scored measures of a) hiring; b) pay increases; c) capital investments. The variable "Decentralization - Sales, Marketing, & New Products" is the z-scored average of the z-scored measures of d) product introduction; e) product pricing; f) product advertising. The sample excludes plants whose firm headquarters are on-site. Skills is the log of % of plant employees with a college degree measured in 2010. Noise controls include: the tenure and hierarchical seniority of the survey respondent, whether the survey was submitted online or through the mail, a reliability score based on the difference between 2005 employment as measured in the 2010 MOPS and 2005 employment as measured in the 2005 ASM, and dummies for the day of the week in which the survey was submitted.

Table 8A - Coordination (WMS)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable: Sales Growth (3 years log change)									
Decentralization	0.041	0.050	0.062	0.115	0.046	0.067	0.127	-0.013	0.361
	(0.417)	(0.418)	(0.417)	(0.422)	(0.413)	(0.419)	(0.413)	(0.448)	(0.983)
Decentralization*EXPORT Growth	-0.047**	-0.047**	-0.045**	-0.046**	-0.047***	-0.047**	-0.050***	-0.046**	-0.094**
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.019)	(0.047)
Log(employees)*EXPORT Growth		-0.940							
		(0.816)							
Log(plant employees)			-0.228						
			(0.513)						
Log(plant employees)*EXPORT Growth			0.008						
			(0.021)						
No. of production sites				-0.003					
				(0.027)					
No. of production sites*EXPORT Growth				0.003					
				(0.002)					
Diversification dummy					1.302				
					(0.898)				
Diversification dummy*EXPORT Growth					0.027				
					(0.055)				
MNE dummy						-2.478*			
						(1.384)			
MNE dummy*EXPORT Growth						1.691			
						(1.730)			
Foreign MNE dummy							-1.820**		
							(0.833)		
Foreign MNE dummy*EXPORT Growth							0.016		
							(0.039)		
Log(1+share outsourced production)								-0.090	
								(0.281)	
Log(1+share outsourced production)*EXPORT Growth								0.001	
								(0.012)	
Materials Share									-6.991
									(7.065)
Materials Share*EXPORT Growth									0.817**
									(0.357)
Observations	3151	3151	3105	3127	3151	3151	3151	3029	1201
Controls									
Country + Year	**y**	**y**	**y**	**y**	**y**	**y**	**y**	**y**	**y**
Industry by Country (SIC3)	**y**	**y**	**y**	**y**	**y**	**y**	**y**	**y**	**y**
Noise	**y**	**y**	**y**	**y**	**y**	**y**	**y**	**y**	**y**
Firm & plant employment, skills	**y**	**y**	**y**	**y**	**y**	**y**	**y**	**y**	**y**
Cluster	SIC3*Cty	SIC3*Cty	SIC3*Cty	SIC3*Cty	SIC3*Cty	SIC3*Cty	SIC3*Cty	SIC3*Cty	SIC3*Cty

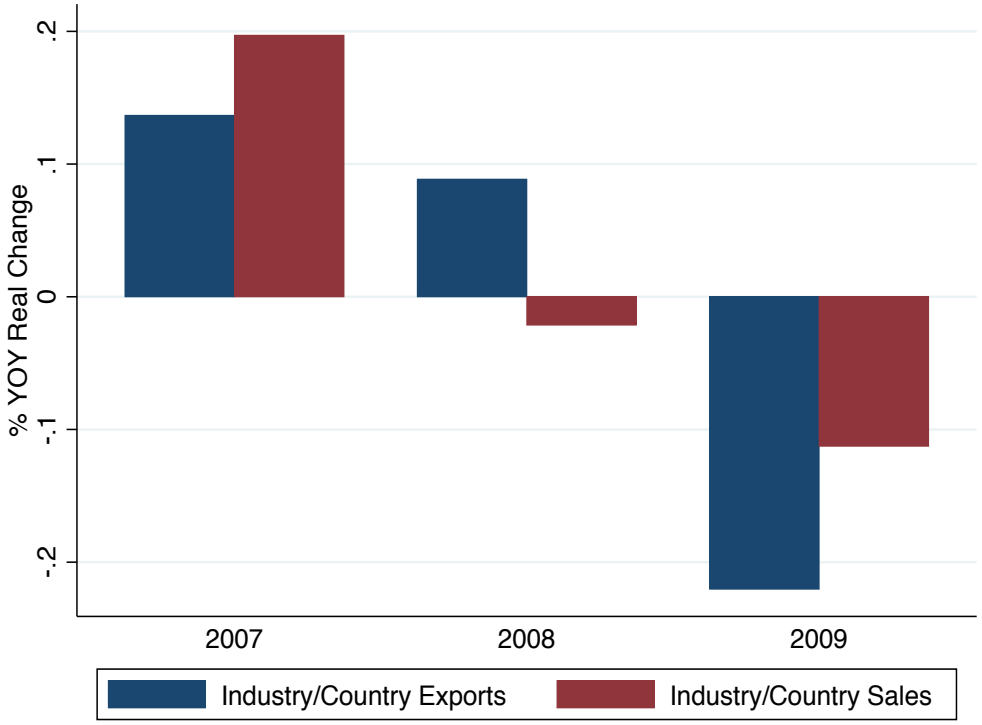
Notes: *significant at 10%; ** significant at 5%; *** significant at 1%. All columns estimated by OLS. Standard errors under coefficient are clustered at the country/industry (SIC3) level in all columns. The dependent variable in all columns is the three years log growth rate of firm sales starting in 2006, 2007 and 2008. The variable "Decentralization" is the z-scored average of four different z-scored measures of plant manager autonomy in a) hiring; b) capital investiments; c) product introduction; d) marketing and sales decisions, all measured in 2006. The sample includes only firms in which the plant manager is not the CEO of the firm, and is within 4 hierarchical levels from the CEO. The variable "EXPORT Growth" is is the log change in exports in the SIC3 industry/country cell in 2008/09 (the main Great Recession years) compared to 2006/07 (the latest pre-Recession years). Firm and plant employment are measured in 2006. Skills is the log of % of firm employees with a college degree. Management is the z-scored average across 18 z-scored management questions (see Bloom and Van Reenen 2007 for details). MNE is a dummy taking values one if the firm belongs to a foreign or domestic multinational. Diversified is a dummy taking value one if the firm has multiple primary SIC4 codes. Noise controls include: the tenure of the plant manager in the company, the hierarchical seniority of the plant manager, analyst dummies, an interview reliability score assigned by the interviewer at the end of the interview, dummies for the day of the week in which the interview was conducted, the duration of the interview.

Table 8B - Coordination (MOPS)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable: Sales Growth (3 years log change)									
Decentralization	1.709**	2.19***	2.14***	-0.359	0.909	0.686	2.341***	0.76	2.958***
	(0.674)	(0.725)	(0.736)	(2.248)	(1.066)	(0.97)	(0.89)	(0.921)	(0.865)
Decentralization*EXPORT Growth	-0.105**	-0.092**	-0.091**	-0.095**	-0.101**	-0.098**	-0.099**	-0.093**	-0.096**
	(0.0438)	(0.044)	(0.045)	(0.042)	(0.041)	(0.042)	(0.042)	(0.041)	(0.041)
Multiproduct		-0.893							
		(1.75)							
Multiproduct*EXPORT Growth		0.023							
		(0.105)							
Log(plant employment)*EXPORT Growth			0.010						
			(0.067)						
Log(firm employment)*EXPORT Growth			0.020						
			(0.031)						
Log(firm employment)*Decentralization				0.333					
				(0.283)					
Log(No. of plants)					-1.591				
					(0.984)				
Log(No. of plants)*Decentralization					0.52				
					(0.429)				
Log(No. of states w/ plants)						0.119			
						(1.184)			
Log(No. of states w/ plants)*Decentralization						0.807*			
						(0.461)			
Plant is in same state as largest plant							3.001*		
							(1.642)		
Same state as largest plant*Decentralization							-0.456		
							(1.047)		
Log(No. of manufacturing industries)								-1.627*	
								(0.926)	
Log(No. of manufacturing industries)*Decentralization								1.056**	
								(0.438)	
Plant is in same industry as largest plant									2.356
									(1.561)
Same industry as largest plant*Decentralization									-1.423
									(1.107)
Firms	3147	3147	3147	3147	3147	3147	3147	3147	3147
Observations	8774	8774	8774	8774	8774	8774	8774	8774	8774
Controls									
Noise	**y**	**y**	**y**	**y**	**y**	**y**	**y**	**y**	**y**
Firm & plant employment, skills	**y**	**y**	**y**	**y**	**y**	**y**	**y**	**y**	**y**
Industry (SIC3)	**y**	**y**	**y**	**y**	**y**	**y**	**y**	**y**	**y**
Cluster	SIC3	SIC3	SIC3	SIC3	SIC3	SIC3	SIC3	SIC3	SIC3

Notes: *significant at 10%; ** significant at 5%; *** significant at 1%. All columns estimated by OLS. Standard errors under coefficient are clustered at the industry (SIC3) level. The dependent variable is the three years log growth rate of establishment sales starting in 2006. The variable "Multiproduct" equals 1 if a plant produced at least 2 products (7-digit NAICS) in 2009, and 0 otherwise. Firm employment includes manufacturing and non-manufacturing employment. The word "plant" refers to a manufacturing establishment. The variable "Log(No. of manufacturing industries)" is the log of the number of unique primary industry codes (6-Digit NAICS) assigned to the firm's manufacturing establishments in 2009. The variable "plant is in same state as largest plant" equals 1 if plant is in the same U.S. state as the firm's largest plant by employment in 2009, and 0 otherwise. The variable "plant is in same industry as largest plant" is defined similarly with an industry defined as 6-digit NAICS code. The variable "EXPORT Growth" is the log change in exports in the SIC3 industry 2008/09 (the main Great Recession years) compared to 2006/07 (the latest pre-Recession years). The variable "Decentralization" is the z-scored average of six different z-scored measures of plant manager autonomy in 2005 in a) hiring; b) pay increases; c) capital investments; d) product introduction; e) product pricing; f) product advertising, all measured in 2010. The sample excludes plants whose firm headquarters are on-site. Skills is the log of % of plant employees with a college degree measured in 2010. Noise controls include: the tenure and hierarchical seniority of the survey respondent, whether the survey was submitted online or through the mail, a reliability score based on the difference between 2005 employment as measured in the 2010 MOPS and 2005 employment as measured in the 2005 ASM, and dummies for the day of the week in which the survey was submitted.

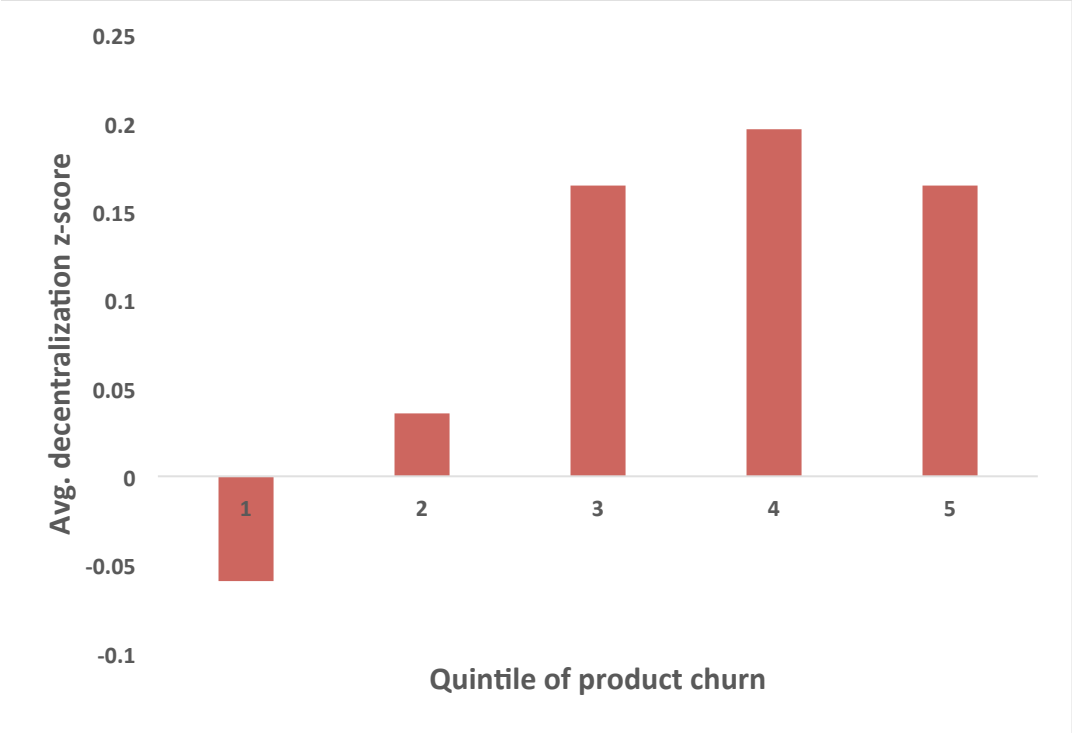
Figure A1 - Changes in Industry/Country Exports and Sales before and after the Great Recession



0.13
0.09
-0.21

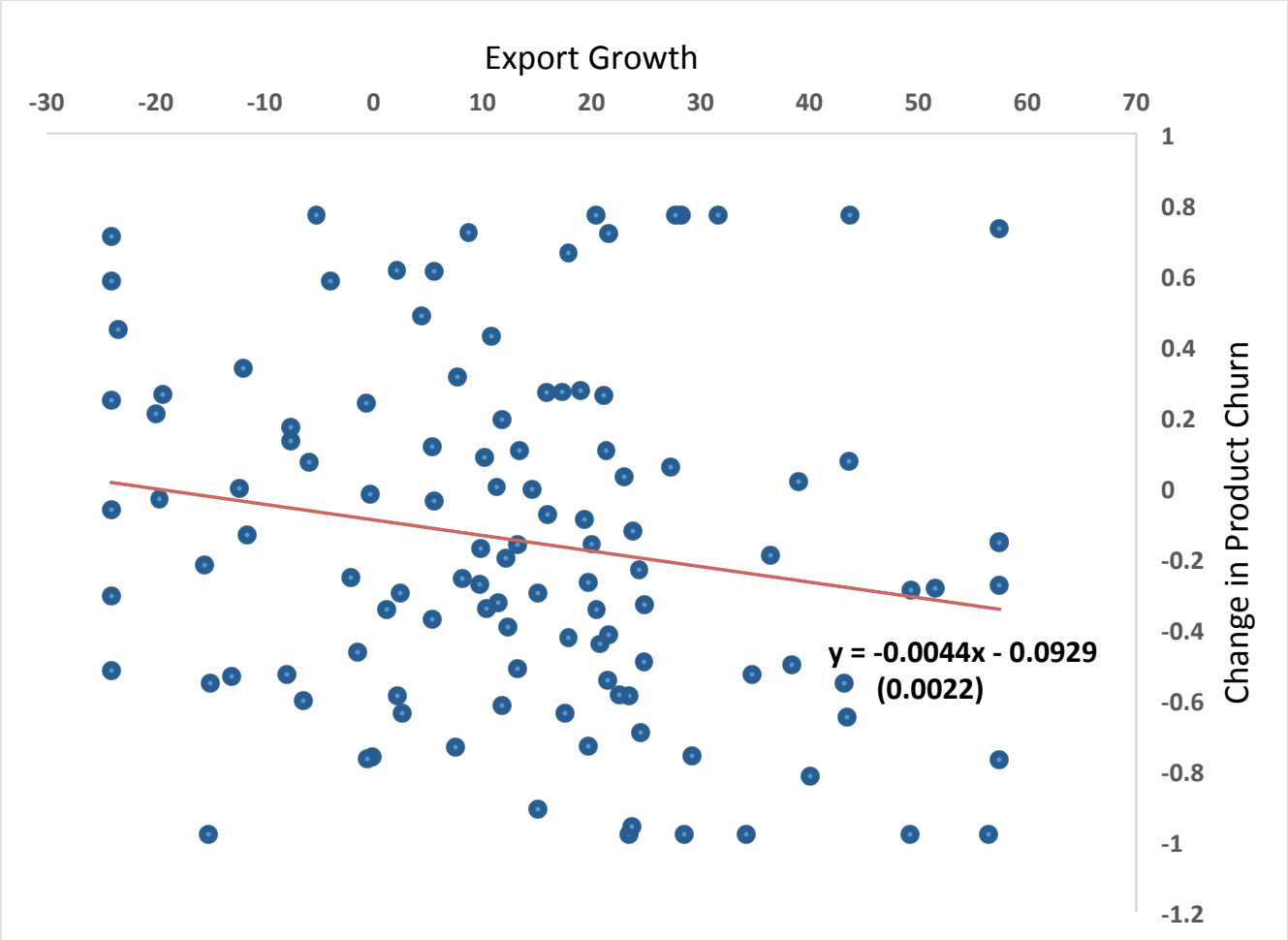
Notes: Each bar plots the yearly log change in real industry exports (left bar) and sales (right bar) between 2006 and 2009. Manufacturing only. Exports data calculated from country/industry (SIC3) aggregates built from product level data in COMTRADE. Sales data calculated using country/industry (SIC3) aggregates built from firm level data in ORBIS. The countries included in the sample are France, Germany, Greece, Italy, Japan, Poland, Portugal, Sweden, UK, US.

Figure A2 - Average Decentralization Z-score by Quintile of Product Churn



Notes: MOPS data. Industry product churn is the average of plant product churn. Plant product churn = (# products added from '02 to '07 + # products dropped from '02 and '07)/(0.5*# products produced in '02 + 0.5*# products produced in '07).

Figure A3 - Export Growth and Change in Industry Product Churn



Notes: Change in industry product churn is industry product churn in 2012 minus industry product churn in 2007. Exports growth is 100*log change in industry exports from 2007 to 2012. Both variables are winzorized at the 5th and 95th percentiles. An industry is a 3-Digit SIC.

Table A1 - Decentralization questions

For Questions D1, D3, and D4 any score can be given, but the scoring guide is only provided for scores of 1, 3, and 5.

Question D1: "*To hire a FULL-TIME PERMANENT SHOPFLOOR worker what agreement would your plant need from CHQ (Central Head Quarters)?*"

Probe until you can accurately score the question—for example if they say "*It is my decision, but I need sign-off from corporate HQ.*" ask "*How often would sign-off be given?*"

	Score 1	Score 3	Score 5
Scoring grid:	No authority—even for replacement hires	Requires sign-off from CHQ based on the business case. Typically agreed (i.e. about 80% or 90% of the time).	Complete authority—it is my decision entirely

Question D2: "*What is the largest CAPITAL INVESTMENT your plant could make without prior authorization from CHQ?*"

Notes: (a) Ignore form-filling

(b) Please cross check any zero response by asking "*What about buying a new computer—would that be possible?*" and then probe….

(c) Challenge any very large numbers (e.g. >$¼m in US) by asking "*To confirm your plant could spend $X on a new piece of equipment without prior clearance from CHQ?*"

(d) Use the national currency and do not omit zeros (i.e. for a U.S. firm twenty thousand dollars would be 20000).

Question D3: "*Where are decisions taken on new product introductions—at the plant, at the CHQ or both*"?

Probe until you can accurately score the question—for example if they say "*It is complex, we both play a role*," ask "*Could you talk me through the process for a recent product innovation?*"

	Score 1	Score 3	Score 5
Scoring grid:	All new product introduction decisions are taken at the CHQ	New product introductions are jointly determined by the plant and CHQ	All new product introduction decisions taken at the plant level

Question D4: "*How much of sales and marketing is carried out at the plant level (rather than at the CHQ)*"?

Probe until you can accurately score the question. Also take an average score for sales and marketing if they are taken at different levels.

	Score 1	Score 3	Score 5
Scoring grid:	None—sales and marketing is all run by CHQ	Sales and marketing decisions are split between the plant and CHQ	The plant runs all sales and marketing

Question D5: "*Is the CHQ on the site being interviewed*"?

Notes: The electronic survey, training materials and survey video footage are available on www.worldmanagementsurvey.com

Table A2 -MOPS Sampling

Sample	Source	Sample Criteria	Number of establishments (in thousands)	Total employment (in thousands)	Average employment
(1) Universe of establishments	LBD	None	7041	134637	19.1
(2) Manufacturing	LBD	NAICS 31-33	298	12027	40.4
(3) Annual Survey of Manufactures	ASM	NAICS 31-33, and either over 500 employees, or in ASM random sample. Positive employment and sales, and tabbed	51	7387	143.5
(4) MOPS respondents	MOPS	As in (3), also responded to MOPS	36	5629	155.8
(5) ORG module respondents	MOPS	As in (4), and responded to any of MOPS questions 18-23	20	3580	178.4
(6) Regression sample	MOPS	As in (5), responded to all ORG "recall" questions, match to ASM 2006 and ASM 2009, positive value added, employment and imputed capital in ASM 2010	9	2135	243.3

Table A3 - Robustness WMS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable: Sales Growth (3 years log change)							
Decentralization	0.041	-0.098	0.026	0.046	-0.241	0.044	-0.078
	(0.417)	(0.423)	(0.416)	(0.431)	(0.451)	(0.417)	(0.424)
Decentralization*EXPORT Growth	-0.047**	-0.054***	-0.046**	-0.043**	-0.049**	-0.047**	-0.049**
	(0.018)	(0.018)	(0.018)	(0.018)	(0.020)	(0.018)	(0.019)
Management		0.977					
		(0.664)					
Management*EXPORT Growth		0.042*					
		(0.025)					
Log(% employees with a college degree)*EXPORT Growth			0.023				
			(0.038)				
Workers' decentralization				-0.038			
				(1.015)			
Workers' decentralization*EXPORT Growth				-0.074*			
				(0.040)			
Foreign Plant Manager					0.478		
					(2.293)		
Foreign Plant Manager *EXPORT Growth					0.182***		
					(0.069)		
Male Plant Manager						-0.392	
						(1.662)	
Male Plant Manager*EXPORT Growth						0.046	
						(0.052)	
Plant Manager Age							-3.687
							(2.966)
Plant Manager Age*Export Growth							-0.104
							(0.093)
Observations	3151	3151	3151	3097	2784	3151	3125
Controls							
Country + Year	**y**	**y**	**y**	**y**	**y**	**y**	**y**
Industry by Country (SIC3)	**y**	**y**	**y**	**y**	**y**	**y**	**y**
Noise	**y**	**y**	**y**	**y**	**y**	**y**	**y**
Firm & plant employment, skills	**y**	**y**	**y**	**y**	**y**	**y**	**y**
Cluster	SIC3*Cty	SIC3*Cty	SIC3*Cty	SIC3*Cty	SIC3*Cty	SIC3*Cty	SIC3*Cty

Notes: *significant at 10%; ** significant at 5%; *** significant at 1%. All columns estimated by OLS. Standard errors under coefficient are clustered at the country/industry (SIC3) level in all columns. The dependent variable in all columns is the three years log growth rate of firm sales measured in 2006, 2007 and 2008. The variable "Decentralization" is the z-scored average of four different z-scored measures of plant manager autonomy in a) hiring; b) capital investiments; c) product introduction; d) marketing and sales decisions, all measured in 2006. The sample includes only firms in which the plant manager is not the CEO of the firm, and is within 4 hierarchical levels from the CEO. The variable "EXPORT Growth" is is the log change in exports in the SIC3 industry/country cell in 2008/09 (the main Great Recession years) compared to 2006/07 (the latest pre-Recession years). Firm and plant employment are measured in 2006. Skills is the log of % of firm employees with a college degree. Management is the z-scored average across 18 z-scored management questions (see Bloom and Van Reenen 2007 for details). MNE is a dummy taking values one if the firm belongs to a foreign or domestic multinational. Diversified is a dummy taking value one if the firm has multiple primary SIC4 codes. Noise controls include: the tenure of the plant manager in the company, the hierarchical seniority of the plant manager, analyst dummies, an interview reliability score assigned by the interviewer at the end of the interview, dummies for the day of the week in which the interview was conducted, the duration of the interview.

Table A4 -Robustness in the U.S. Census Data

	(1)	(2)	(3)	(4)	(5)
Dependent Variable: Sales Growth (3 years log change)					
Decentralization	1.709**	2.13***	2.11***	2.10***	2.06***
	(0.674)	(0.740)	(0.741)	(0.739)	(0.728)
Decentralization*EXPORT Growth	-0.105**	-0.0905**	-0.0896**	-0.0858*	-0.0858*
	(0.0438)	(0.0453)	(0.0451)	(0.0455)	(0.0444)
Management		-0.816			
		-0.724			
Management*Export Shock		0.0204			
		(0.0405)			
Data-Driven Decision-Making			-1.05		
			-0.643		
Data-Driven Decision-Making*Export Shock			0.00371		
			(0.044)		
Log(% Degree)*Export Shock				-0.0582	
				(0.0451)	
Union					-5.30**
					(2.14)
Union*Export Shock					0.188
					(0.156)
Firms	3147	3147	3147	3147	3147
Observations	8774	8774	8774	8774	8774
Controls					
Noise	**y**	**y**	**y**	**y**	**y**
Firm & plant employment, skills	**y**	**y**	**y**	**y**	**y**
Industry (SIC3)	**y**	**y**	**y**	**y**	**y**
Cluster	SIC3	SIC3	SIC3	SIC3	SIC3

Notes: *significant at 10%; ** significant at 5%; *** significant at 1%. All columns estimated by OLS. Standard errors under coefficient are clustered at the industry (SIC3) level in all columns. The dependent variable is the three years log growth rate of establishment sales starting in 2006. The variable "Decentralization" is the z-scored average of six different z-scored measures of plant manager autonomy in 2005 in a) hiring; b) pay increases; c) capital investments; d) product introduction; e) product pricing; f) product advertising, all measured in 2010. The sample excludes plants whose firm headquarters are on-site. Firm and plant employment are measured in 2005. Skills is the log of % of plant employees with a college degree measured in 2010. Management is the z-scored average of 18 z-scored management questions (see Bloom and Van Reenen 2007 for details). Union is the percent of plant employees belonging to a labor union. The variable "Data-Driven Decision Making" is the z-scored average of two z-scored measures of the (1) availability and (2) use of data in decision making in 2005. The sample excludes plants whose firm headquarters are on-site. Noise controls include: the tenure and hierarchical seniority of the survey respondent, whether the survey was submitted online or through the mail, a reliability score based on the difference between 2005 employment as measured in the 2010 MOPS and 2005 employment as measured in the 2005 ASM, and dummies for the day of the week in which the survey was submitted.

Table A5 - Decentralization and Growth - Robust to controlling for other industry level interactions

	(1)	(2)	(3)	(4)
Dependent Variable		**Sales Growth (3 years log change)**		
Decentralization	-0.492	-0.270	0.348	-0.282
	(1.748)	(2.408)	(0.605)	(1.460)
Decentralization*EXPORT Growth	-0.039**	-0.036**	-0.040**	-0.036**
	(0.018)	(0.018)	(0.017)	(0.017)
Decentralization*Asset tangibility	2.167			
	(5.914)			
Decentralization*Inventory/Sales		2.367		
		(14.911)		
Decentralization*External finance dependency			-0.777	
			(1.556)	
Decentralization*Labor costs				2.128
				(7.732)
R-squared	0.310	0.310	0.310	0.310
Observations	3132	3132	3132	3132
Number of firms	1545	1545	1545	1545
Controls				
Country	**y**	**y**	**y**	**y**
Year	**y**	**y**	**y**	**y**
Industry by Country (SIC3)	**y**	**y**	**y**	**y**
Log firm and plant employment	**y**	**y**	**y**	**y**
Noise	**y**	**y**	**y**	**y**
Skills	**y**	**y**	**y**	**y**
Cluster	SIC3*Cty	SIC3*Cty	SIC3*Cty	SIC3*Cty

Notes: *significant at 10%; ** significant at 5%; *** significant at 1%. All columns estimated by OLS. Standard errors under coefficient are clustered at the country/industry (SIC3) level in all columns. The dependent variable in all columns is the three years growth rate of firm sales measured in 2006, 2007 and 2008. The variable "Decentralization" is the z-scored average of four different z-scored measures of plant manager autonomy in a) hiring; b) capital investiments; c) product introduction; d) marketing and sales decisions, all measured in 2006. The variable "EXPORT Growth" is is the log change in exports in the SIC3 industry/country cell in 2008/09 (the main Great Recession years) compared to 2006/07 (the latest pre-Recession years). Asset Tangibility is the ratio of tangible assets, i.e. net property, plant and equipment, to total assets for the corresponding industry in the US over the period 1980-1989, computed at the ISIC 3 rev 1 level (inverse measure of credit constraints). Inventory/Sales is measured as the inventories to total sales for the corresponding industry in the US over the period 1980-1989 (measure of liquidity dependence). External finance dependency is measured as capital expenditures minus cash flow divided by cash flow for the corresponding industry in the US over the period 1980-1989 (measure of credit constraint). Labor cost is measured as the total labour costs to total sales for the corresponding industry in the US over the period 1980-1989 (another measure of liquidity dependence). Employment is the number of firm and plant level employees measured in 2006. Skills is the log of % of firm employees with a college degree. Noise controls include: the tenure of the plant manager in the company, the hierarchical seniority of the plant manager, analyst dummies, an interview reliability score assigned by the interviewer at the end of the interview, dummies for the day of the week in which the interview was conducted, the duration of the interview.

Table A6 - Decentralization and Product Churn

	(1)	(2)	(3)	(4)	(5)	(6)
			U.S. Census Data - MOPS			
Dependent Variable: Decentralization z-score						
Decentralization Questions	**All**		**Capital Expenditure, Hiring, and Raises**		**Product Introductions and Sales and Marketing**	
Gross change in products	0.0470***	0.0487***	0.012	0.0250**	0.0600***	0.0520***
	(0.013)	(0.012)	(0.013)	(0.012)	(0.013)	(0.013)
% with BA, MOPS		0.172***		0.133***		0.147***
		(0.013)		(0.012)		(0.013)
Plant employment, ASM		0.104***		0.167***		0.0177*
		(0.011)		(0.011)		(0.011)
Firm employment, LBD		-0.0352***		-0.00451		-0.0486***
		(0.007)		(0.007)		(0.007)
Management		-0.0308***		0.0136		-0.0567***
		(0.011)		(0.011)		(0.011)
R-squared	0.003	0.047	0.005	0.07	0.003	0.039
Observations	8774	8774	8774	8774	8774	8774
Controls						
Industry (SIC3)						
Log firm and plant employment		**y**		**y**		**y**
Skills		**y**		**y**		**y**
Noise		**y**		**y**		**y**
Cluster	SIC3	SIC3	SIC3	SIC3	SIC3	SIC3

Notes: *significant at 10%; ** significant at 5%; *** significant at 1%. All columns estimated by OLS. Standard errors under coefficient are clustered at the industry (SIC3) level in all columns. The dependent variable in columns (1) and (2) is the z-scored average of 6 different z-scored measures of plant manager autonomy in 2005 in the following areas a) hiring; b) capital investiments; c) pay raises; d) product introduction; e) product pricing; f) advertising, all measured in 2010. The dependent variable in columns (3) and (4) is the z-scored average of the 3 decentralization questions concerning a) hiring; b) capital investiments; c) pay raises. The dependent variable in columns (5) and (6) is the z-scored average of the 3 decentralization questions concerning d) product introduction; e) product pricing; f) advertising. The sample includes only establishments for which central HQ is not located on-site. Firm and plant employment are measured in 2006. Skills is the log of % of firm employees with a college degree measured in 2006. Noise controls include: the tenure of the plant manager in the company, the hierarchical seniority of the plant manager, dummies for the day of the week in which the survey was submitted.

Table A7 - Changes in Decentralization

	(1) World Management Survey	(2) U.S. Census Data
Dependent Variable	**Change in Decentralization (2006 to 2009/2010)**	**Change in Decentralization (2005 to 2010)**
Decentralization questions	**All**	**All**
EXPORT Growth	-0.023**	-0.001*
	(0.010)	(0.000)
N	88	8774
Controls		
Country	y	
Year	y	
Industry (SIC2)	y	y
Log firm and plant employment	y	y
Skills	y	y
Noise	y	y
Cluster	SIC3*Cty	SIC3

Notes: *significant at 10%; ** significant at 5%; *** significant at 1%. All columns estimated by OLS. **Column (1):** Standard errors under coefficient are clustered at the country/industry (SIC3). The dependent variable is the change in z-scored decentralization between 2006 and 2009/2010. The sample includes only firms in which the plant manager is not the CEO of the firm, and is within 4 hierarchical levels from the CEO in both years in which the decentralization score is computed. The variable "EXPORT Growth is the log change in exports in the SIC3 industry 2008/09 (the main Great Recession years) compared to 2006/07 (the latest pre-Recession years). Firm and plant employment are measured in 2006. Skills is the log of % of firm employees with a college degree measured in 2006. Noise controls include: the tenure of the plant manager in the company, the hierarchical seniority of the plant manager, analyst dummies, an interview reliability score assigned by the interviewer at the end of the interview, dummies for the day of the week in which the interview was conducted, the duration of the interview. **Column (2):** Standard errors under coefficient are clustered at the industry (SIC3) level. The dependent variable is the change in z-scored decentralization in 2005 compared to 2010, both measured in 2010. The variable "EXPORT Growth" is the log change in exports in the SIC3 industry 2008/09 (the main Great Recession years) compared to 2006/07 (the latest pre-Recession years). The sample excludes plants whose firm headquarters are on-site. Skills is the log of % of plant employees with a college degree measured in 2010. Noise controls include: the tenure and hierarchical seniority of the survey respondent, whether the survey was submitted online or through the mail, a reliability score based on the difference between 2005 employment as measured in the 2010 MOPS and 2005 employment as measured in the 2005 ASM, and dummies for the day of the week in which the survey was submitted.

Table A8 - Decentralization and Product Churn, By Type of Decentralization

	(1)	(2)	(3)	(4)	(5)	(6)
		Exports			Durability	
Panel A: Decentralization of Sales, Marketing, and New Products						
Dependent Variable: Sales growth ('07-'12)						
Decentralization	0.989	0.954	1.520*	-1.975	0.954	-0.273
	(0.735)	(0.759)	(0.811)	(1.233)	(0.759)	(1.35)
Decent*Change in Product Churn		5.576***	4.760**		5.576***	5.135***
		(1.851)	(1.978)		(1.851)	(1.935)
Decent*Export Growth ('07-'12)	-0.088**		-0.053			
	(0.035)		(0.038)			
Decent*Durability				0.888*		0.581
				(0.48)		(0.466)
Firms	3004	3004	3004	3004	3004	3004
Observations	8243	8243	8243	8243	8243	8243
Panel A: Decentralization of Hiring & Investment						
Dependent Variable: Sales growth ('07-'12)						
Decentralization	3.409***	3.459***	3.717***	1.910**	3.459***	2.997**
	(0.843)	(0.783)	(0.831)	(0.943)	(0.783)	(1.211)
Decent*Change in Product Churn		3.022*	2.703		3.022*	2.807
		(1.652)	(1.756)		(1.652)	(1.755)
Decent*Export Growth ('07-'12)	-0.044		-0.022			
	(0.037)		(0.039)			
Decent*Durability				0.458		0.229
				(0.438)		(0.483)
Firms	3004	3004	3004	3004	3004	3004
Observations	8243	8243	8243	8243	8243	8243
Controls						
Industry (SIC3)	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
Noise	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
Firm and plant employment, skills	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
Cluster	SIC3	SIC3	SIC3	SIC3	SIC3	SIC3

NOTES: Standard errors under coefficient are clustered at the industry (SIC3) level. The dependent variable is the five years log growth rate of establishment sales starting in 2007. The variable "CHANGE IN PRODUCT CHURN" is measured by subtracting industry product churn from 2002 to 2007, average over all multiproduct plants within an industry of (# products added between 2002 and 2007 + # products dropped between 2002 and 2007)/(0.5*number of products in 2002 + 0.5*number of products in 2007), from industry product churn from 2007 to 2012, average over all multiproduct plants within an industry of (# products added between 2007 and 2012 + # products dropped between 2007 and 2012)/(0.5*number of products in 2007 + 0.5*number of products in 2012).The variable "EXPORT Growth" is the log change in exports in the SIC3 industry 2012 compared to 2007. The variable "DURABILITY" is the log of the average durability of the goods produced in the SIC 3 industry (durability data is aggregated from SIC4 to SIC3 to avoid dropping observations). In Panel A, the variable "Decentralization" is the z-scored average of the z-scored measures of d) product introduction; e) product pricing; f) product advertising. In Panel B, the variable "Decentralization" is the z-scored average of the z-scored measures of a) hiring; b) pay increases; c) capital investments. The sample excludes plants whose firm headquarters are on-site. Skills is the log of % of plant employees with a college degree measured in 2010. Noise controls include: the tenure and hierarchical seniority of the survey respondent, whether the survey was submitted online or through the mail, a reliability score based on the difference between 2005 employment as measured in the 2010 MOPS and 2005 employment as measured in the 2005 ASM, and dummies for the day of the week in which the survey was submitted.