

Preliminary Draft

**The Flattening Firm and Product Market Competition:
The Effect of Trade Costs and Liberalization**

Maria Guadalupe
Columbia University

Julie Wulf
Wharton School

May 2007

Abstract

It has been documented that firm hierarchies are flattening. CEO span of control has increased significantly over time while the number of levels in the hierarchy has declined. In this paper, we establish a causal effect of foreign competition (using changes in trade costs and trade liberalization) on various characteristics of organizational design. We exploit a unique panel dataset of large US firms with detailed information on firm hierarchies and managerial positions over the period 1986-1999. We find that globalization leads to flatter firms: (i) firms reduce the number of positions between the CEO and division managers, and (ii) increase the number of positions reporting directly to the CEO. We also find that competition increases performance-based pay for division managers and affects the reporting relationships of senior officers including Chief Financial Officers and Legal Counsel. The results are generally consistent with the explanation that intensified competition increases the value of innovation and quick decision making, causing multidivisional firms to redesign their organizations to be more adaptive to local information while simultaneously coordinating activities across divisions.

Corresponding author: Maria Guadalupe, 3022 Broadway, Uris Hall 624, New York NY 10025; p: 212 854 6176; e: mg2341@columbia.edu

1. Introduction

Firm hierarchies are becoming flatter. Spans of control have broadened and the number of levels within firms has declined (Rajan and Wulf, 2006). These trends are consistent with conventional wisdom discussed in the business press and have been suggested and documented in several academic papers (e.g. Powell; 1990, Osterman, 1996; Scott, et al., 1996; Useem, 1996; and Whittington, et al., 1999). While there are several possible explanations for flattening firms, the two most plausible explanations are changes in information technology and increased competition in product markets. In this paper, we focus on the latter and explore the effect of changes in product market competition on the flattening of firm hierarchies.

There is little research in economics that explores the link between competition in product markets and the internal hierarchies of firms. Yet, management scholars have argued that increased competition leads firms to search for new organizational practices in an attempt to replace traditional hierarchical structures. Since additional layers in the hierarchy impede information flows, firms eliminate layers (i.e. “delayer”) to improve response times to changes in competitive forces. Moreover, firms decentralize decision-making to respond more quickly to changes in the business environment and to exploit knowledge of lower level managers.¹ Finally, there is empirical evidence that the internal hierarchical organization of the firm has a significant impact on productivity (Liberti, 2006; Garicano and Hubbard, 2006) suggesting that investments in organizational design can have substantial efficiency consequences. In this paper, we investigate whether product market competition resulting from the globalization of markets is an important driver of organizational change.

Our findings indicate that greater international competition leads to flatter firms. We find that as competition increases, the number of hierarchical levels is reduced, with the division manager getting closer to the CEO. Moreover, division manager total pay increases with a larger fraction of compensation being incentive based. At the same time, the CEO’s span of control increases, with a greater number of senior functional positions reporting directly to the CEO. We show that these results are not driven by increases in

¹ Refer to Whittington, et al. (1999) for a review of the relevant literature in management.

expenditures on IT (although we find interesting results on the interaction between IT and competition); nor exclusively by firms changing their business focus, location of activities, and a host of other potential confounding factors. The results are consistent across our two main empirical specifications and suggest that responding to increased competition may indeed be one of the most important drivers of the flattening of firms.

In order to establish a causal effect between competition and hierarchical structures, we implement two complementary empirical strategies that identify exogenous changes in the level of competition that firms face. First, we analyze changes in tariffs and transport costs that represent entry barriers into the US market. Over the sample period, changes in tariffs are mostly driven by trade liberalizations and WTO agreements, and changes in transport costs have followed technology improvements. We exploit the fact that these changes have very different patterns across industries. Second, we exploit the 1989 Canada US Free Trade Agreement (and the 1994 NAFTA follow up), that eliminated tariffs between the US and Canada. Canada is the biggest trading partner of the US accounting for 20 percent of US imports. Firms in industries with high US tariffs on Canadian imports prior to 1989 experienced a higher increase in competition from the CUSFTA than those in industries with negligible tariffs. This allows us to implement a difference-in-differences strategy to assess the causal effect of competition on a number of features of firms' hierarchies.

There are several advantages to our empirical approach. Due to data limitations, previous papers on hierarchies -and organizations more generally- have been unable to establish causality in studying organizational change. Furthermore, since we have access to a panel of firms that spans 14 years, we can control for firm and position unobserved heterogeneity and establish results using the changes *within* firms (and positions) over time. Finally, the dataset we use is quite unique in the level of information it contains on the internal organization of firms and spans a large number of industries over many years.

A number of papers have explored the relationship between information technology and organizational characteristics, including firm size (Brynjolfsson, Malone, Gurbaxani, Kambil, 1994), work practices (Bresnahan, Brynjolfsson and Hitt, 2002), skill-biased organizational change (Caroli and Van Reenen, 2001), adoption of new management practices (Bartel et al. 2006), firm boundaries (Baker and Hubbard, 2004) and delegation

of authority (Acemoglu et al. 2006). However, there is little evidence on the role of competition.² While acknowledging the importance of information technology, our focus is on whether there is a causal effect of product market competition on the observed flattening of firms.

The remainder of the paper is organized as follows. Section 2 reviews the theoretical literature on hierarchies and discusses the potential links between product market competition, internal hierarchies and managerial incentives. Section 3 describes the data and our empirical strategy. Section 4 outlines our results and discusses potential interpretations. Section 5 concludes.

2. Background on Hierarchies and Competition

The decentralized or multidivisional form as described and documented in the pioneering work of Alfred Chandler (1962) was adopted initially by large industrial firms in the U.S. during the early part of the 20th century. Broadly speaking, M-form organizations are comprised of a central administrative unit or “headquarters” and operating units or divisions. Headquarters is responsible for generating the firm’s strategy and long-term goals, coordinating activities and allocating resources across the divisions within the firm. In contrast, divisions are “concerned with all the functions in the overall process of handling a line of products or services.” An organizational *structure* (according to Chandler) is defined by two features: (1) the lines of authority and communication between the different administrative offices and officers, and (2) the information and data that flow through these lines of communication and authority.

There is a growing theoretical literature in economics that relates to each of these features. Several models explore the role of a hierarchy in enabling a firm to process and communicate information among agents (e.g. Radner, 1993; Bolton and Dewatripont, 1994; Garicano, 2000). More recent research builds on the importance of information

²An exception is Bloom and Van Reenen (2007) who find that the level of import penetration is significant in explaining the adoption of management practices across industries and countries.

and considers the allocation of authority and decision-making to positions across the organization (e.g. Aghion and Tirole, 1997; Dessein, 2002; Hart and Moore, 2005).³

Whether we consider hierarchies as information processing networks or structures to allocate authority, in this paper, we explore how greater product market competition alters the optimal hierarchical structure and incentive design for managers. To our knowledge, there is limited research in economics that explicitly links product market competition to the internal organization of firms. One exception is Marin and Verdier (2003) who develop a model of hierarchies based on Aghion and Tirole (1997) and show that greater international competition leads to a delegation of authority from the CEO to the managers.⁴ In order to better understand the potential importance of competitive pressure arising from trade liberalization and reductions in trade costs, we need to relate the drivers of organizational structures to the theories on the effects of competition on firms as well as the trade models of multi-product firms' choices.

Competition has a first order effect on the incentives of firms to innovate, where innovation is represented by product development (create new varieties), process development (reduce the marginal costs of production), or quality upgrading (improve existing varieties). While a number of papers in industrial organization have studied this question with ambiguous results, Vives (2006) generalizes these models and shows that, under very general conditions, an increase in competition will typically lead to greater innovative activity.⁵ As such, we expect an increase in competitive pressure to increase the value of innovation and product development.

Innovation is critical to the success (and survival) of firms and is highly dependent on the ability to adapt quickly to changing market conditions. The new competitive

³ The early theoretical work which is less central to this paper considers hierarchies as a means to create incentives (e.g. Lazear and Rosen, 1981), to supervise workers (e.g. Williamson, 1967; Calvo and Wellisz, 1978) or to assign talent (e.g. Rosen, 1982).

⁴ Other related papers do not deal explicitly with hierarchies. Askenazy, Thesmar and Thoenig (2006) consider how new technologies increase the value of innovation which causes firms to design more "reactive" organizations. Thesmar and Thoenig (2000) show that an increase in the rate of creative destruction (the arrival of new products) has an impact on organizational choice. Harstad (2007) explores the effect of competition in the choice of U-form versus M-form by firms.

⁵Vives (2006) discusses the previous literature on competition and innovation and, in generalizing a number of these models, shows that as long as there is free entry into the market (both in situations of quantity and price competition with differentiated goods) an increase in competition will typically lead to an increase in innovative activity. Process innovation through R&D investment will increase, and product innovation also will be higher in the Bertrand game with differentiated products.

environment is likely to alter firm structure as defined earlier and, in turn, the roles of various management positions. Given that division managers have better information on suppliers, customers and competitors, they can potentially respond more quickly to new information. As quick adaptation to local information becomes more important, we might expect organizations to become more decentralized and grant greater decision rights to division managers (e.g. Aghion and Tirole, 1997, Dessein, 2002, and Marin and Verdier, 2003). Moreover, as firms enhance the decision-making authority of division managers or broaden the scope of their jobs, they may change their position in the hierarchy. This could lead to either delayering (or a reduced number of levels in the hierarchy) or to steeper hierarchies.

A further rationale for delayering could be to minimize loss of control induced by the multiple layers in a hierarchical structure (Williamson, 1967). Delayering may be optimal to the extent that information is garbled as it goes up the hierarchy and that competition requires greater precision in information for more accurate and quicker decisions by top management. Furthermore, if increasing competition takes the form of creative destruction, where new products replace older ones, the need for a heightened rate of new product introduction, more effective R&D, and faster decision-making all become critical (Thesmar and Thoenig, 2000)

While competition tends to raise the incentives to adapt to local market conditions, there is a cost to delegating decision making to lower levels in the organization. Self-interested division managers may not act in the best interest of the firm and, in a multi-divisional firm, there may be a greater need to coordinate actions across autonomous division managers. Adaptation to local information may come at the cost of increased coordination and potentially lead firms to alter the role of managers closer to the top of the hierarchy (e.g. Dessein and Santos, 2006; Alonso, Dessein and Matouschek, 2006). More specifically, firms may emphasize the role of the CEOs in coordinating activities--defining the long-term goals of the firm, allocating resources across divisions, and making strategic decisions--while day-to-day operating decisions become the primary responsibility of division managers. Furthermore, the coordinating role of other senior officers (e.g. Chief Financial Officer, Legal or General Counsel, Head of Strategic

Planning) may change with a corresponding shift in their hierarchical positioning.⁶ This could lead to a change in the CEO's span of control or the number of positions reporting directly to the CEO.

In addition to altering the hierarchy, increased competition is likely to change the importance of incentives provided through pay independently of the effect on hierarchies (e.g. Raith, 2004; Cuñat and Guadalupe, 2006). Incentive provision may interact with the design of the hierarchical structure as both are choice variables at the disposal of the firm (Mookerjee, 2005). If division managers are given more decision-making authority in order to quickly adapt to local information, firms may increase pay levels and performance-based pay as the responsibility or scope of the job increases (e.g. Athey and Roberts, 2001; Aggarwal and Samwick, 2003; Wulf, 2007).

To sum up, we expect intensified competition to increase the value of innovation and quick decisions leading multidivisional firms to change their organizational structures—potentially to better respond to local information while simultaneously strengthening mechanisms that coordinate activities across divisions. Firms may delegate more decision making to division managers (i.e. specialists with local expertise) coupled with a change in the number of levels in the hierarchy and a potential shift to performance-based pay. Also, firms may alter the role of coordinators (i.e. managers at headquarters) which may change the CEO's span of control and the position of senior functional officers in the organizational hierarchy.⁷

Of course there are other explanations for the flattening of firms, the most obvious being the rise of information technology. Managers receive, process, and transmit information and improvements in the technology of communication and computation may directly affect hierarchical structure and may have differential effects in more competitive environments. For example, improvements in communication technology

⁶ “As leadership becomes more complex, the skills and perspectives that top business lawyers bring to strategy and leadership is becoming highly valued.” “The best corporate General Counsels are so closely tied to the work of the CEO that they’re capturing an unparalleled view and understanding of critical business issues that drive or influence the business.” K. Griffin, “Lawyer CEOs,” *Leadership Excellence*; Mar 2007, 3, pg. 6.

⁷ Much of the recent literature focuses on whether organizations have become more decentralized. While a variety of definitions are employed in the literature, Hart and Moore (2005) define an organization to be “centralized if it is likely that a decision will be made by someone at headquarters (a coordinator) rather than by some with local expertise (a specialist)” and “...decentralized if a decision is likely to be made by a specialist rather than a coordinator.”

may allow more efficient processing of information thereby increasing spans of control, and this effect may be more pronounced in competitive environments in which quick decision-making is essential. As discussed in the introduction, a number of empirical papers demonstrate that IT is an important determinant of organizational design. However, to our knowledge, there is little empirical evidence on the relationship between IT or competition and the structure of the internal hierarchy.

Finally, increased competition can affect hierarchies through many channels, including, but not limited to: changes in business scope⁸, greater emphasis on innovation and the importance of R&D, the reduction of organizational slack (or X-inefficiency), and outsourcing or offshoring. While it is beyond the scope of the paper to consider each of these various channels, we will attempt to control for several of these mechanisms in our empirical specifications.

3. Data

3.1 Organizational Data

The primary dataset from which we draw our sample is an unbalanced cross-industry panel of more than 300 publicly traded U.S. firms over the years 1986-1999. This dataset includes detailed information on job descriptions, titles, reporting relationships, and reporting levels of senior and middle management positions that allow us to characterize organizational structures of firms in a potentially more accurate way than previous research. The dataset is rather unique because it systematically captures Chandler's notion of "lines of authority and communication" and the information flow within firms over a 14-year period that is characterized by significant organizational change.

The data are collected from a confidential compensation survey conducted by Hewitt Associates, a leading human resources consulting firm specializing in executive compensation and benefits. The survey is the largest private compensation survey (as measured by the number of participating firms). The survey participants are typically the

⁸ Over 90% of US manufacturing output is produced by firms with more than one product line (Bernard, Jensen and Schott 2005). Importantly, this holds in the multidivisional firms that we are studying. The trade literature has recently started analyzing multiproduct firms and the effect of trade liberalization on their diversification choices. Nocke and Yeaple (2006) and Bernard, Redding and Schott (2006) show that a fall in transport costs or trade liberalization leads firms to divest, reduce the number of product lines they have, and focus on their core competencies.

leaders in their sectors and the survey sample is most representative of Fortune 500 firms. For a more detailed description of the data and their representativeness, see Rajan and Wulf (2006).

An observation in the dataset is a managerial position within a firm in a year. This includes both operational positions (e.g., chief operations officer and division managers) and senior staff positions (e.g., chief financial officer and general or legal counsel). The data for each position include all components of compensation including salary, actual bonus, and grants of restricted stock, stock options, and other forms of long-term incentives (e.g., performance units)⁹; as well as position-specific characteristics such as job title, the title of the position that the job reports to (i.e., the position's boss), number of positions between the position and the CEO in the organizational hierarchy, and both the incumbent's status as a corporate officer and tenure in position.

We capture changes in organizational structure by focusing on two measures: the breadth and depth of the hierarchy. These can be defined consistently across firms and over time and reflect important information about two important positions in the hierarchy, namely the division manager and the CEO.

Span is a firm level measure that captures a horizontal dimension or breadth of the hierarchy. It represents the Chief Executive Officer's span of control (CEO Span) and is defined as the number of positions reporting to the CEO. Since we know the title of the position that each position reports to (i.e. the position's boss), we can determine which positions report directly to the CEO. Figure 2 (top panel) shows the evolution of median span in our sample. It went from 4.5 positions in 1986 to 7 positions in 1999. Our other measure, depth, is defined at the division level and represents a vertical dimension of the hierarchy. It is defined as the number of positions between the CEO and the division manager. In the survey, a division is defined as "the lowest level of profit center responsibility for a business unit that engineers, manufactures and sells its own products." Figure 2 (bottom panel) shows that depth fell from 1.5 to 1 in our sample period. Figure 2 also shows how these organizational measures correlate with our measures of trade costs in aggregate. We discuss these in the next section.

⁹The Hewitt database is thus far more comprehensive than the SEC filings which form the basis for the ExecuComp database. Because firms are required to only file information on the top five executive officers, information on divisional managers is rarely included in these sources.

We focus on the division manager position for two reasons: (i) it is the position furthest down the hierarchy that is most consistently defined across firms; and (ii) it is informative about the extent to which responsibility is delegated in the firm. Figure 1 displays an example of a hierarchy that demonstrates both measures of span and depth. In this example, the measure of span equals 4 -- there are four positions reporting directly to the CEO -- and the measure of depth equals 2 — there are two positions between the CEO and the division manager.

In this paper, we focus on the subset of firms that operate in the manufacturing sector for which we have data on the measures of competition. This leads to a sample of approximately 1419 firm-years and 5029 division-years that includes 149 firms and 1319 divisions. We will report both firm level regressions (span of control is a firm level variable) and division level regressions (depth, or the number of positions between the division manager and CEO will vary by division within the firm).

The above data are supplemented with financial information from Compustat. While the Hewitt survey is conducted in April of each year and the compensation data describe the firm in the year of survey completion, some statistics (e.g., number of employees in the firm) represent the end of the most recent fiscal year. To maintain consistency, we match Compustat data using the year prior to the year of the survey. We also have information on division level sales and employment.

Finally, we construct a number of variables that are used as controls and that we will describe in the results section (see the Data Appendix for details on how these are built).

3.2 Competition Data

In order to measure the impact of globalization on firm hierarchies, we use two different approaches in our search for causality and to confirm the generality of our results. First we use data on trade costs (both tariffs and transport costs) facing foreign competitors. Second we exploit a quasi-natural experiment, namely the bilateral trade liberalization between the US and Canada. Both are measures of the extent of openness and globalization of US firms, and capture changes in the degree of competitive pressure.

Trade Costs

A reduction in trade costs can be interpreted as a fall in entry barriers into the US market and hence as an increase in competitive pressure as the industry becomes more global. In order to measure trade costs, we use the data constructed by Bernard, Jensen and Schott (2006) that contain industry tariffs and transport costs at the 4-digit SIC level. These trade costs are constructed from the underlying product level data compiled by Feenstra (1996) using product level information on duties and imports.

Industry level tariffs are constructed as the import weighted average tariff rate across all products in industry s at time t , where the weights are the import values from all source countries. This is constructed as duties collected ($duties_{st}$) relative to the Free-On-Board customs value of imports (fob_{st}), $Tariff_{st} = duties_{st} / fob_{st}$. The transport costs measure is a measure of ad valorem freight and insurance rates constructed as the markup of the Cost-Insurance-Freight value (cif_{st}) over fob_{st} relative to fob_{st} , $TransportCost_{st} = (cif_{st}/fob_{st}) - 1$. (Bernard, Jensen and Schott, 2006). This is also weighted by import values of the source countries by industry and year. We run regressions of our organizational variables ORG_{fst} by firm f (or division, where division level information is available), industry s and year t on tariffs and transport costs, controlling for year dummies d_t , firm (or division) fixed effects η_f and a number of control variables X_{fst} that we will discuss later:

$$ORG_{fst} = \phi_1 Tariff_{st} + \phi_2 TranspCost_{st} + X_{fst}' \beta + d_t + \eta_f + \varepsilon_{fst} \quad (1)$$

Using these trade costs presents some clear advantages for our purposes. First, tariffs and transport costs are arguably exogenous to firms' internal structures. Tariff reductions are mostly driven by trade liberalization and World Trade Organization agreements. Transport cost reductions are mostly driven by lower prices and improvement in transport technology (especially from land and air transport, Hummels, 2007).

In terms of interpreting the results, trade costs for foreign firms selling in the US are possibly highly correlated with trade costs facing foreign firms so that the effect captured by these measures includes both reductions in entry barriers for foreign firms as well as increases in market size for domestic firms. Both of these effects represent a different

aspect of competitive pressure (Vives, 2006) and it will be hard to disentangle the two. Similarly, to the extent that tariffs are set bilaterally or multilaterally, the same comment applies to the tariff rate. It is for this reason that we interpret these measures as proxies for globalization, more broadly. Second, from a purely practical empirical perspective, these measures vary both cross-sectionally and over time. It is generally difficult to find measures of competitive pressure that exhibit this variation. Furthermore, these two measures capture distinct features of barriers to entry, evidenced by their very low correlation (0.09).

However, these data are also subject to a number of caveats as discussed in Bernard, Jensen and Schott (2006). One concern is that the weights on tariffs and transport costs are related to the fraction of imports from each country and this may change over time. As a result, some of the variation may arise from changes in the pattern of trade and not in tariffs or transport costs themselves. For our purposes (namely identifying a causal effect in the data), the main disadvantage is that some tariff reductions may be the result of lobbying by domestic industries that fear international competition, such that it may be harder to argue absolute exogeneity in these measures.

Trade Liberalization

To deal with these concerns, we provide an additional set of results using a quasi-natural experiment. This is the bilateral trade liberalization between the US and Canada in 1989 (CUSFTA) and 1994 (NAFTA). This is arguably exogenous, it affected all manufacturing industries and there is no concern about the weights changing over time.

The main trade liberalization between Canada and the US occurred in 1989. Both countries agreed to eliminate all tariff barriers in manufacturing within 10 years. This was largely unexpected by firms -- a referendum was held where the treaty was approved against all expectations. Also, it affected a substantial fraction of US trade since the US-Canada trade relationship is the largest in volume in the world and Canadian imports represent an average of 20% of total US imports (in comparison to Mexico at around 5%). In addition, in terms of product specialization, Canada is similar to the US so that Canadian products are likely to compete directly with US products. Finally, there were no

other important trade agreements during that period so that the shock to trade with Canada is unlikely to be confounded with other factors.

In our empirical approach, we propose that firms in industries with high tariffs on Canadian imports prior to 1989 suffered a bigger ‘competitive shock’ following the liberalization than firms facing low tariffs. In order to define the level of exposure of the firm to the liberalization, we define the average tariff on Canadian imports by industry for the period between 1986 and 1988 (Feenstra et al., 2002). Higher tariff industries were more protected prior to 1989 and we expect the shock to those industries to be greater. In other words, firms in high tariff industries face greater competitive pressure after 1989 relative to firms in low tariff industries.

Therefore the specification that exploits the trade liberalization is a difference-in-differences regression where the treatment is continuous (AvT^{pre89}_{fs} the level of tariffs on Canadian imports in the industry pre-89) is as follows:

$$ORG_{fst} = \theta_1 AvT^{pre89}_{fs} + \theta_2 P89_t + \theta_3 P89 * AvT^{pre89}_{fs} + X_{fst} ' \beta + d_t + \eta_f + D_s * t + \varepsilon_{fst} \quad (2)$$

where $P89_t$ is a dummy that equals one after 1989, $D_s * t$ are industry specific time trends and the other variables are defined as before. θ_3 captures the differential effect of the liberalization on firms according to their trade exposure prior to 1989, net of the general change post 1989 and the pre-existing cross-sectional differences (notice that in practice, firm fixed effects will absorb the latter).

Romalis (2005) shows a substantial effect of the agreements on trade volumes with Canada. This was confirmed in our data: the fraction of Canadian imports out of total imports by industry increased more in industries that were highly protected prior to 1989.¹⁰ Since the liberalization was bilateral, Canadian tariffs on US imports also fell. To the extent that tariffs on both countries are highly correlated, our results will capture the overall competitive effect of lower entry barriers into the US and increased market size for US firms.

¹⁰ There is also substantial evidence on the effect of the trade liberalization on Canadian firms (Head and Ries, 1999, Trefler, 2004).

The main trade liberalization agreement with Canada was the 1989 CUSFTA. However, since the NAFTA treaty was implemented in 1994 and incorporated CUSFTA, we allow for a potential distinct effect in 1994 by interacting the average tariff on Canadian imports in the period 1990 to 1993 with a post 1994 dummy. The equation that we estimate including both CUSFTA and NAFTA effects is as follows:

$$\begin{aligned}
 ORG_{fst} = & \theta_1 AvT^{pre89} + \theta_2 P89_t + \theta_3 P89 * AvT^{pre89} \\
 & + \delta_1 AvT^{90-94} + \delta_2 P94_t + \delta_3 P94_t * AvT^{90-94} + X_{fst}' \beta + d_t + \eta_f + D_s * t + \varepsilon_{fst}
 \end{aligned} \tag{3}$$

As we will see, in general, the results on NAFTA are statistically insignificant, confirming that the bulk of the effect of the trade liberalization with Canada occurred with CUSFTA (see Trefler 2004, Romalis 2005).

We will also see how the trade costs and the liberalization affected other firm outcomes beyond the organizational variables to provide a fuller picture of how firms adapt to global competition.

4. Results

In this section we present results on the effect of competition on two main organizational outcomes (CEO span of control and division depth), using our two empirical strategies: 1) the variation in trade costs (tariffs and transport costs) and 2) the 1989 Canada US free trade agreement (CUSFTA). These measures capture slightly different effects and have strengths and weaknesses, but together they provide a clear picture of the effect of competitive pressure and globalization on the flattening of firms. Later in this section we will explore the reasons why firms may respond to the changing environment by flattening their hierarchies, and discuss the possible mechanisms by which these changes occur.

4.1 Trade Costs, Trade Liberalization and the Flattening Firm

Span of Control

Span of control (defined as the number managers that report directly to the CEO within the organization) reflects the “lines of authority and communication” that Chandler refers to in defining an organizational *structure*. One obvious question is: what information is reflected in a reporting relationship to the CEO? First, the CEO should have direct authority over the manager in the position (i.e. his subordinate), and second, presumably the exchange of information between the CEO and the manager is more direct than it would be if the “chain of command” included other intermediary positions. Since the CEO is at the top of the lines of authority and communication, his job involves decision making at the highest level, but also includes a role of coordinator of information and decisions that are associated with a complex, multidivisional firm. As our measures of globalization and trade liberalization reflect the increased competitive pressure and complexity of product markets, we expect that the role of the CEO will change and this should be reflected in the span of control.

Table 2 reports the span results using the negative of tariffs and transport cost, such that an increase in the variables as defined (a fall in tariffs or transport costs) reflects an increase in competition or market openness. All regressions control for year dummies and firm size (as log of firm sales) and cluster standard errors at the industry level. Column 2 presents the firm fixed effects specification and shows that increasing pressure from falling tariffs and transport costs leads to an increase in the span of control: a one standard deviation change in both measures leads to an increase in span of one position, which is about half of the overall increase in span over the period. Columns 2 through 7 include firm fixed effects. This means that our estimates are net of any permanent unobserved heterogeneity across firms that would bias the results and are exclusively identified from within firm variation in our trade measures (and not from differences across firms).

The increase in the number of direct reports comes from senior officer positions (CFO, COO etc.), as well as from lower level managers. Column 3 controls for the presence of a number of senior officer positions that may report directly to the CEO. We find that the effect of tariffs is approximately halved (suggesting that some of the effect of tariffs on span is driven by the increased direct reporting of these higher level officers), while there are no significant changes to the effect of transport costs. Overall, the results

indicate that the increase in span includes both senior officer positions and managers traditionally lower in the hierarchy. In the next section, we will analyze explicitly how the distance (or the number of positions) between the division manager and the CEO changes, but these results already indicate that the distance is falling, since more lower level managers are reporting directly to the CEO.

Column 4 includes controls for other standard indicators of competition, specifically, the top three concentration ratio of industry sales (CR3) and the firm's Lerner index (the price cost margin). We find that both coefficients are statistically insignificant, although the sign on the Lerner index suggests that more competition (lower Lerner) is associated with broader span. Under some restrictive assumptions, increases in these measures should reflect falling competition in the industry, however, they are plagued with problems in interpretation (Schmalensee, 1989; Boone, 2000) and so we present them with the utmost caution.¹¹

Next, we evaluate the role of information technology (IT) using the growth in IT capital stock at the 2-digit SIC industry level from the Bureau of Economic Analysis (BEA) (refer to the data appendix for specifics). The quality of these data is less than what we would require for a conclusive analysis, however, they allow us to evaluate the robustness of our main results and to preliminarily explore potential interactions between competition and IT adoption. Column 5 introduces industry IT growth directly and interacted with our competition measures. We find that a one standard deviation higher rate of IT growth leads to an increase in span of 0.3 of a position. This is consistent with much of the literature on organizational change and technology (e.g. Garicano, 2000) that predicts that better communication technology will lead to an increase in span of control. However, it does not take away from the effect of competition, although the two interact: in industries with an average growth rate in IT capital stock (relative to no growth), a one standard deviation increase in competition leads to a 0.23 broader CEO span of control.

We exploit the within firm variation in tariffs and transport costs by introducing firm fixed effects and we include year dummies to capture the trends in these measures over time. However, to further check the robustness of our results, in column 7, we include

¹¹ The fact that these measures are so poor is partly what led us to look for more exogenous changes driven by tariffs and trade liberalization.

industry specific time trends (industry dummies interacted with a trend) as additional controls. The results are statistically identical to those in column 2.

Finally, as we mentioned earlier, there are a number of other mechanisms that could be driving these results. Span might be changing because firms decide to offshore some of their production as trade costs fall, or because they diversify the range of products they offer thereby creating more divisions to manage. Similarly, competitive pressure may lead them to change the degree of innovation and R&D. In column 7, we control for these additional factors (on top of the existing controls): (i) the fraction of sales produced by foreign subsidiaries (computed from Compustat Geographic Segments as non-domestic sales over total sales), (ii) the herfindahl index (HHI) of segment sales (computed from Compustat Business segment data as the sum of the squared share of each segment in total sales), and (iii) R&D expenditure (R&D divided by sales). The results are again statistically identical, and if anything slightly larger than those in column 2 suggesting that some of the effect of competition operates through the adjustment along these other margins. The interpretation of column 7 in econometric terms is complicated though (trade costs should be the reduced form of the overall effect) and we present the results only as suggestive of potential mechanisms, and not as a proper test. We will turn to a more careful discussion of a potential mechanism later. For now, span is broader in firms with larger fraction of foreign sales, with greater diversification (or less segment concentration), and with less R&D.

Table 3 presents similar specifications, but uses the bilateral trade liberalization with Canada as the experiment. We interact the average tariff before the 1989 CUSFTA with a post 89 dummy. The agreement specified that all tariffs be eliminated (within a time frame) after 1989. As such, we expect the agreement to reflect a greater increase in competitive pressure (i.e. a larger fall in entry barriers) in industries with high tariffs relative to low tariff industries. The results indicate that span increased 0.5 more in firms with median tariffs pre-1989, relative to firms in industries with no tariffs. This represents about 20% of the median change in span for our sample of firms. Column 2 controls for all the intermediate factors we introduced in the previous table, and we'll discuss these in more detail later. Column 3 controls for whether senior officers report directly to the CEO, so that the remaining effect is largely driven by executives at lower

levels of the hierarchy. We find that around half of the increase in span arises from lower level managers.

Most of the liberalization agreements with Canada were made in 1989, but since the North American Free-Trade Agreement was signed in 1994, we also include in all regressions an interaction of the average tariff between 1990 and 1993 with a post-94 dummy variable. This captures the differential effect of the agreement across firms with different levels of protection before 1994. Even though we obtain the same sign as with the 1989 experiment, the point estimates are much smaller and statistically insignificant. This suggests that most of the effect comes from the 1989 agreement, and that indeed, there were no radical changes in tariff agreements with respect to Canada that firms had to respond to in 1994. The absence of an effect for the 1994 experiment suggests that we are not just capturing a spurious time trend. If it was spurious, the 1994 experiment coefficient should be significant, particularly since most of the flattening occurred during the late 1990s.¹² We also explicitly control for the potential that the trend was present in the data before the trade liberalization, by including industry specific time trends in the regressions. Column 4 presents those regressions, with similar results.¹³

In sum, we find that span of control increases with competitive pressure represented by falling trade costs and the trade liberalization with Canada. The results are robust to controlling for industry trends and seem to suggest that around half of the overall increase in span arises from managers below the senior officers that are more likely to report directly to the CEO. Next we turn to analyze directly the position of the division manager in relation to the CEO, to have a fuller picture of how flattening occurred.

Depth

Division managers are the highest authority in the division, where a division is defined as the lowest level of profit center responsibility for a business unit that engineers, manufactures, and sells its own products. While CEOs are at the top of organizational structure, division managers represent the lowest level managerial position

¹²As an additional robustness check, we limited the sample where transport costs had increased between the first and last year (where it was more costly to ship and competition was lower), and found similar results, which indicates that our results are not just a spurious trend.

¹³These regressions include all firms in our sample. When we restrict the sample to firms that are there from before 1989, we obtain similar results, with slightly larger coefficients.

with P&L responsibility (manufacturing plants are typically cost centers with no sales function). We measure depth of the hierarchy as the number of positions between the division manager and the CEO. Depth ranges from 0 (the DM reports directly to the CEO) to 4 (there are four positions between the DM and the CEO), with an average of 1.3.

Tables 4 and 5 present the results for the depth regressions in which the unit of observation is no longer the firm-year, but instead the division-year (there are 1314 divisions in the data). We include division fixed effects and cluster errors at the industry level. We analyze how changes in each division's depth vary over time with changes in trade costs measured again as (minus) tariffs and (minus) transport costs at the industry level. The results shown are based on trade costs faced by the firm's primary industry measured at the 4-digit SIC level. When we use trade costs of the division's industry (that is unfortunately only available at the 3-digit level), we obtain similar results (unreported).

The fact that we include division fixed effects means that we are looking at the same division as it changes over time. As the role of the division manager changes it is likely that the division will also change in size, so we control throughout for division employment. Of course, divisions experience other changes over time and this may be reflected in depth: our estimates only reflect how depth is affected by trade costs and liberalization.

Column 2 of Table 4 shows that a one standard deviation change in transport costs leads to a decrease in depth of 0.1 of a position. Over the sample period, depth decreased by 0.5 positions on average. The tariff measure has the opposite sign, but is not significant. Column 6 replicates the same regression including not only year dummies, but also industry trends to allow for differential trends in these industries. The magnitude of the coefficient on transport costs doubles and is still significant, while the tariff result is still insignificant, suggesting that firms are indeed responding to transport costs, and this is not a result of a spurious trend in the data.

Column 3 includes the Lerner index and industry concentration, and both suggest that the more competitive the industry is (low Lerner and low concentration), the fewer number of layers in the hierarchy. However, as mentioned earlier, these measures have a number of drawbacks that lead us to interpret them with caution. Column 4 explores the

role of IT, and shows that divisions in firms operating in IT-intensive industries are further away from the top. This suggests that IT enables better communication thereby allowing DMs to be further away from the top without a loss in the quality of information transmitted up the hierarchy. The interaction between IT and our trade costs measures suggest that as competitive pressure increases, low IT firms flatten, but high IT firms become steeper. Finally, we assess how other variables are associated with changes in depth in column 5, with no additional highly significant results.

Overall, firms seem to delayer as a result of lower transport costs. We interpret this as the effect of a more global market where foreign firms can export to the US more easily. However, to the extent that transport costs for domestic and foreign firms are correlated, domestic companies also find it easier to ship goods abroad. It is this feature of the globalization of trade that leads firms to flatten.

Table 5 focuses on the trade liberalization. Results are similar in the sense that firms experiencing a larger decline in tariffs reduced division depth more, relative to firms not affected by the liberalization.

4.2 Why are firms flattening?

The previous results show that reductions in trade costs and trade liberalization explain some of the flattening of firms—both the increased span of control of the CEO and the delayering of levels in the hierarchy. Arguably, they represent causal estimates that go beyond the simple correlations of prior research. However, even though they capture a significant causal effect, they say nothing about the reasons for why firms alter their organizational structure and what the flattening actually means. While it is difficult to identify precise channels for the causal mechanism, in this section we attempt to shed some light on this issue and discuss a possible interpretation that is generally consistent with our results.

Division Manager (DM) Compensation

As shown earlier, following trade liberalization and reductions in transport costs, division managers are closer to the CEO in the organizational hierarchy. We argue that this reflects the increased responsibility of DMs and potentially greater delegation of

authority as an optimal response to competition (consistent with Marin and Verdier, 2003). Strictly speaking, our depth measure reflects “number of reporting levels” without any information on the actual role of the DM. However, by looking at DM compensation and the importance of performance pay in their contracts, we can potentially infer a difference in job scope.

Tables 6 and 7 show the effect of trade costs and the trade liberalization on the logarithm of division manager pay. The regressions include division manager position fixed effects and cluster standard errors at the industry level. The results indicate that higher competitive pressure leads to higher total pay. A one standard deviation fall in transport costs and in tariffs (column 1 table 6) lead to a 3.8% and 1.6% increase in total pay respectively, although the latter effect is not significant. Regarding the trade liberalization, division managers in industries with median tariffs on Canada pre-1989 had a 4.7% increase relative to those with no tariffs before 1989 (column 1 table 7). The results hold when we include a number of other factors that may affect pay as well as industry time trends.

We interpret this increase in pay along with the simultaneous reduction in depth and increase in span as a delegation of authority from the top of the firm to division managers. More decision making authority is delegated to the lower ranks with a commensurate increase in pay. All regressions include division fixed effects, and control for firm size as well as division size, so the higher pay is not just driven by permanent differences across divisions, nor by changes in the size of the division. Unfortunately, even though we control for division fixed effects, we cannot include individual fixed effects, and the division could very well be changing managers over this period. If as competition increases, firms are hiring more talented managers that require higher pay, then our result is a mixture of more skilled managers hired for a more complex job with greater autonomy. All we can confidently say is that the role of these managers as reflected by their pay is more important, whether this comes from hiring more skilled/better managers or from a change in the job description.

In addition to greater delegation of decision-making, firms may increase performance-based pay to ensure that division managers make decisions that are optimal for the firm. Athey and Roberts (2001) indicate that both incentives and delegation of

authority are effective in delivering certain outcomes, but not others. In reality, we are likely to observe a mixture of both instruments. We evaluate incentive provision by firms in Tables 8 and 9 where the dependent variable is the fraction of long-term incentive pay out of total pay that division managers receive. The value of the long-term compensation includes restricted stock, stock options and other components of long-term incentives and is determined by a modified version of Black-Scholes.¹⁴ The results indicate that higher competitive pressure leads to a higher fraction of total pay in the form of long-term incentives. This is again true for trade costs (in particular for transport costs in Table 8) and the trade liberalization (Table 9), and when controlling for other factors (column 2) and industry trends (column 3).¹⁵

Senior Functional Officers

The increase in the CEO's span of control suggests that the role of the CEO is changing. A broader span of control may limit the CEO's involvement in operating decisions simply due to time constraints. However, there may be a greater role for the CEO in coordinating decisions across multiple business units. Furthermore, while globalization may require division managers to quickly adapt to local conditions and make more day-to-day operating decisions, the CEO's role in the planning of long-term strategy may be of increasing importance to the firm's performance. This would be driven by the fact that the complexity and speed of change implied by the globalization process makes good decision making at the top of the hierarchy more crucial (the cost of a bad strategic decision is more damaging in a competitive setting).

To evaluate how the CEO's role is changing, we explore the changes in the composition of the positions that report directly to the CEO as competition increases. For

¹⁴ The value of long-term compensation is computed by Hewitt Associates. Stock options are valued using a modified version of Black-Scholes that takes into account vesting and termination provisions in addition to the standard variables of interest rates, stock price volatility, and dividends. As is standard practice among compensation consulting firms, the other components of long-term incentives (i.e. restricted stock, performance units and performance shares) are valued using an economic valuation similar to Black-Scholes that takes into account vesting, termination provisions, and the probability of achieving performance goals.

¹⁵ One concern is that the notion of a division varies across firms and what we are picking up in our pay regressions is either just differences in a firm's definition of a division or differences in firm compensation policies. Since we have division fixed effects, permanent cross-sectional differences in how firms define a division will not affect our estimates, and they are also robust to controlling for division depth.

this purpose we focus on whether the senior functional officers report directly to the CEO. In Table 10, we define the dependent variable as a dummy variable representing whether the Chief Financial Officer (columns 1 and 2), the Legal Counsel (columns 3 and 4) or the Long-Range Planning & Business Development Officer (columns 5 and 6) report directly to the CEO.

The Chief Financial Officer (CFO) is the functional head responsible for all financial operations of the corporation including both the treasury and accounting functions. The Legal Counsel (or General Counsel) is the head of all legal affairs of the company and supervises outside legal counsel. We find that both of these positions are more likely to report directly to the CEO as competitive pressure increases. What might explain the closer proximity of these positions to the CEO? The CFO is responsible for the efficient design of the firm's capital structure, while the Legal Counsel is responsible for all of the firm's legal issues (e.g. protection from lawsuits, especially with regards to patents, other proprietary innovations, environmental issues and, more generally, the public image of the company.) As competitive pressure intensifies and the role of the CEO as strategist and coordinator becomes more important, direct communication between these senior officers and the CEO may be critical to faster and more accurate decision-making.

On the other hand, we find that the Long-Range Planning & Business Development Officer (Planning) is less likely to report directly to the CEO. This position is the functional head responsible for developing and obtaining agreement on overall corporate strategy and for recommending the allocation of resources to existing businesses, acquisitions of new businesses, and disposition of existing businesses. With increased competitive pressure, the importance of this position is lessening, arguably because the CEO is more involved in developing corporate strategy.

We also looked at other senior officer positions in the firm, but did not find systematically significant relationships between changes in hierarchical position and changes in competition. The results are available upon request.

4.3 What else is changing?

Clearly, firms have undergone many more changes during this period than simply altering their organizational structures. To evaluate what other factors are associated with

increased competition, we regress a number of other outcomes on our measures of trade costs (table 11, odd column numbers) and liberalization (even column numbers). These include the number of other intermediary positions between the CEO and division managers, the degree of business diversification, the extent of offshoring, and expenditures on R&D. Table 11 presents these results.

We find that the number of other intermediate positions (defined as any manager in the data that is not a senior officer or a division manager) between the CEO and the division managers falls with competitive pressure (columns 1 and 2). This reflects the flattening of firms in a different way, and suggests that some decisions made by these intermediaries may now be the responsibility of DMs. Furthermore, as these positions disappear, information travels through fewer levels leading to more precise information at the top.

We also find that multidivisional firms tend to decrease scope and focus their business operations (or become less diversified) in the presence of increased competition. This is true whether we measure focus as the concentration of firm sales across different business segments (segment HHI in columns 3 and 4), as the number of segments, or as the fraction of total sales represented by the largest segment (the latter two are unreported). In contrast to more focused business operations in more competitive industries, we find greater geographic diversification. That is, firms tend to increase the fraction of sales produced by foreign subsidiaries (columns 5 and 6) when competition intensifies.¹⁶ Finally, firms spend more on R&D in more competitive industries (however, the results are not highly statistically significant). This is consistent with empirical work on the effect of foreign competition on innovation (Bertschek, 1995) and suggests that firms increase their level of innovation to stay ahead of the competition.

These results are suggestive of firms responding in a variety of ways to the fall in trade costs and the trade liberalization. These include focusing on their core businesses, but expanding geographically, and investing more resources in innovation. The findings

¹⁶ Roberts (2004) argues that “if environmental changes allow new opportunities for growth in a firm’s core businesses, it might be expected to focus on these and leave other lines of business... Thus, we might expect to see decreased scope.... Globalization is one such change: lowering barriers to trade ...and increased ease of communicating, traveling, and shipping across borders mean that companies have new opportunities to expand internationally and can grow by increasing their geography without increasing the scope of products or services that they offer.” Pg. 230.

on flattening that we establish in this paper are possibly part of the implementation of this new corporate strategy.

5. Conclusion

Conventional wisdom and recent empirical evidence suggest that firm hierarchies are flattening—broader spans of control and delayed organizational structures (or fewer levels in the hierarchy). What are the possible explanations for the flattening of firms? Do hierarchies flatten because of the adoption of information technology, changes in work practices or managerial skill, or new plans for firm strategy and shifts in business mix? Many have argued that increased competition from globalization has driven firms to search for new organizational forms to replace traditional hierarchical structures. In this paper, we focus on this explanation.

The main contribution of the paper is to establish a causal effect between increased foreign competition and firms becoming flatter. Using trade costs and the Canada US free trade agreement as a quasi-natural experiment, we find that greater international competition reduces the number of hierarchical levels (with the division manager getting closer to the CEO) and increases the CEO span of control. But, since this causal effect says nothing about the mechanism that leads firms to flatten, we provide a set of additional results that helps us interpret how firms respond. We find that division manager total pay increases with a larger fraction of compensation being incentive based and that a greater number of senior functional positions report directly to the CEO. These results are consistent with an explanation based on the changing roles of CEOs and division managers in response to intensified product competition from globalization. To the extent that global competition increases the value of innovation and quick decision-making, it makes it profitable for multidivisional firms to alter their organizations to be more adaptive to local information while simultaneously coordinating activities across divisions. In more competitive markets, division managers are granted greater decision-making authority to enable faster adaptation to local market conditions. This is why the division manager position has moved closer to the top of the hierarchy and compensation and performance-based pay has risen to remain commensurate with broader job scope. Also in response to intensified competition, the CEO's span of control has broadened

enabling more accurate transmission of information between the CEO and senior officers and a more important coordinating role for the CEO across both functional areas (e.g. finance and legal) and operating divisions in multidivisional firms.

Finally, we only identify one channel for the flattening of firms, and there are possibly many others, such as the increased availability of IT. Moreover, firms may be responding to the new competitive environment along other dimensions, with the change in the hierarchy being complementary. We find some evidence that, in response to competition, firms spend more on R&D, “refocus” on core competencies, and increase offshoring of a range of activities. Further investigation of how organizational structure interacts with these other corporate responses and the overall impact of these changes on firm performance is left for future research.

References

- Acemoglu, Daron, Philippe Aghion, Claire Lelarge, John Van Reenen and Fabrizio Zilibotti. 2007. "Technology, Information and the Decentralization of the Firm" *Quarterly Journal of Economics*, forthcoming.
- Aggarwal, Rajesh K., and Andrew A. Samwick. 2003. "Performance Incentives within Firms: The Effect of Managerial Responsibility." *Journal of Finance*, vol. 58, no. 4, August 2003, pp. 1613-49.
- Aghion, Philippe, and Jean Tirole. 1997. "Formal and Real Authority in Organizations," *Journal of Political Economy*, 105, 1-27.
- Alonso, Ricardo, Wouter Dessein and Niko Matouschek, 2006. "When Does Coordination Require Centralization?" Northwestern working paper.
- Askenazy, P., D. Thesmar, and M. Thoenig. 2006. "On the Relation Between Organisational Practices and New Technologies: The Role of Time Based Competition." *The Economic Journal*, vol. 116, pp.128-154.
- Athey, S. and J. Roberts. 2001. "Organizational Design: Decision Rights and Incentive Contracts," *American Economic Review*, Papers and Proceedings, vol.91, pp. 200-205.
- Bartel, Ann, Casey Ichniowski and Kathryn Shaw. 2006. "How Does Information Technology Affect Productivity? Plant-Level Comparisons of Product Innovation, Process Improvement and Worker Skills." *Quarterly Journal of Economics*, forthcoming.
- Bernard, Andrew B., J. Bradford Jensen and Peter Schott. 2005. "Importers, Exporters, and Multinationals: A Portrait of Firms in the U.S. that Trade Goods" National Bureau of Economic Research Working Papers: 11404
- Bernard, Andrew B., J. Bradford Jensen and Peter Schott. 2006. "Trade Costs, Firms and Productivity" *Journal of Monetary Economics*, vol. 53(5), iss. 5, pp. 917-37.
- Bernard, Andrew B.; Stephen J. Redding and Peter Schott. 2006. "Multi-Product Firms and Trade Liberalization" National Bureau of Economic Research, Inc, NBER Working Papers: 12782
- Bolton, Patrick and Mathias Dewatripont. 1994. "The Firm as a Communication Network", *Quarterly Journal of Economics*, Vol.109, iss. 4, pp.809-839.
- Bloom, Nick, and John Van Reenen. 2007. "Measuring and Explaining Management Practices Across Firms and Countries." *Quarterly Journal of Economics*, forthcoming

- Bresnahan, Tim, Eric Brynjolfsson and Lorin Hitt. 2002. "Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence," *Quarterly Journal of Economics*, February 2002, 339–376.
- Brynjolfsson, Erik, Malone, Thomas W., Gurbaxani, Vijay, and Kambil, Ajit. 1994. "Does Information Technology Lead to Smaller Firms?" *Management Science*, Vol. 40, Iss. 12. pp. 1628-45.
- Calvo, G. and S. Wellisz. 1979. "Hierarchy, Ability, and Income Distribution." *Journal of Political Economy*. Vol. 87 (5). p 991-1010. Part 1, Oct. 1979.
- Caroli, Eve, and Van Reenen, John. 2001. "Skill Biased Organizational Change," *Quarterly Journal of Economics*, 116, pp.1448-1492.
- Chandler, Alfred D., Jr. 1962. *Strategy and Structure: Chapters in the History of Industrial Enterprise*. Cambridge, Mass. MIT Press.
- Dessein, Wouter. 2002. "Authority and Communication in Organizations", *Review of Economic Studies*, Vol. 69 (4), pp.811-838.
- Dessein, Wouter and Tano Santos. 2006. "Adaptive Organizations." *The Journal of Political Economy*. October. Vol. 114, Iss. 5; pp. 956
- Feenstra, Robert C., John Romalis, John and Peter K. Schott. 2002. "U.S. Imports, Exports, and Tariff Data, 1989-2001" National Bureau of Economic Research Working Papers: 9387
- Garicano, Luis. 2000. "Hierarchies and the Organization of Knowledge in Production" *Journal of Political Economy*, Vol.108, pp.874-904.
- Garicano, Luis and Tom Hubbard. 2006. "The Return to Knowledge Hierarchies" Working Paper Chicago GSB.
- Harstad, Bard. 2007. "Organizational Form and the Market for Talent", *Journal of Labor Economics*, forthcoming.
- Hart, Oliver and John Moore. 2005 "On the Design of Hierarchies: Coordination Versus Specialization" *Journal of Political Economy* , Vol.113, pp.675-702.
- Hummels, David. 2007. Transportation Costs and International Trade Over Time, *Journal of Economic Perspectives*, forthcoming.
- Lazear, Edward and Rosen, Sherwin. 1981, "Rank Order Tournaments as Optimal Labor Contracts." *Journal of Political Economy*, Vol. 89, pp.841-864.

Liberti, Jose Maria. 2006, "Initiative, Incentives, and Soft Information: How Does Delegation Impact the Role of Bank Relationship Managers?," Working paper, Northwestern University.

Mookherjee, Dilip. 2006. "Decentralization, Hierarchies, and Incentives: A Mechanism Design Perspective" *Journal of Economic Literature*, Vol. XLIV, pp. 367-390

Nocke, Volker and Stephen Yeaple. 2006. "Globalization and Endogenous Firm Scope." NBER working paper 12322.

Osterman, P. 1996. *Broken ladders: Managerial careers in the new economy*. New York: Oxford University Press.

Powell, Walter. 1990. "Neither Market Nor Hierarchy: Network Forms of Organization." In *Research in Organizational Behavior*, edited by Barry Straw and Lawrence Cummings, 295-336. Greenwich, Conn: JAI Press.

Radner, Roy. 1993. "The Organization of Decentralized Information Processing," *Econometrica*, vol. 61, no. 5, pp.1109-1146.

Michael Raith. 2003 "Competition, risk, and managerial incentives", *The American Economic Review*, Vol. 93, Iss. 4; p. 1425

Rajan, Raghuram and Wulf, Julie. 2006, "The Flattening Firm: Evidence on the Changing Nature of Firm Hierarchies from Panel Data." *Review of Economics and Statistics*, 88(4), pp.759-773.

Roberts, John. 2004. "The Modern Firm: Organizational Design for Performance and Growth." Oxford University Press, Oxford.

Rosen, Sherwin. 1982. "Authority, Control, and the Distribution of Earnings", *The Bell Journal of Economics*, Vol. 13, pp.311-323.

Scott, Elizabeth D, O'Shaughnessy, K C, and Cappelli, Peter. 1996. "Management Jobs in the Insurance Industry: Organizational Deskillling and Rising Pay Inequity" in *Broken ladders: Managerial careers in the new economy*, Osterman, Paul, ed., New York and Oxford: Oxford University Press. Pp. 126-154.

Stiroh, Kevin J., 2002, "Information Technology and the U.S. Productivity Revival: What Do the Industry Data Say?" *The American Economic Review*. Vol. 92, Iss. 5; p. 1559 (18 pages)

Thesmar, David and Mathias Thoenig. 2000. "Creative Destruction and Firm Organizational Choice", *The Quarterly Journal of Economics*, vol. 115, iss. 4, pp. 1201-37.

Trefler, Daniel. 2004. "The Long and Short of the Canada-U.S. Free Trade Agreement" *The American Economic Review*. vol. 94, Iss. 4. pp. 870-896.

Useem, M. 1996. "Corporate Restructuring and the Restructured World of Senior Management", *Broken ladders: Managerial careers in the new economy*, Osterman, Paul, ed., New York and Oxford: Oxford University Press. pp. 23-54.

Whittington, R., A. Pettigrew, S. Peck, E. Fenton, M. Conyon. 1999. "Change and Complementarities in the New Competitive Landscape: A European Panel Study, 1992-1996." *Organization Science*, Vol. 10, No. 5; pp. 583-600.

Williamson, Oliver E. 1967. "Hierarchical Control and Optimum Firm Size." *Journal of Political Economy*, Vol. 75, No. 2.

Wulf, Julie. 2007. "Authority, Risk, and Performance Incentives: Evidence from Division Manager Positions Inside Firms." *Journal of Industrial Economics*, Vol.LV, March, pp. 169-196.

TABLE 1: Descriptive Statistics

Variable	Observations	Mean	Std.Dev	Percentiles		
				10th	50th	90th
Span	1419	5.311	2.665	2	5	9
Div. Depth	5495	1.481	0.809	1	1	2
Ln DM pay (\$)	5514	12.7	0.70	11.84	12.64	13.6
DM incentives	5514	0.289	0.161	0.088	0.278	0.506
Lerner Index	1419	0.387	0.189	0.163	0.358	0.681
CR3	1419	0.633	0.244	0.301	0.658	0.958
ln firm sales (\$Mill)	1419	8.324	1.266	6.746	8.188	9.960
IT growth	1419	0.077	0.054	0.009	0.082	0.136
HHI Segment	1402	0.640	0.263	0.325	0.578	1.000
% foreign sales	1381	0.281	0.205	0	0.288	0.514
R&D expenditure	1419	0.044	0.050	0	0.028	0.112
AvT^{pre89}	1343	0.031	0.041	0	0.031	0.053
$AvT^{90/93}$	1343	0.018	0.025	0	0.011	0.042
Tariff (-)	1419	-0.025	-0.026	-0.05	-0.19	0
Transp.Cost (-)	1419	-0.038	-0.272	-0.08	-0.30	-0.11
COO	1419	0.475	0.500	0	0	1
CFO	1419	0.684	0.470	0	1	1
Legal Counsel	1419	0.671	0.479	0	1	1
CAO	1419	0.323	0.468	0	0	1
Planning	1419	0.264	0.441	0	0	1
HR	1419	0.534	0.507	0	1	1
Interm. Posit	1014	2.699	1.589	1	2	5
ln div employ.	5047	-0.059	1.409	-1.833	-0.025	1.761

Notes: Span is the number of managers that report directly to the CEO. Div Depth is the number of managers between the DM and the CEO. Ln DM pay is the log of Div. Manager total pay. DM incentives is fraction of long term incentives over Div. Manager total pay. Lerner index is the firm's price cost margin, CR3 is the industry (SIC3) top3 concentration ratio, IT growth is the annual change in log IT capital stock at 2 digit SIC from BEA data; Tariff is the industry (SIC4) import weighted average tariff on imports; Transport Cost is the import weighted average of transport costs by industry (includes freight and insurance); HHI Segment is the herfindahl index of segment sales (inverse measure of diversification); % foreign sales is the fraction of sales from foreign subsidiaries; R&D expenditure is R&D expenditure over sales; AvT^{pre89} ($AvT^{90/93}$) is the average tariff rate on Canadian imports in 86-88 (90-93), by industry. COO is whether the Chief Operation Officer reports directly to the CEO (identical for Chief Financial Officer, Legal Counsel, Chief Administrative Officer; Planning and Dev. Officer; HR); Interm. Posit is the number of intermediate positions between the DM and the CEO; (see data appendix for more details and sources)

TABLE 2: Trade Costs and CEO Span of Control

	Span 1	Span 2	Span 3	Span 4	Span 5	Span 6	Span 7
Tariff (-)	12.92 [9.59]	14.48* [8.57]	9.07 [6.82]	14.32 [8.63]	11.06 [8.60]	12.33 [9.32]	15.61* [8.51]
Transp.Cost (-)	30.78*** [10.46]	21.75*** [5.45]	23.32*** [7.78]	21.96*** [4.89]	15.43** [5.93]	29.90** [12.08]	23.51*** [6.06]
Lerner Index				-3.35 [2.66]			-1.31 [2.74]
CR3				1.32 [2.26]			0.67 [2.39]
% foreign sales							1.19 [0.91]
Segment HHI							-1.48* [0.87]
R&D							-8.29 [7.08]
IT growth					6.23** [2.52]		3.56 [2.43]
Trf (-) *IT growth					44.16 [64.75]		
T.Cost (-) *IT growth					64.97 [43.26]		
COO			-0.76*** [0.24]				
CAO			1.15*** [0.15]				
CFO			1.65*** [0.18]				
Legal Counsel			1.28*** [0.19]				
Planning			1.67*** [0.20]				
HR			1.68*** [0.19]				
ln(sales)	0.08 [0.17]	-0.24 [0.25]	0.04 [0.23]	-0.38 [0.26]	-0.33 [0.26]	-0.22 [0.34]	-0.44 [0.28]
Fixed effects	Industry	Firm	Firm	Firm	Firm	Firm	Firm
Industry trends	-	-	-	-	-	yes	-
Observations	1419	1419	1419	1419	1419	1419	1371
R-squared	0.08	0.1	0.46	0.11	0.11	0.12	0.12

Notes: Std. Errors in brackets, clustered by industry (SIC4). All regressions include year dummies and ln firm sales as controls. Span is the number of managers that report directly to the CEO. Tariff is the industry (SIC4) import weighted average tariff on imports; Transport Cost is the import weighted average of transport costs by industry (includes freight and insurance); See notes to table 1 for definition of other variables.

TABLE 3: Trade Liberalization and CEO Span of Control

	Span 1	Span 2	Span 3	Span 4
$AvT^{pre89} * Post89$	16.26*** [5.72]	16.90*** [5.50]	9.36** [4.08]	19.64** [8.18]
$AvT^{90/93} * Post94$	3.13 [6.28]	9.04 [6.95]	2.04 [4.52]	4.64 [6.87]
Post89	0.88*** [0.32]	1.20*** [0.41]	0.33 [0.29]	
Post94	1.27*** [0.45]	0.77 [0.57]	0.57** [0.28]	
Lerner Index		-1.82 [2.72]		
CR3		-2.6 [1.88]		
IT growth		4.07* [2.33]		
R&D		-8.45 [7.81]		
Segment HHI		-1.61* [0.90]		
% foreign sales		1.83* [1.02]		
ln(sales)	-0.3 [0.26]	-0.48* [0.27]	-0.01 [0.19]	-0.41 [0.33]
Fixed effects	Firm	Firm	Firm	Firm
Industry trends	-	-	-	yes
Additional Controls			officer dummies	
Observations	1343	1296	1343	1343
R-squared	0.1	0.12	0.43	0.11

Notes: Std. Errors in brackets, clustered by industry (SIC4). All regressions include year dummies and ln firm sales as controls. Span is the number of managers that report directly to the CEO. AvT^{pre89} ($AvT^{90/93}$) is the average tariff rate on Canadian imports in 86-88 (90-93), by industry. See notes to table 1 for definition of other variables.

TABLE 4: Trade Costs and Division Depth

	Div.Depth	Div.Depth	Div.Depth	Div.Depth	Div.Depth	Div.Depth
	1	2	3	4	5	6
Tariff (-)	0.63 [2.10]	1.96 [1.85]	1.9 [1.96]	1.12 [1.95]	1.71 [2.00]	-0.63 [1.83]
Transp.Cost (-)	-3.30*** [1.10]	-3.51*** [1.03]	-3.53*** [1.02]	-6.56*** [1.22]	-3.73*** [0.99]	-7.03*** [1.30]
Lerner Index			0.53 [0.62]		0.43 [0.71]	
CR3			0.82** [0.35]		0.81** [0.34]	
Segment HHI					0.15 [0.30]	
% foreign sales					-0.15 [0.28]	
R&D					-1.13 [1.71]	
IT growth				1.40** [0.60]	0.15 [0.50]	
Trf (-) *IT growth				16.22 [9.88]		
T.Cost (-) *IT growth				31.33** [14.54]		
ln(sales)	0.29* [0.15]	0.24* [0.14]	0.22 [0.13]	0.23 [0.14]	0.26* [0.15]	0.22 [0.14]
ln(div.empl.)	-0.12*** [0.03]	-0.10*** [0.03]	-0.09*** [0.03]	-0.09*** [0.03]	-0.10*** [0.03]	-0.10*** [0.02]
Fixed effects	Firm	Division	Division	Division	Division	Division
Industry trends	-	-	-	-	-	yes
Observations	5029	5029	5029	5029	4855	5029
R-squared	0.07	0.05	0.06	0.06	0.06	0.07

Notes: Std. Errors in brackets, clustered by industry (SIC4). All regressions include year dummies and ln firm sales as controls. Div Depth is the number of managers between the DM and the CEO. Tariff is the industry (SIC4) import weighted average tariff on imports; Transport Cost is the import weighted average of transport costs by industry (includes freight and insurance); See notes to table 1 for definition of other variables.

TABLE 5: Trade Liberalization and Division Depth

	Div.Depth	Div.Depth	Div.Depth	Div.Depth
	1	2	3	4
$AvT^{pre89} * Post89$	0.596 [1.100]	-1.055** [0.319]	-1.098*** [0.248]	-0.765* [0.307]
$AvT^{90/93} * Post94$	-0.965 [2.731]	0.357 [0.902]	0.161 [0.897]	0.169 [0.609]
Post89	-0.248*** [0.082]	-0.004 [0.026]	-0.019 [0.045]	
Post94	-0.198* [0.101]	-0.027 [0.018]	-0.037 [0.034]	
Lerner Index			0.029 [0.113]	
CR3			-0.067 [0.126]	
R&D			0.102 [0.376]	
IT growth			0.072 [0.170]	
Segment HHI			-0.05 [0.046]	
% foreign sales			-0.166** [0.075]	
ln(sales)	0.243 [0.149]	0.001 [0.030]	0.017 [0.028]	0.01 [0.035]
ln(div.empl.)	-0.103*** [0.026]	-0.052** [0.014]	-0.052*** [0.015]	-0.056** [0.014]
depth		0.967** [0.017]	0.971*** [0.016]	0.969** [0.016]
Fixed effects	Division	Division	Division	Division
Industry trends	-	-	-	yes
Observations	4657	4652	4478	4652
R-squared	0.049	0.63	0.634	0.63

Notes: Std. Errors in brackets, clustered by industry (SIC4). All regressions include year dummies and ln firm sales as controls. Div Depth is the number of managers between the DM and the CEO. AvT^{pre89} ($AvT^{90/93}$) is the average tariff rate on Canadian imports in 86-88 (90-93), by industry. Depth is the average firm depth across all divisions in the sample. See notes to table 1 for definition of other variables

TABLE 6: Trade Costs and Division Manager Pay

	ln DM pay	ln DM pay	ln DM pay
	1	2	3
Tariff (-)	0.59 [0.83]	0.47 [0.72]	0.28 [1.00]
Transp.Cost (-)	1.38*** [0.35]	1.43** [0.55]	1.93*** [0.70]
Lerner Index		1.37*** [0.45]	
CR3		-0.12 [0.25]	
Segment HHI		0.16 [0.10]	
% foreign sales		-0.06 [0.16]	
R&D		-2.37** [1.02]	
IT growth		-0.03 [0.22]	
ln(sales)	0.20*** [0.06]	0.22*** [0.05]	0.16*** [0.05]
ln(div.empl.)	0.14*** [0.02]	0.13*** [0.01]	0.14*** [0.02]
Fixed effects	Division	Division	Division
Industry trends	-	-	yes
Observations	5047	4863	5047
R-squared	0.6	0.61	0.62

Notes: Std. Errors in brackets, clustered by industry (SIC4). All regressions include year dummies and ln firm sales as controls. ln DM pay is the log of Div. Manager total pay. Tariff is the industry (SIC4) import weighted average tariff on imports; Transport Cost is the import weighted average of transport costs by industry (includes freight and insurance); See notes to table 1 for definition of other variables.

TABLE 7: Trade Liberalization and Division Manager Pay

	ln DM pay	ln DM pay	ln DM pay
	1	2	3
$AvT^{pre89} * Post89$	1.502** [0.595]	1.539** [0.649]	1.840* [0.795]
$AvT^{90/93} * Post94$	-0.553 [1.594]	-1.26 [1.386]	-0.505 [1.818]
Post89	0.695*** [0.081]	0.232*** [0.044]	
Post94	0.177*** [0.046]	0.737*** [0.065]	
Lerner Index		1.467*** [0.481]	
CR3		-0.102 [0.278]	
R&D		-2.672*** [0.969]	
IT growth		-0.072 [0.234]	
Segment HHI		0.170* [0.099]	
% foreign sales		-0.026 [0.164]	
ln(sales)	0.203*** [0.070]	0.229*** [0.058]	0.179** [0.060]
ln(div.empl.)	0.139*** [0.015]	0.130*** [0.014]	0.139** [0.015]
Fixed effects	Division	Division	Division
Industry trends	-	-	yes
Observations	4666	4491	4666
R-squared	0.589	0.602	0.61

Notes: Std. Errors in brackets, clustered by industry (SIC4). All regressions include year dummies and ln firm sales as controls. ln DM pay is the log of Div. Manager total pay. Tariff is the industry (SIC4) import weighted average tariff on imports; AvT^{pre89} ($AvT^{90/93}$) is the average tariff rate on Canadian imports in 86-88 (90-93), by industry. See notes to table 1 for definition of other variables.

TABLE 8: Trade Costs and DM incentives

	DM incentives	DM incentives	DM incentives
	1	2	3
Tariff (-)	0.2 [0.28]	0.2 [0.30]	0.32 [0.64]
Transp.Cost (-)	0.76* [0.38]	0.64 [0.39]	1.11** [0.55]
Lerner Index		0.04 [0.12]	
CR3		0.06 [0.09]	
Segment HHI		-0.02 [0.04]	
% foreign sales		0.06 [0.06]	
R&D		0.01 [0.56]	
IT growth		-0.01 [0.12]	
ln(sales)	0.07*** [0.02]	0.07*** [0.02]	0.06** [0.02]
ln(div.empl.)	0.02*** [0.00]	0.02*** [0.00]	0.02*** [0.00]
Fixed effects	Division	Division	Division
Industry trends	-	-	yes
Observations	5047	4863	5047
R-squared	0.22	0.22	0.24

Notes: Std. Errors in brackets, clustered by industry (SIC4). All regressions include year dummies and ln firm sales as controls. DM incentives is fraction of long term incentives over Div. Manager total pay. Tariff is the industry (SIC4) import weighted average tariff on imports; Transport Cost is the import weighted average of transport costs by industry (includes freight and insurance); See notes to table 1 for definition of other variables.

TABLE 9: Trade Liberalization and DM incentives

	DM incentives	DM incentives	DM incentives
	1	2	3
$AvT^{pre89} * Post89$	0.662* [0.339]	0.651* [0.341]	0.999** [0.328]
$AvT^{90/93} * Post94$	-0.296 [0.587]	-0.343 [0.518]	0.378 [0.713]
Post89	0.053 [0.034]	0 [0.025]	
Post94	0.043** [0.017]	0.127*** [0.018]	
Lerner Index		-0.001 [0.120]	
CR3		0.042 [0.094]	
R&D		-0.021 [0.562]	
IT growth		-0.007 [0.124]	
Segment HHI		-0.013 [0.035]	
% foreign sales		0.084 [0.063]	
ln(sales)	0.073*** [0.021]	0.071*** [0.024]	0.071* [0.027]
ln(div.empl.)	0.023*** [0.004]	0.023*** [0.004]	0.023** [0.004]
Fixed effects	Division	Division	Division
Industry trends	-	-	yes
Observations	4666	4491	4666
R-squared	0.216	0.221	0.24

Notes: Std. Errors in brackets, clustered by industry (SIC4). All regressions include year dummies and ln firm sales as controls. DM incentives is fraction of long term incentives over Div. Manager total pay. AvT^{pre89} ($AvT^{90/93}$) is the average tariff rate on Canadian imports in 86-88 (90-93), by industry. See notes to table 1 for definition of other variables.

TABLE 10: Senior Functional Officers

	CFO	CFO	Legal	Legal	Planning	Planning
	1	2	3	4	5	6
Tariff (-)	4.19***		3.00**		-2.36**	
	[1.48]		[1.35]		[1.00]	
Transp.Cost (-)	-0.94		1.96*		-1.27	
	[1.10]		[1.01]		[1.42]	
Lerner Index	-0.38		0.03		-0.4	
	[0.25]		[0.33]		[0.32]	
CR3	-0.32		0.2		-0.44*	
	[0.35]		[0.23]		[0.23]	
AvT^{pre89} *Post89		2.93***		3.01**		-0.88*
		[0.94]		[1.26]		[0.52]
$AvT^{90/93}$ *Post94		2.35		0.81		-1.26
		[1.78]		[0.98]		[1.35]
Post89		0.13**		0.02		0.03
		[0.06]		[0.09]		[0.06]
Post94		0.08		0.09*		0.04
		[0.07]		[0.05]		[0.07]
Fixed effects	Firm	Firm	Firm	Firm	Firm	Firm
Observations	1419	1343	1419	1343	1419	1343
R-squared	0.1	0.09	0.05	0.05	0.02	0.01

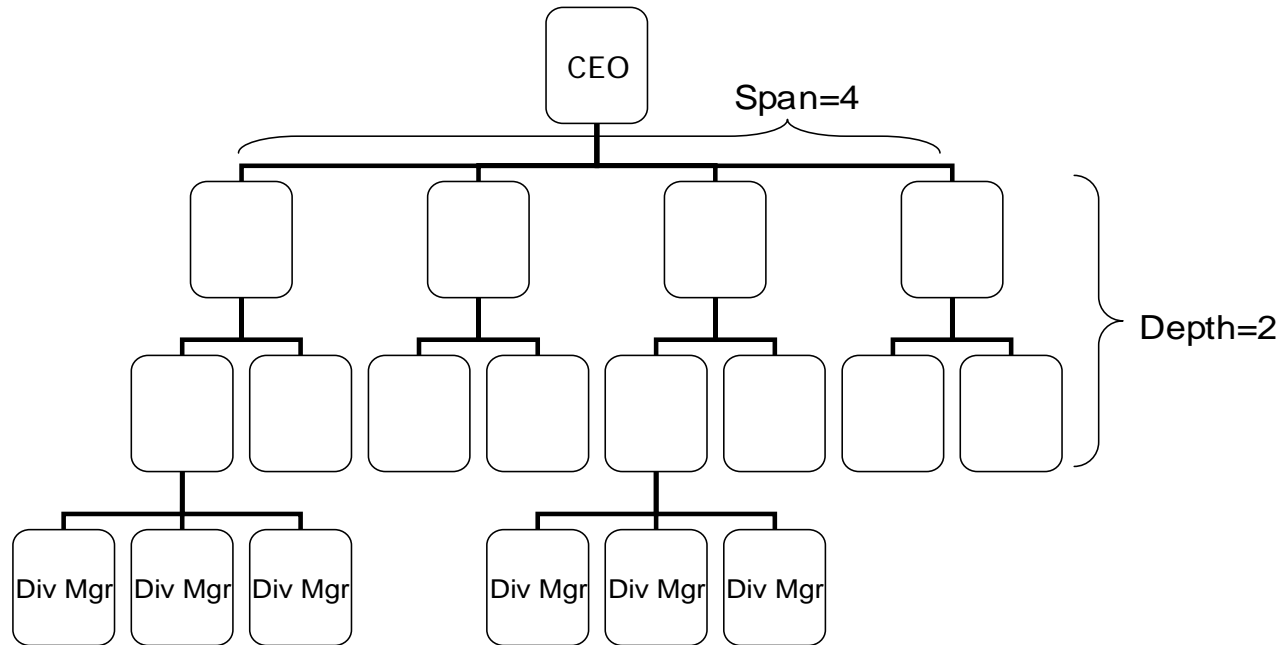
Notes: Std. Errors in brackets, clustered by industry (SIC4). All regressions include year dummies and ln firm sales as controls. Dep variable is whether the CFO/Legal Counsel/Planning officer report directly to the CEO. Tariff is the industry (SIC4) import weighted average tariff on imports; Transport Cost is the import weighted average of transport costs by industry (includes freight and insurance); AvT^{pre89} ($AvT^{90/93}$) is the average tariff rate on Canadian imports in 86-88 (90-93). See notes to table 1 for definition of other variables.

TABLE 11: Changes in Intermediate positions, Diversification, Offshoring and R&D

	Interm Posit.	Interm Posit.	Seg. HHI	Seg. HHI	% foreign	% foreign	R&D	R&D
	1	2	3	4	5	6	7	8
Tariff (-)	-6.77*		0.06		0.51		0.08	
	[3.41]		[0.45]		[0.41]		[0.06]	
Transp.Cost (-)	-6.57		1.20*		0.49**		0.03	
	[4.24]		[0.63]		[0.21]		[0.05]	
AvT^{pre89} *Post89		-6.28**		0.46		0.26		0.05*
		[2.64]		[0.35]		[0.19]		[0.03]
$AvT^{90/93}$ *Post94		2.08		1.28*		0.14		0.08
		[4.28]		[0.69]		[0.34]		[0.08]
Post89		0.44**		0.07**		0.04***		0
		[0.22]		[0.03]		[0.01]		[0.00]
Post94		-0.05		-0.11***		0.01		0.01*
		[0.17]		[0.03]		[0.02]		[0.00]
Fixed Effects	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Observations	1013	963	1402	1326	1366	1291	1419	1343
R-squared	0.1	0.11	0.09	0.11	0.19	0.17	0.06	0.06

Notes: Std. Errors in brackets, clustered by industry (SIC4). All regressions include year dummies and ln firm sales as controls. Interm. Posit is the number of intermediate positions between the DM and the CEO; Seg. HHI is the herfindahl index of segment sales (inverse measure of diversification); % foreign is the fraction of sales from foreign subsidiaries; R&D is R&D expenditure over sales. Tariff is the industry (SIC4) import weighted average tariff on imports; Transport Cost is the import weighted average of transport costs by industry (includes freight and insurance); AvT^{pre89} ($AvT^{90/93}$) is the average tariff rate on Canadian imports in 86-88 (90-93). See notes to table 1 for definition of other variables.

Figure 1: An Example of a Hierarchy: Span and Depth

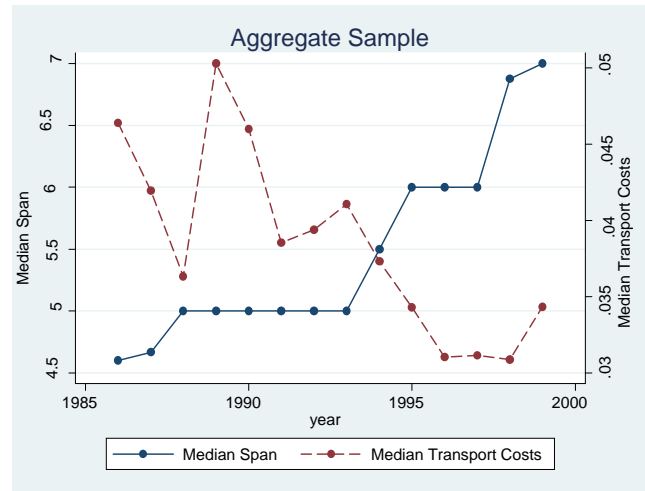
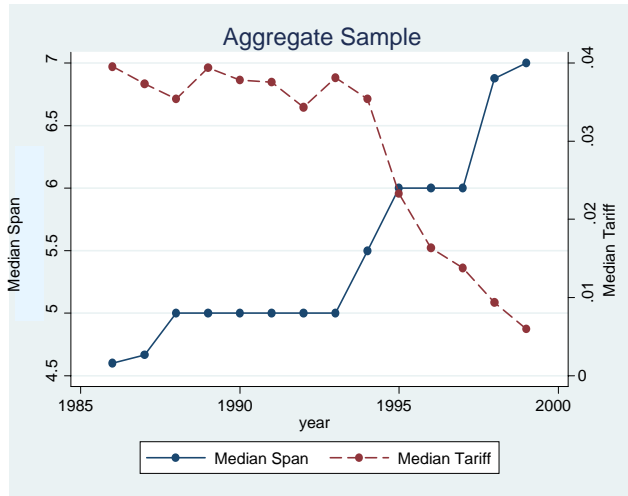


Span=number of positions reporting to CEO

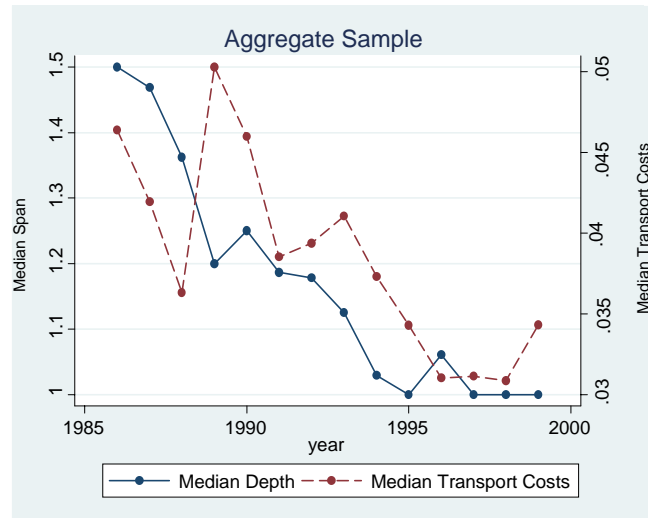
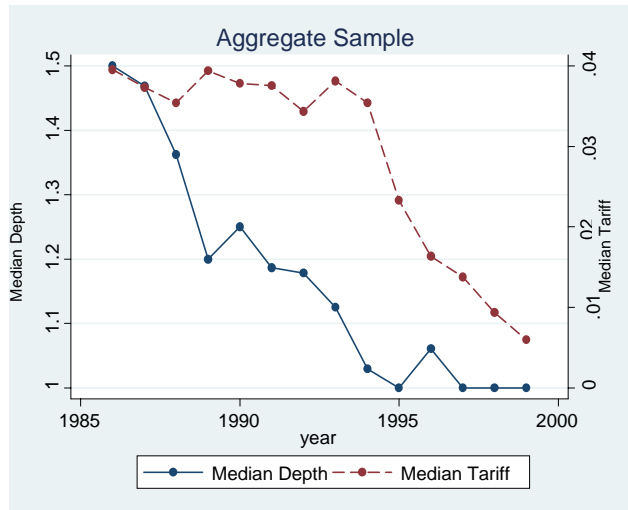
Depth=number of positions *between* the CEO and Division Manager

Figure 2: CEO Span, Firm Depth and Trade Costs (Tariffs & Transport Costs) (1986-1999)

Span



Depth



DATA APPENDIX

Additional Firm and Industry Data (Source: Compustat.)

- Lerner Index: Price cost margin by firm. Computed as $(\text{sales} - \text{cost of sales}) / \text{sales}$.
- CR3: share of total sales by industry (3 digit SIC) represented by the 3 largest firms. This is an imperfect measure of concentration because it is based on Compustat, which does not cover the population of US firms, although it represents a large amount of US output.
- In firm sales: Natural logarithm of firm sales (in million dollars)
- HHI Segment: Using Compustat Business Segment data, we construct the herfinhal index (HHI) of segment sales as the sum of squared shares of each reported segment sales over total sales. Business Segments are declared by firms that report the industries they operate in.
- % foreign sales: Using Compustat Geographic Segment data, we compute the fraction of total sales that the firm reports as originating from their foreign subsidiaries.
- R&D expenditure: Defined from Compustat as R&D expenditure over sales.

Information Technology data

- IT growth is defined as the change in the natural logarithm of average real stock of the components of IT capital, per year and industry (at 2 digit SIC).

We obtain the average real stock of the components of capital at the industry level over the time period. The Bureau of Economic Analysis (BEA) industry data are based on data from the Census Bureau in the benchmark years (1982, 1987, and 1992) and interpolations in the intervening years are made based on data from the Survey of Manufactures and the Annual Capital Expenditures Survey. These data are used in Stiroh (2001). Using a similar approach, we determine the change in the importance of Information Technology in a 2-digit industry by calculating the growth in IT capital stock (normalized by total capital stock) between the current and prior year. Data are estimates of real non-residential fixed assets (all corporations and proprietorships) from Detailed Fixed Assets Tables available on the BEA website. Series are adjusted using the quality-adjusted PPI deflator. Information technology capital stock includes hardware, software, and communications with components in each category as follows: (i) Hardware includes mainframe computers, personal computers, direct access storage devices, printers, terminals, tape drives, storage devices, integrated systems, and office/ accounting equipment, (ii) software includes prepackaged, custom, and own-account software, and (iii) communications includes communication equipment.