

The Flattening Firm and Product Market Competition:

The Effect of Trade Liberalization

PRELIMINARY AND INCOMPLETE

- Maria Guadalupe
Columbia University
- Julie Wulf
Graduate School of Business Administration
Harvard University

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

PRELIMINARY AND INCOMPLETE

Maria Guadalupe
Columbia University

Julie Wulf
*Graduate School of Business Administration
Harvard University*

November 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 competition, from trade liberalization and changing trade costs 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 increasing foreign competition 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 delegation and fast 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 reasons for flattening firms, the leading candidate is possibly the changes in the nature of the product market, in particular the increase in domestic and foreign competition from the dramatic reductions in trade, communication and transport costs. The purpose of this paper is to evaluate this hypothesis 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 firm hierarchies. 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 the knowledge of lower level managers.¹ Despite the fact that there is empirical evidence that the internal hierarchical organization of the firm (Liberti, 2006; Garicano and Hubbard, 2006) and organizational and workplace practices (Black and Lynch, 2001) have a significant impact on productivity, there is also little work on the role of internal hierarchies as an element of the organization of labor. In this paper, we investigate whether product market competition resulting from the globalization of markets is an important driver of organizational change. In doing so, we are able to shed light on the reasons behind internal organization choices and the mechanics of the communication and decision making processes inside firms

Our findings indicate that greater international competition leads to flatter firms. We find that as competition increases, the number of hierarchical levels is reduced,

¹ Refer to Whittington, Pettigrew, Peck, Fenton and Conyon (1999) for a review of the relevant literature in management and refer to Chapter 5 in Roberts (2004) for a broad discussion of organization and performance.

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. Our estimates explain 24 percent of the reduction in hierarchical levels and 35 percent of the increase in span of control. We show that these results are not driven by increases in expenditures on IT, nor exclusively by firms changing their business focus, location of activities, and a host of other potential confounding factors. Therefore the results suggest that responding to increased competition may indeed be one of the most important drivers of the flattening of firms.

While we provide evidence on the relationship between the organizational hierarchy variables and a number of standard measures of product market competition, including the industry Herfindahl index and average price cost numerous concerns can be raised when using these measures (they are endogenous to changes in the competitiveness of markets, they are non-monotonic in competition (Sutton, 1998; Schmalensee, 1989; Boone, 2000)). Therefore, in order to establish a causal effect between competition and hierarchical structures, we implement an empirical strategy that identifies exogenous changes in the level of competition that firms face. 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 greater 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.

Finally, we evaluate how general the estimated effect of foreign competition is by looking at the effect of trade costs (that includes import tariffs and transport costs) on all the organizational outcomes and find similar results, which suggests that our estimates are not particular to the CUSFTA, but generalize to other reductions in trade costs.

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 division

unobserved heterogeneity, and establish results using the changes *within* firms (and divisions) 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, Ichniowski, and Shaw, 2006), firm boundaries (Baker and Hubbard, 2004) and delegation of authority (Acemoglu, Aghion, Lelarge, Van Reenen and Zilibotti, 2007). 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 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.

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.

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 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 (2004) 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.

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.

⁵ Vives (2006) discusses the 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

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 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.

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.

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 delegation 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 off shoring. 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 leaders in their sectors and the survey sample is most representative

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.

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. Our other measure, depth, is defined at the division level and represents a vertical dimension, or steepness, 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." 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

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.

CEO and the division manager. Span (median) increased from 4.5 positions in 1986 to 7 positions in 1999 and depth (median) fell from 1.5 to 1. We discuss these in the next section.

In this paper, we focus on the subset of firms that operate in the manufacturing sector -for which we have data on tariffs. This leads to a sample of approximately 1584 firm-years and 5482 division-years that includes 172 firms and 1375 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 Product Market Competition: The 1989 Canada US Free trade Agreement

In order to identify a potential causal link between the level of competition in the product market and organizational change, we exploit 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 and it affected all manufacturing industries. 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., 1996).¹⁰ Tariffs are defined as duty divided by customs value by 4 digit SIC by year and we take the average of the three years before 1989. We also define the average at three digit SIC in a similar way.

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. This is the variation we will be using in what follows.

We run regressions of our organizational variables ORG_{fst} by firm f (or division), industry s and year t . The specification that exploits the trade liberalization is a standard difference-in-differences regression where the treatment is continuous ($AvT89_{fs}$ the level of tariffs on Canadian imports in the industry pre-89) and is as follows:

$$ORG_{fst} = \theta_1 AvT89_f + \theta_2 P89_t + \theta_3 AvT89_f * P89_t + \varepsilon_{fst} \quad (1)$$

where $P89_t$ is a dummy that equals one after 1989. 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.

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 US imports by industry increased more in industries that were highly protected prior to 1989.¹¹ Since the liberalization was bilateral, Canadian tariffs on US exports

¹⁰ The data are available from <http://www.internationaldata.org/> in the “1972-2001 U.S. import data”.

¹¹ There is also substantial evidence on the effect of the trade liberalization on Canadian firms (Head and Ries, 1999, Trefler, 2004).

to Canada also fell. To the extent that tariffs in 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.

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. We also allow for a lagged effect of the 1989 liberalization and include year dummies d_t , firm (or division) fixed effects η_f and a number of control variables X_{fst} (including firm and division sales as well as other controls of interest that will be discussed later) and $D_s * t$, which are industry specific time trends. The equation that we estimate including both CUSFTA and NAFTA effects is as follows:

$$\begin{aligned} ORG_{fst} = & \theta_3 AvT89_f * P89_t + \psi_3 LagAvT89_f * P89_t \\ & + \delta_3 AvT94_f * P94_t + X_{fst}' \beta + d_t + \eta_f + D_s * t + \varepsilon_{fst} \end{aligned} \quad (2)$$

Notice that the effect of the post 89 and post 94 dummies is absorbed by the year dummies and the pre-existing differences $AvT89$ and $AvT94$ (and other cross-sectional differences) are absorbed in the firm (or division) fixed effects. 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 Trebler 2004, Romalis 2005).

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

4. Results

4.1 Trade Liberalization and the Flattening Firm

In what follows we focus on the effect of the trade liberalization on Division Depth and CEO Span of control, as the main organizational change variables. 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. Section 4.4 will evaluate the effect of the general reductions in trade costs on the observed organizational changes.

Division Depth

Division managers (DM) 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 the organizational structure, division managers represent the lowest level managerial position 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 1.48.

Tables 2 and 3 present the results for the depth regressions in which the unit of observation is the division-year (there are 1481 divisions in the data). We interact the average tariff before the 1989 CUSFTA with a post 89 dummy (variable $AvT89*Post89$). 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. We also allow for a lagged effect of the liberalization.

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 ($AvT94*Post94$). 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.

In Table 2, we merge the experiment variables by the firm's four digit primary SIC code (three digit for firms that only report a three digit primary industry). This implies that Table 2 includes all divisions within firms in industries involved in international trade (both manufacturing and services divisions). Table 2 evaluates the differential effect of the liberalization across firms in industries with different levels of protection before 1989. It indicates that firms in industries with average tariffs on Canadian imports (3.8%) pre-1989 experienced a reduction of 0.08 of a position following the liberalization (Column 1). Over the sample period, depth decreased by 0.5 positions on average.

The evidence suggest that firms changed depth fairly soon after the trade liberalization. Once we control for division fixed effects, the results are somewhat larger. The specifications that include division fixed effects (Columns 2 to 8) capture the evolution within a division as it changes over time.

Most of the effect on depth is contemporaneous, with the coefficient on the lagged $AvT89*Post89$ being insignificant in all specifications. We also allow for an additional effect of NAFTA, and find again no significant results.

As the role of the division manager changes, it is likely that the division will also change in size. Columns 3 to 8 control for division employment and we find that larger divisions are closer to the CEO. This slightly reduces the effect of the liberalization. Controlling for division employment allows also us to control for the potential down-sizing of the divisions due to outsourcing. The results show that outsourcing is unlikely to be driving the results. Columns 4 to 8 further saturate the model by including industry trends to allow for differential trends across industries. The magnitude of the coefficient on the 1989 liberalization generally increases, suggesting that our result is not due to a spurious trend in the data.

Further, the results are larger if we restrict the sample to only firms that report a 4 digit SIC code as their main industry (column 5). The results do not change substantially if we restrict the sample to firms that are present in the sample before 1989 (Column 6).

Column 7 controls for IT investment at the industry level 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 to investments in technology. We find that our

coefficient of interest is unaffected, and that high IT is associated with divisions being 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. Columns 8 and 9 control for two standard indicators of the degree of competition in product markets, namely the industry Herfindahl index (HHI) and Price Cost Margin (PCM). These are constructed from Compustat by year and 4 digit SIC. The Herfindahl index (HHI) is defined as the sum of squared market shares of all firms in an industry, and the price cost margin is defined as the ratio of Gross Operating Income (inclusive of R&D expenditures) over total firm sales. While these are standard measures, their disadvantages however are well known. They are not measures of exogenous changes to competition and they are not monotonic in the underlying degree of competitiveness (Sutton 1998, Schmalensee, 1989; Boone, 2000). The estimated impact of the CUSFTA is unaffected when controlling for these two variables. Regarding the impact of HHI and PCM themselves, we find that the more competitive the industry is (low PCM and low HHI), the fewer number of layers in the hierarchy. Interpreting these measures as inverse indicators of competition, leads to the conclusion that firms also respond to other forms of competition (domestic concentration from the HHI, and any form that leads to lower PCM) by flattening. However, these results are not highly significant and more importantly, these variables have a number of drawbacks as measures of competition that lead us to interpret them with caution.

Finally, column 9 accounts for the fact that firms operate in multiple segments. Instead of using the Canadian tariff of the primary SIC code, we use the weighted average of Canadian tariffs pre-89, where the weights are the fraction of sales in each of the segments the firm operated in before the liberalization in 1988. The weights are kept constant over the sample period and segments that are not traded are considered to have zero tariffs. We obtain again similar results with a bigger weight on the lagged value of the experiment.

Overall, firms in industries with high tariffs on Canadian imports pre-1989 seem to delay as a result of the trade liberalization. As for the magnitude of the effect, once we control for industry trends, firm size, division employment, and division fixed effects, our estimates are that the trade liberalization led to a reduction in firm depth of 0.12 positions, or 24 percent of the overall reduction in depth over the sample period (column 4).

However, since our firms are multidivisional, and not all divisions within a firm are in closely related industries, we next explore the effect of the division specific shock to the liberalization. Which divisions within firms become closer to the top? Do all respond in a similar way?

To address these questions and to further evaluate the robustness of our main findings, Table 3 presents the depth results where the pre-liberalization tariff levels are merged at the division level by 3 digit SIC¹² and vary by division within a firm. We find that divisions respond to both their treatment (based on their own SIC pre-89 tariff) as well as to the firm-level treatment. When we merge at the division level, the response to the liberalization is more heavily weighted on the one year lag, and the effect is larger if we restrict the analysis to divisions in the firms' SIC code (column 2). When allowing for a firm-level and a division-level treatment at the same time (Column 3), we find that what matters most is the firm-level shock, with the division shock being important also.

Overall, we find systematic evidence that firms experiencing a larger shock following the trade liberalization (those in more protected industries prior to 1989) reduced division depth more, relative to firms less affected by the liberalization. Next, we analyze the effect of the liberalization on our second measure of organizational structure.

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. Following the trade liberalization, and the subsequent

¹² This implies that table 3 only includes divisions of Table 2 firms that are in industries involved international trade –where we could merge AvT89 and AvT94.

increased competitive pressure and complexity of product markets, we expect that firms in highly protected industries may change the role of the CEO, and this should be reflected in the span of control.

Table 4 reports the span results. All regressions include year dummies, control for firm size (as log of firm sales) and cluster standard errors at the industry level. They also include firm fixed effects such that our estimates are net of any permanent unobserved heterogeneity across firms that would bias the results. The estimates are exclusively identified from within firm variation in their exposure to the CUSFTA (and not from differences across firms).

The increase in the number of direct reports may come from senior officer positions as well as from lower level managers. In particular, over the sample period the presence of the Chief Operating Officer (COO) has decreased substantially. Column 2 controls for the presence of a COO and a Chief Administrative Officer (CAO) that may report directly to the CEO. We find that the effect of the liberalization is only slightly reduced (19.88 to 17.93), suggesting that the estimated increase in span must include senior officer positions as well as managers traditionally lower in the hierarchy.

Next, we evaluate the role of information technology (IT). The introduction of industry IT investment as a control in Column 3 does not affect the trade liberalization results. We find that a one standard deviation higher rate of IT investment leads to an increase in span of 0.17 positions (this is significant only at 14%). 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.

Column 4 includes controls for the other standard measures of competition, specifically, the Herfindahl Index of industry sales (HHI) and industry average price cost margin (PCM). We find that PCM is insignificant and that HHI has a positive effect: more concentration is associated with broader span. However, the effect of the liberalization is unaffected by the inclusion of these additional measures.

We also explicitly control for the potential that a trend was present in the data before the trade liberalization, by including industry specific time trends in Column

5.¹³ The only difference is that the coefficient on $AvT94*Post94$ is now also significant suggesting that some further flattening may have occurred around that year due to the continuing fall in tariffs.

The results indicate that span increased 0.8 positions more in firms with mean tariffs pre-1989, relative to firms in industries with no tariffs. This represents about 35% of the median change in span for our sample of firms.

In sum, we find that span of control increases and division depth decreases with competitive pressure represented by the trade liberalization with Canada.

4.2 Why are firms flattening?

The previous results show that the differential effect that the trade liberalization had across US firms explains some of the flattening of firms—both the increased span of control of the CEO and the layering 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 are silent on 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 and Incentives

As shown earlier, following the trade liberalization, division managers are closer to the CEO in the organizational hierarchy. We argue that this reflects the increased responsibility of division managers (DM) 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.¹⁴

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.

¹⁴ 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. Moreover, the results are robust to controlling for division depth.

Table 5 shows the effect on the logarithm of division manager pay. Total pay for DMs is the sum of salary, bonus and long-term compensation. 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.¹⁵ 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. Division managers in industries with mean tariffs on Canada pre-1989 had a 6.8% percent increase in total compensation relative to those with no tariffs before 1989 (column 2 table 5). The results hold when we control for division employment (column 3), when we include industry time trends (column 4) and when we restrict the sample to firms that report a 4 digit SIC (column 5).

In columns 6 through 8, we also evaluate the effect of the liberalization in the division's industry (at the division 3 digit SIC) instead of in the firm's industry (at the firm's primary SIC code). The results suggest that it is mostly the firm level increase in competition that raises total compensation for division managers, rather than the division level (except for the divisions that are in the same SIC as the firm –the main division of operation- column 7).

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 (executive) 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

¹⁵ 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.

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 Table 6 where the dependent variable is the fraction of long-term incentive pay out of total pay that division managers receive. The results in Table 6 show that higher competitive pressure leads to a higher fraction of total pay in the form of long-term incentives. And, in particular, it is again the firm level competition that drives most of the increase, rather than the division level.

To the extent that firms are flattening in order to delegate authority to division managers, they would simultaneously change compensation structures to align incentives. Generally, in order to have the DMs make decisions in the interest of the firm and take into account the impact of their decisions on other divisions, it is optimal for the firm to increase the fraction of pay that is related to the performance of the company. Stock options are by definition related to firm performance, and we can interpret the results in Table 6 as a complement to the increased authority of DMs.

Senior Functional Officers

The increase in the CEO's span of control suggests that the role of the CEO is also 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 the increase in competition 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 increasing competitive pressure 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 following the trade

liberalization. For this purpose we focus on whether the senior functional officers report directly to the CEO. In Table 7 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), the Human Resources Officer (columns 5 and 6) or the Long-Range Planning & Business Development Officer (columns 7 and 8) report directly to the CEO.¹⁶

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.

We obtain similar results for the head of Human Resources, potentially indicating the importance of human capital retention in a more competitive industry as well as the increased complexity in the compensation packages.

On the other hand, we find that the Long-Range Planning & Business Development Officer (Planning) is (weakly) 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

¹⁶ Odd-numbered columns show the results using linear probability models, and even-numbered columns show the results from fixed effects logit regressions.

position is lessening, arguably because the CEO is more involved in developing corporate strategy.¹⁷

4.2 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 the trade liberalization, we analyze a number of other outcomes. These include the number of other intermediary positions between the CEO and division managers, the degree of business diversification, the extent of off shoring, and expenditures on R&D. Table 8 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.¹⁸ Finally, firms spend more on R&D in more

¹⁷ 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.

¹⁸ 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.

competitive industries (however, the results are not always 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 (either to reduce costs or to develop new products).

These results are suggestive of firms responding in a variety of ways to the trade liberalization. These include focusing on their core businesses, but expanding geographically, and investing more resources in innovation. The findings on flattening that we establish in this paper are possibly part of the implementation of this new corporate strategy.

4.4 Competition and Changing Hierarchies: Evidence using Trade Costs

We have shown that the CUSFTA significantly affected the internal organization of firms. However, we would like to know whether this result extends to other forms of increasing international competition. Table 9 replicates the results in all previous tables using trade costs as the independent variable. 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.¹⁹

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).²⁰

¹⁹ Trade costs are the sum of tariffs and transport costs. 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 shares from each trading partner. 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 shares of the source countries by industry and year.

²⁰ 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

The results using trade costs are consistent with the previous evidence using the trade liberalization: reductions in trade costs reduce firm depth, increase span of control, increase division manager pay and incentives and makes it more likely that the CFO and the Legal Counsel report directly to the CEO.

While it is harder to interpret these results as causal, Table 9 reinforces the results using the trade liberalization and suggests that the effect of trade and foreign competition on organizational variables is ubiquitous.

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 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

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 changes in tariffs 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.

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 market competition. To the extent that competition increases the value of delegation 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 possibly 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 "refocus" on core competencies, increase off shoring of a range of activities and spend more on R&D. 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.
- Black, Sandra and Lisa M. Lynch. 2001. "How to Compete: The Impact of Workplace Practices and Information Technology on Productivity", *Review of Economics and Statistics*, 83(3), 434-445, August.
- 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. 1996. "NBER Trade Database, Disk1: U.S. Imports, 1972-1994: Data and Concordances," NBER Working Paper no. 5515.
- 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.
- Romalis, John. 2005. "NAFTA's and CUSFTA's impact on international trade" NBER Working paper 11059
- 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)
- Sutton, John. 1998. *Technology and Market Structure*, MIT Press

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.

Vives, Xavier. 2004. "Innovation and Competitive Pressure", CEPR Discussion Papers: 4369

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

	Observ.	Mean	Std.Dev.	Percentiles		
				10th	50th	90th
Span	1584	5.254	2.803	2	5	9
Div. Depth	5482	1.460	0.796	1	1	2
Trade. Costs	1577	0.071	0.044	0.016	0.062	0.131
AvT89	1584	0.039	0.042	0.0006851	0.032	0.083
AvT94	1554	0.026	0.032	0.0004676	0.019	0.053
PCM	1580	0.015	0.198	-0.241	0.091	0.169
HHI	1580	0.241	0.186	0.063	0.191	0.477
ln sales	1584	8.240	1.293	6.594	8.136	9.981
IT	1584	0.079	0.052	0.009	0.082	0.136
Seg.HHI	1567	0.819	0.220	0.500	0.991	1.000
%Foreign	1546	0.284	0.202	0.0E+00	0.296	0.514
R&D	1584	0.040	0.049	0	0.023	0.111
COO	1584	0.465	0.499	0	0	1
CFO	1584	0.689	0.466	0	1	1
Legal	1584	0.662	0.481	0	1	1
CAO	1584	0.329	0.470	0	0	1
Planning	1584	0.218	0.413	0	0	1
HR	1584	0.535	0.506	0	1	1
Interm. Posit.	1097	2.579	1.547	1	2	4
Ln DM pay	5501	12.687	0.690	11.84	12.63	13.59
DM						
Incentives.	5501	0.288	0.163	0.08	0.28	0.51
ln div. empl	5501	-0.136	1.465	-1.97	-0.12	1.77

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. Trade Costs is the sum of tariffs and transport costs by industry at 4 digit SIC (tariffs are the industry (SIC4) import weighted average tariff on imports; Transport Cost are the import weighted average of transport costs by industry - includes freight and insurance). AvT89 (AvT94) is the average tariff rate on Canadian imports in 86-88 (90-93), by industry. PCM is the industry average price cost margin (4 digit), HHI is the industry herfindahl index (4 digit). IT is the annual change in log IT capital stock at 2 digit SIC from BEA data; Segment HHI is the herfindahl index of segment sales (inverse measure of diversification); % Foreign is the fraction of sales from foreign subsidiaries; R&D expenditure is R&D expenditure over sales. 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; Ln DM pay is the log of Div. Manager total pay. DM incentives is the fraction of long term incentives over Div. Manager total pay. Ln div empl. is the log of division employment (see data appendix for more details and sources)

TABLE 2: Division Depth and Trade Liberalization

	Depth 1	Depth 2	Depth 3	Depth 4	Depth 4 digit 5	Depth Pres 89 6	Depth 7	Depth 8	Depth Weighted 9
AvT89*Post89	-2.07*	-2.45**	-2.20**	-3.20***	-4.62***	-3.05***	-3.26***	-3.21***	-2.629
	[1.119]	[1.047]	[1.047]	[1.052]	[1.117]	[1.140]	[1.038]	[1.134]	[1.853]
LagAvT89*Post89	1.586	0.809	1.605	-0.248	1.427	-0.578	-0.273	-0.24	-3.704*
	[2.336]	[2.080]	[1.727]	[2.235]	[1.800]	[2.115]	[2.279]	[2.261]	[2.211]
AvT94*Post94	-1.231	-0.512	-0.026	0.825	-1.935	2.499	0.842	0.647	-1.286
	[1.610]	[1.490]	[1.300]	[1.601]	[2.852]	[1.627]	[1.609]	[1.648]	[2.796]
IT Invest.							0.241		
							[0.523]		
PCM								0.12	0.135*
								[0.110]	[0.078]
HHI								0.069	0.089
								[0.270]	[0.198]
In div empl.			-0.09***	-0.09***	-0.09***	-0.09***	-0.09***	-0.09***	-0.092***
			[0.027]	[0.023]	[0.028]	[0.028]	[0.023]	[0.023]	[0.023]
In sales	0.259	0.285*	0.269	0.314*	0.351	0.389*	0.309*	0.301*	0.316***
	[0.170]	[0.163]	[0.163]	[0.185]	[0.235]	[0.229]	[0.183]	[0.179]	[0.116]
Fixed Effects	Firm	Division	Division	Division	Division	Division	Division	Division	Division
Industry Trends				yes	yes	yes	yes	yes	yes
Observations	5604	5604	5132	5132	3792	3137	5132	5120	4797
Number of firms	156								
Number of div.	1481	1481	1375	1375	975	591	1375	1375	1097
R-squared	0.021	0.03	0.04	0.11	0.11	0.16	0.111	0.111	0.121

Notes: Std. Errors in brackets, clustered by industry (SIC4). All regressions include year dummies. Div Depth is the number of managers between the DM and the CEO. AvT89 (AvT94) is the average tariff rate on Canadian imports in 86-88 (90-93), by industry. Column 5 restricts the sample to firms that report a 4 digit SIC code as their primary industry, Column 6 restricts the sample to divisions that are present before 1989 and column 9 uses weighted averages of tariffs on Canadian imports by firm where the weights are the 1988 fractions of sales in the firm's different segments. See notes to table 1 for definition of other variables

TABLE 3: Division Depth and Trade Liberalization

	Depth	Depth Main Div	Depth
	1	2	3
DIV AvT89*Post89	0.168 [1.073]	-1.891 [1.553]	0.802 [1.520]
DIV LagAvT89*Post89	-2.262** [1.032]	-3.522* [1.911]	-2.138* [1.206]
DIV AvT94*Post94	4.825 [3.642]	0.461 [6.245]	7.011** [3.240]
AvT89*Post89			-2.572* [1.480]
LagAvT89*Post89			-2.134* [1.183]
AvT94*Post94			-2.199 [3.570]
In div empl.	-0.045 [0.029]	-0.081** [0.031]	-0.043 [0.029]
In sales	0.332* [0.169]	0.591** [0.257]	0.341** [0.165]
Fixed Effects	Division	Division	Division
Industry Trends	yes	yes	yes
Observations	3121	1638	3055
Number of divisions	664	349	645
R-squared	0.14	0.18	0.14

Notes: Std. Errors in brackets, clustered by industry (SIC4). All regressions include year dummies. Div Depth is the number of managers between the DM and the CEO. AvT89 (AvT94) 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: CEO Span of control

	Span 1	Span 2	Span 3	Span 4	Span 5
AvT89*Post89	19.88*** [5.30]	17.93*** [5.16]	19.42*** [5.30]	21.61*** [6.89]	20.66*** [7.47]
LagAvT89*Post89	-9.34 [8.59]	-5.85 [8.43]	-9.81 [8.59]	-2.54 [8.06]	-0.12 [11.96]
AvT94*Post94	-3.86 [6.40]	-2.00 [5.88]	-2.93 [6.38]	-0.42 [6.59]	7.87* [4.33]
COO		-1.00*** [0.34]			
CAO		0.2 [0.26]			
IT Invest.			3.23 [2.21]		
PCM				-0.83 [0.56]	
HHI				2.02* [1.14]	
In sales	0.03 [0.28]	0.08 [0.28]	-0.03 [0.29]	-0.06 [0.28]	-0.19 [0.50]
Fixed Effects	Firm	Firm	Firm	Firm	Firm
Industry Trends				yes	yes
Observations	1554	1554	1554	1550	1108
Number of Firms	172	172	172	172	120
R-squared	0.07	0.1	0.07	0.07	0.11

Notes: Std. Errors in brackets, clustered by industry (SIC4). All regressions include year dummies. Span is the number of managers that report directly to the CEO. AvT89 (AvT94) 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 5: Division Manager (DM) Pay

	ln DM pay	ln DM pay	ln DM pay	ln DM pay	ln DM pay	ln DM pay	ln DM pay Main Div	ln DM pay
	1	2	3	4	4 digit 5	6	7	8
AvT89*Post89	2.112*** [0.560]	1.823*** [0.504]	1.678*** [0.590]	1.669** [0.650]	2.167*** [0.503]			1.715** [0.845]
LagAvT89*Post89	-0.938 [0.950]	-0.026 [0.700]	0.022 [0.653]	-0.164 [0.688]	-0.043 [0.849]			0.78 [0.796]
AvT94*Post94	0.294 [0.848]	0.151 [0.755]	0.043 [0.635]	-1.660** [0.668]	-0.449 [1.188]			-2.032 [2.174]
DIV AvT89*Post89						0.042 [0.498]	2.117** [0.922]	-0.541 [0.514]
DIV LagAvT89*Post89						0.233 [0.483]	-0.004 [1.245]	0.067 [0.660]
DIV AvT94*Post94						-0.168 [1.630]	1.456 [3.182]	1.711 [2.267]
ln div empl.			0.124*** [0.014]	0.126*** [0.013]	0.139*** [0.015]	-0.045 [0.029]	-0.08** [0.031]	-0.043 [0.029]
ln sales	0.353*** [0.076]	0.294*** [0.074]	0.250*** [0.071]	0.114** [0.048]	0.093 [0.056]	0.332* [0.169]	0.591** [0.257]	0.341** [0.165]
Fixed Effects	Firm	Division	Division	Division	Division	Division	Division	Division
Industry Trends				Yes	yes	yes	yes	yes
Observations	5624	5624	5151	5151	3807	3124	1639	3058
Number of div.	1484	1484	1380	1380	980	0.66	0.65	0.66
R-squared	0.459	0.55	0.59	0.65	0.65	0.664	0.349	0.645

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. AvT89 (AvT94) 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 6: Division Manager (DM) Incentives

	DM Incent.	DM Incent.	DM Incent.	DM Incent.	DM Incent.	DM Incent.	DM Incent. Main Div	DM Incent.
	1	2	3	4	4 digit 5	6	7	8
AvT89*Post89	0.849** [0.329]	0.94*** [0.288]	0.93*** [0.310]	0.96*** [0.342]	1.13*** [0.296]			0.95** [0.361]
LagAvT89*Post89	-0.541** [0.210]	-0.467** [0.202]	-0.418** [0.194]	-0.341 [0.327]	-0.162 [0.323]			-0.515 [0.399]
AvT94*Post94	0.416 [0.294]	0.205 [0.261]	0.201 [0.253]	-0.057 [0.367]	0.816 [0.498]			0.191 [0.720]
DIV AvT89*Post89						0.4 [0.272]	1.347** [0.521]	-0.024 [0.337]
DIV LagAvT89*Post89						-0.231 [0.200]	-0.231 [0.471]	0.061 [0.314]
DIV AvT94*Post94						0.277 [0.519]	2.044** [0.980]	0.395 [0.710]
In div empl.			0.021*** [0.004]	0.022*** [0.003]	0.024*** [0.004]	0.021*** [0.003]	0.020*** [0.005]	0.021*** [0.003]
In sales	0.090*** [0.021]	0.078*** [0.022]	0.072*** [0.022]	0.055* [0.031]	0.05 [0.035]	0.053** [0.026]	0.037 [0.041]	0.056** [0.027]
Fixed Effects	Firm	Division	Division	Division	Division	Division	Division	Division
Industry Trends				yes	yes	yes	yes	Yes
Observations	5624	5624	5151	5151	3807	3124	1639	3058
Number of div.	1484	1484	1380	1380	980	664	349	645
R-squared	0.209	0.22	0.23	0.31	0.32	0.31	0.32	0.31

Notes: Std. Errors in brackets, clustered by industry (SIC4). All regressions include year dummies and In firm sales as controls. DM incentives is the fraction of long term incentives over Div. Manager total pay. AvT89 (AvT94) 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 7: Senior Functional Officers

	CFO	CFO logit	Legal	Legal logit	HR	HR logit	Planning	Planning logit
	1	2	3	4	5	6	7	8
AvT89*Post89	2.20** [1.00]	13.98** [6.14]	2.83** [1.12]	23.22*** [7.51]	3.17** [1.56]	30.70*** [7.32]	-0.07 [0.71]	0.53 [7.55]
AvT94*Post94	0.44 [1.24]	2.203 [6.04]	0.47 [0.64]	12.46 [9.07]	0.34 [0.83]	4.309 [6.94]	-0.64 [0.76]	-16.60* [10.1]
In sales	-0.12* [0.07]	-1.023*** [0.31]	0.01 [0.06]	0.369 [0.4]	-0.04 [0.06]	-0.171 [0.31]	0.08 [0.05]	0.641* [0.33]
Fixed Effects	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Observations	1554	919	1554	894	1554	961	1554	751
R-squared	0.05		0.05		0.05		0.01	
Number of Firms	172	94	172	89	172	97	172	75

Notes: Std. Errors in brackets. Odd columns are linear probability models with std. errors clustered by industry (SIC4). Even columns are fixed effects logit regressions. All regressions include year dummies. The Dep. variable is whether the CFO/Legal Counsel/HR/Planning officer report directly to the CEO. AvT89 (AvT94) is the average tariff rate on Canadian imports in 86-88 (90-93). See notes to table 1 for definition of other variables.

TABLE 8: Changes in Intermediate Positions, Diversification, Off-shoring and R&D

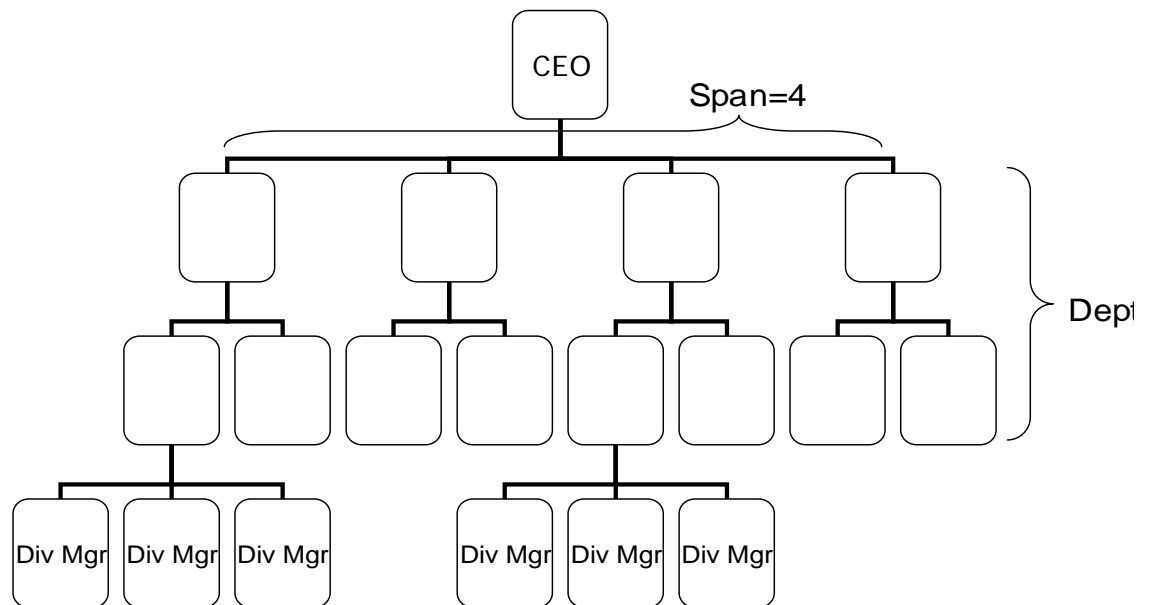
	Interm Posit.	Interm Pos.	Seg. HHI	Seg. HHI	%Foreign	%Foreign	R&D	R&D 4 digit
	1	4 digit 2	3	4 digit 4	5	4 digit 6	7	8
AvT89*Post89	-3.39*	-1.82	0.72**	0.65	0.06	-0.06	0.02	0.04*
	[1.84]	[2.08]	[0.29]	[0.41]	[0.17]	[0.16]	[0.02]	[0.02]
LagAvT89*Post89	-2.66	-3.89	-0.12	0.07	0.42***	0.56***	0	0.03
	[2.44]	[2.43]	[0.18]	[0.23]	[0.15]	[0.15]	[0.02]	[0.04]
AvT94*Post94	7.03	4.58	-0.02	0.21	0.02	0.06	0.06	0.1
	[4.72]	[4.54]	[0.28]	[0.32]	[0.21]	[0.35]	[0.05]	[0.08]
In sales	0.45**	0.43**	-0.05*	-0.02	0.01	0.02	0	0
	[0.19]	[0.20]	[0.03]	[0.02]	[0.02]	[0.01]	[0.00]	[0.00]
Fixed Effects	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Observations	1070	771	1537	1094	1518	1080	1554	1108
R-squared	0.13	0.13	0.06	0.05	0.19	0.18	0.05	0.09
Num. of firms	143	97	172	120	172	120	172	120

Notes: Std. Errors in brackets, clustered by industry (SIC4). All regressions include year dummies. Interm. Posit is the number of intermediate positions between the DM and the CEO; Seg. HHI is the herfindahl index of segment sales at 2 digit SIC (inverse measure of diversification); % Foreign is the fraction of sales from foreign subsidiaries; R&D is R&D expenditure over sales. AvT89 (AvT94) is the average tariff rate on Canadian imports in 86-88 (90-93). See notes to table 1 for definition of other variables.

Table 9: Trade Costs

	Div. Depth 1	ln DM Comp 2	DM Inc. 3	Span 4	ln CEO 5	CEO Inc. 6	CFO 7	Legal 8
Trade Costs	2.405* [1.361]	-1.427** [0.646]	-0.562** [0.260]	-17.12*** [5.456]	-0.87 [0.827]	-0.82*** [0.245]	-1.86 [1.607]	-2.18** [0.876]
ln Sales	0.376* [0.198]	0.318*** [0.089]	0.082*** [0.025]	-0.074 [0.309]	0.357*** [0.094]	0.063* [0.037]	-0.15** [0.073]	-0.018 [0.059]
Fixed Effects	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Observations	4134	4150	4150	1126	1126	1126	1126	1126
R-squared	0.027	0.426	0.213	0.074	0.654	0.32	0.067	0.04
Notes: Std. Errors in brackets, clustered by industry (SIC4). All regressions include year dummies. Trade Costs are the sum of Tariffs and Transport costs at 4 digit SIC. 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

DATA APPENDIX

Additional Firm and Industry Data (Source: Compustat.)

- 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 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.