

**KNOWLEDGE RESOURCES AND THEIR IMPLICATIONS FOR THE THEORY OF
THE FIRM AND CORPORATE GOVERNANCE**

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[Preliminary Version]

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We benefited from comments of participants at the 9th Annual Conference of the International Society for New Institutional Economics (ISNIE) held at Pompeu Fabra University, in Barcelona (2005).

ABSTRACT

Corporate scholars usually rely on traditional theories of the firm – mainly the agency cost framework – to analyze corporate structure and corporate contracting. Traditional theories of the firm, however, have long neglected the role of knowledge in shaping the internal structure of firms. Current analyses that rely on these theories therefore suffer from serious shortcomings. This paper aims to fill this gap by proposing to analyze knowledge resources and investigate their influence in corporate governance. We propose a new typology that explains firm governance structure based on the *types of knowledge used in the production process*. We discuss particular applications of the typology, showing how the management of knowledge resources required in mass production and high tech firms differentially affects the decisional hierarchies of firms, and also their ownership structure in certain instances. The paper goes on to analyze the interaction of law and knowledge management. We investigate how firms can bind knowledge by means of patents, trade secrets and private contracting, such as covenants not to compete. We build on Gilson's case study (1999) in arguing that California's statutory prohibition against the enforcement of covenants-not-to-compete affected firm structure in Silicon Valley. Unencumbered by restrictive covenants, employees in Silicon Valley were free to appropriate certain tacit knowledge acquired during the course of employment and to put it to use in direct competition with their former employers. Such "knowledge spillovers" permitted start-ups to thrive and allowed greater numbers of smaller firms to specialize in developing pieces of the overall technology required for the commercialization of marketable products. We then connect California's prohibition against restrictive covenants with the development of alternative contractual means in the Valley to bind knowledge to the firm through the extensive use of employee stock options, thereby encouraging knowledgeable employees to stick with the more promising startups while simultaneously transforming ownership and decisional hierarchies. We further explore how legal policy related to these issues can affect corporate governance.

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I. INTRODUCTION

In the last ten years the literature on corporate governance has addressed several variables that affect corporate structure and governance. The explanations recently presented by scholars to account for corporate governance patterns mainly refer to legal rules,¹ the private order that exists in a particular country,² competition in the products market,³ tax considerations,⁴ path dependence,⁵ as well as the particular political⁶ and cultural⁷ conditions in place in a given country.

Despite significant improvements achieved by these theories in our comprehension of factors that shape corporate structure and governance, we believe that there is a very important variable that has remained largely forgotten in this debate. This variable has to do with the core ingredient that firms use to achieve their corporate objective, which is to generate the products or services that they will sell in the market: the *knowledge requirements* that firms use in the production process. This ingredient is tantamount to the whole business enterprise: first I have to have an idea, which, in turn, will require the application of knowledge in order to develop the final product or service that I want to sell in the market.

A theory that develops the effects of the knowledge requirements of different production processes on corporate governance structure is missing. Knowledge resources affect corporate governance. And the reverse is also true, in that corporate governance practices can affect knowledge management and production. Corporate governance practices can promote or inhibit the efficient use of knowledge resources within the firm. Moreover, absent from the corporate governance literature is a discussion of the effect that intellectual property rights mechanisms

¹ Rafael La Porta, Florencio Lopez-de-Silanes, Andrei Shleifer & Robert Vishny, *Investor Protection and Corporate Governance*, 58 J. FIN. ECON. 3 (2000); Rafael La Porta, Florencio Lopez-de-Silanes, Andrei Shleifer & Robert Vishny, *Law and Finance*, 106 J. POL. ECON. 1113 (Dec. 1998); Rafael La Porta, Florencio Lopez-de-Silanes, Andrei Shleifer & Robert Vishny, *Legal Determinants of External Finance*, 52 J. FIN. 1131, 1138 (Jul. 1997).

² John C. Coffee Jr., *The Rise of Dispersed Ownership: the Roles of Law and the State in the Separation of Ownership and Control*, 111 YALE L. J. 76 (2001).

³ Mark J. Roe, *Rents and their Corporate Consequences*, 53 STAN. L. REV. 1463 (2001). Mark J. Roe, *The Shareholder Wealth Maximization Norm and Industrial Organization*, 149 U.PA. L. REV. 2063 (2001).

⁴ Steven A. Bank, *Tax, Corporate Governance, and Norms*. 61 Washington & Lee Law Review XX (2004). Desai, Mihir A., Dyck, I. J. Alexander and Zingales, Luigi, *Theft and Taxes* (October 2005). ECGI - Finance Research Paper No. 63/2005 Available at SSRN: <http://ssrn.com/abstract=629350>; Ayers, Benjamin C., Lefanowicz, Craig E. and Robinson, John R., *The Effects of Goodwill Tax Deductions on the Market for Corporate Acquisitions* (August 1999). Available at SSRN: <http://ssrn.com/abstract=173095>

⁵ Lucian A. Bebchuk & Mark Roe, *A Theory of Path Dependence in Corporate Ownership and Governance*, 52 STAN. L. REV. 127 (1999).

⁶ Mark J. Roe, *Political Preconditions to Separating Ownership from Corporate Control*, 53 STAN. L. REV. 539 (2000). Mark J. Roe, *POLITICAL DETERMINANTS OF CORPORATE GOVERNANCE* (2003).

⁷ Melvin A. Eisenberg, *Corporate Law and Social Norms*, 99 COLUM. L. REV. 1253 (1999); Amir N. Licht, *The Mother of all Path Dependencies: Toward a Cross-Cultural Theory of Corporate Governance Systems*, 26 DEL. J. CORP. L. 147 (2001); John C. Coffee, Jr., *Do Norms Matter? A Cross-Country Evaluation*, 149 U. PA. L. REV. 2151 (2001). Mark J. Roe, *Can Culture Ever Constrain the Economic Model of Corporate Law?*, 69 U. CHI.L. REV. 1251 (2002). *But see* Marcel Kahan, *The Limited Significance of Norms for Corporate Governance*, 149 U. PA. L. REV. 1869 (2001).

and private contracting exert over the firm internal governance structure.⁸ To be sure, while recent literature has pointed out the importance of human capital and capabilities for corporate governance practices,⁹ there has been no consistent attempt to explain how knowledge requirements of the production process, more generally, affect corporate governance in concrete and specific ways, and vice-versa.¹⁰

This paper begins to fill this gap. Economists and management scholars have increasingly pointed to the special nature of knowledge resources as an explanation for firm boundaries.¹¹ Knowledge resources can explain both why firms exist, and why they choose a particular internal structure.¹² Corporate law theory, however, has not yet recognized these developments in

⁸ The study of Gilson is one exception in this regard for it makes the connection between intellectual property and corporate structure. Ronald Gilson, *The Legal Infrastructure of High Technology Industrial Districts*, 74 N.Y.U. L. Rev. 575 (1999). Gilson analyzes the impact of legal structure on the development of high technology industrial districts. However, he looks at the high tech industry from an aggregate perspective and does not develop the consequences of knowledge resources for firms internal governance structure in Silicon Valley. We pursue his insight further in this paper and complete his story by looking at how high tech firms in Silicon Valley have a different governance structure from high tech firms on Route 128. See also Dan L. Burk, *Intellectual Property and the Firm*, 71 U. CHIC. L. REV. 3 (2004) (doing the reverse, that is, “considering intellectual property in light of the theories of the firm” (at 4). The author proposes to examine “whether existing intellectual property law provides for efficient allocation of intellectual property rights within firms in a manner that comports with property-based theories of the firm.”) There is an increasing awareness in intellectual property and employment law literature that the regulation of knowledge resources impacts the financial and organizational structure of firms. See Robert P. Merges, *The Law and Economics of Employee Inventions*, 13 HARV. L. J. & TECHN. 1 (1999); Robert P. Merges, *Intellectual Property Rights and the New Institutional Economics*, 53 VAND. L. REV. 1857 (2000); Catherine L. Fisk, *Working Knowledge: Trade Secrets, Restrictive Covenants in Employment, and the Rise of Corporate Intellectual Property, 1800-1920*, 52 HAST. L. J. 441 (2001). Katerine V.W. Stone, *Knowledge at Work: Disputes Over Ownership of Human Capital in the Changing Workplace*, 34 CONN. L. REV. 271 (2002).

⁹ Margaret M. Blair, *Firm-Specific Human Capital and Theories of the Firm*. EMPLOYEES AND CORPORATE GOVERNANCE, Margaret M. Blair and Mark J. Roe, eds., Brookings Institution Press, 1999 Available at SSRN: <http://ssrn.com/abstract=167848>. Thomas F. McInerney, *Implications of High Performance Production and Work Practices for Theory of the Firm and Corporate Governance*. Col. Bus. L. Rev. 2004.

¹⁰ Blair, *supra* note __, reviews the economic literature on firm-specific human capital and argues that the law and economics literature has fixated for too long on the relationship between shareholders and managers (the principal-agent approach) to model corporate governance. However, she concludes with a very general proposal: “arrangements for governing the relationships among employees, and between employees and the firm, can no longer be treated as something separate from corporate governance.” (at 86) And she does not explain on how corporate governance literature should take into consideration human capital.

¹¹ Ashish Arora, et al., *Markets for Technology: The Economics of Innovation and Corporate Strategy* (2001). Kathleen R. Conner, C.K. Prahalad, *A Resource-Based Theory of the Firm: Knowledge Versus Opportunism*, 7 ORGANIZATION SCIENCE 477 (1996), Jack A. Nickerson & Todd R. Zenger, *A Knowledge-Based Theory of Governance Choice- A Problem-Solving Approach*, 1, at <http://www.olin.wustl.edu/workingpapers/pdf/2002-06-006.pdf>. Robert M. Grant, *Toward a Knowledge-Based Theory of the Firm*, 17 STRATEGIC MANAGEMENT JOURNAL 109 (1996). Richard N. Langlois & Nicolai J. Foss, *Capabilities and Governance: the Rebirth of Production in Theory of Economic Organization*, (Druid Working Paper No. 97-2 , Jan. 1997) in *Social Science Research Network*, available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=77668.

¹² Some scholars have lamented the insufficiency of the traditional theories of the firm to account for the way production is organized within the firm. See, e.g., Bengt Holmström & John Roberts, *The Theory of the Firm Revisited*, *Journal of Economic Perspectives* 73, vol 14, n 4, fall 1998, (advocating a broader view of the firm and its boundaries: “...it is surprising that the leading economic theories of firm boundaries have paid almost no attention to the role of organizational knowledge.” 90) (citation omitted) “[Firms] have to deal with a much richer variety of problems than simply the provision of investment incentives and the resolution of hold-ups. Ownership patterns are not determined solely by the need to provide investment incentives, and incentives for investment are provided by a variety of means, of which ownership is but one. Thus,

economics and organizational theory. And, in turn, these theories have not recognized the role of legal institutions in shaping knowledge transactions and firm structure. We show that law and contract affect knowledge management and knowledge production in complex ways thereby ultimately influencing corporate structure.

This paper attempts to analyze how law or contract affect the creation of organizational structures suitable to knowledge production, diffusion, and conservation, such that the relevant knowledge is efficiently collocated with decision-making authority within the firm. In particular, we examine the use of intellectual property protections, restrictive covenants, and employee compensation in knowledge management, and consider some effects of such law and contract on firm governance and ownership structure.

The structure of the firm in a competitive environment, we argue, can be viewed as a result of three imperatives: (1) A firm must produce knowledge within the firm; (2) A firm must transfer and diffuse knowledge within the firm; (3) A firm must bind knowledge to the firm, that is, prevent the transfer of knowledge outside of the firm. How a firm produces knowledge, transfers and diffuses it within the firm, and binds it to the firm is intricately related to the organizational structure of the firm. The organizational structure varies accordingly, which variation, we imagine, is capable of being described as a complex function. One crucial variable in this function (though by no means determinative) is the type of knowledge that is used in a given production process. We therefore propose a revision of the theory of the firm in order to include a key element in its organization: the *type of knowledge* that it uses to accomplish its activities.

We propose to reframe some of the positive explanations of firm structure and certain policy proposals with regard to governance that have to date been addressed with a view to containing agency costs. The agency-cost framework provides the basis for the contemporary literature on corporate governance. It is axiomatic in the contemporary setting that most explanations of firm structure and governance derive from considerations of agency-costs containment.¹³ On this view, the significant contribution that law can make to the integrity and the improvement of publicly held corporations is to devise mechanisms to control agency costs. In their normative proposals most contemporary corporate governance experts rely on the agency-cost framework to justify: a) why boards should be composed by outside directors;¹⁴ b) why shareholders should get additional control rights, such as the power to initiate, and

approaches that focus on one incentive problem that is solved by the use of a single instrument give much too limited a view of the nature of the firm, and one that is potentially misleading. (...) Our examples suggest that ownership patterns are responsive to, among other things, agency problems, concerns for common assets, difficulties in transferring knowledge, and the benefits of market monitoring.” 75). See also Demsetz, *infra*.

¹³ See e.g., Mark J. Roe, *Political Preconditions to Separating Ownership from Corporate Control*, 53 http://papers.ssrn.com/sol3/papers.cfm?abstract_id=250951 STAN. L. REV. 539, 602 (2000), explaining why dispersed ownership doesn't take place in certain countries (“[s]ocial democracies raise the agency costs to shareholders in the Berle-Means public firm”); Ronald J. Gilson & Robert H. Mnookin, *Sharing Among the Human Capitalists: an Economic Inquiry into the Corporate Law Firm and How Partners Split Profits*, 37 STANF. L. REV. 313 (1985) (explaining the governance of law firms based on agency cost and portfolio theory); Ronald J. Gilson, *Engineering a Venture Capital Market: Lessons from the American Experience*, 55 http://papers.ssrn.com/sol3/papers.cfm?abstract_id=250951 STAN. L. REV. 1067 (2003) (explaining the characteristics of the American venture capital organization based on agency-costs containment).

¹⁴ Michael Jensen, *The Modern Industrial Revolution, Exit and the Failure of Internal Control Systems*, 48 J. FIN. 831 (July 1993). Jensen also proposed that directors should receive large compensation packages with stock options in order to have the right incentives to monitor firm performance.

approve by vote, major corporate decisions;¹⁵ c) why employees should not sit on corporate boards;¹⁶ d) why shareholders should require that managers reduce equity-based compensation packages and should vote for some compensation agreements.¹⁷ The recent debate in corporate law, for example, concerning possible new regulation to address the crisis of corporate governance in the aftermath of Enron, WorldCom and TYCO scandals, and the subsequent downturn in the stock market appears mostly to ignore the impact of new rules on knowledge production within firms.¹⁸ In this article we challenge these proposals.

These normative claims based on agency cost theory outline a policy of agency cost containment by reducing information asymmetries that exist in the principal-agent relationship. So, more information should be disclosed to shareholders and moreover, they also have to vote and decide important corporate outcomes in face of such information. In addition, outside directors should be in place to monitor the performance of managers and reduce the potential of opportunistic behavior. But these policy prescriptions do not pay attention to the knowledge asymmetries existing in this process which may exacerbate the very original agency problem. We argue that the near exclusive focus in corporate law on managing agency costs fails to appreciate the significant role of law in structuring corporations so as to *facilitate cooperation and specialization* in the production of goods.¹⁹ Cooperation requires governance structures in which knowledgeable directors will propose measures to *coordinate* strategies for implementation by managers. Managers, in turn, must *coordinate* the work of employees, and not just *monitor* them.²⁰ Crucial to successful coordination and decision-making is the collocation of relevant knowledge with the decision-making rights/authority at the various levels of hierarchy within the business organization.²¹ We therefore argue that law has to promote

¹⁵ Lucian A. Bebchuk, *The Case for Increasing Shareholder Power*, 118 HARV. L. REV. 833 (2005). Corporate governance scholars and shareholder activists proposed a variety of mechanisms by which shareholders could police and discipline directors, or at least align their interests more closely with the interests of the shareholders. They called for laws against poison pills, the removal of staggered boards, stock options and increases in performance based executive pay, the strengthening of minority shareholders' rights and of the market for firms.

¹⁶ Michael C. Jensen & William H. Meckling, *Rights and Production Functions: An Application to Labour Managed Firms and Codetermination*, 52 Journal of Business (1979).

¹⁷ LUCIAN BEBCHUK & JESSE FRIED, *PAY WITHOUT PERFORMANCE. THE UNFULFILLED PROMISE OF EXECUTIVE COMPENSATION* 190, 197 (Harvard University Press, 2004).

¹⁸ See, e.g., Lucian A. Bebchuk, *supra* note 15 (recognizing that shareholders' knowledge deficits vis-à-vis management might counsel against greater shareholder intervention in investment, scaling down and end-of-game decisions, but treating such knowledge deficits as information asymmetry).

¹⁹ Alchian & Demsetz, *Production, Information Costs, and Economic Organization*, 777.

²⁰ As Alfred Chandler has shown, "the modern industrial firm [] can be defined as a collection of operating units, each with its own specific facilities and personnel, whose combined resources and activities are coordinated, monitored, and allocated by a hierarchy of middle and top managers. It is the existence of this hierarchy that makes the activities and operations of the whole enterprise more than the sum of its operating units." CHANDLER, *SCALE AND SCOPE* 15.

²¹ Michael C. Jensen & William H. Meckling, *Specific and General Knowledge, and Organization Structure*, in *CONTRACT ECONOMICS*, Lars Werin and Hans Wijkander, eds. (Blackwell, Oxford 1992), pp. 251-274. One can read the merger waves and the concomitant "managerial revolution" that produced the modern Berle-Means corporation as accomplishing precisely that. As Chandler, *supra* note 20, points out, for example, "horizontal combination increased organization capabilities and productivity *only* if a single, centralized administrative control was quickly established over the merged or acquired companies and then the facilities and personnel were rationalized to exploit more fully the economies of scale and scope." (Chandler, 37). Chandler points out that vertical integration, on which transaction cost theory frequently focuses, "rarely resulted in faster throughput, significant cost reductions and increased productivity in terms of output per worker or unit of equipment. (37).

organizational structures suitable to knowledge production, diffusion, and conservation, such that the decision-making authority is collocated with the relevant knowledge existing within the firm.

We argue that the legal form of business firms cannot be explained entirely without reference to the knowledge structure of the firm. We defend the thesis that a firm's governance structure is influenced by the type of knowledge required by its production process. Knowledge that individuals bring to bear on production affects firm organization, while firm organization can also affect the production of new knowledge during the course of work. Knowledge-based transaction costs can help explain both why firms exist – that is why firm organization vs. market contracting is preferred in the production process – and why the firm has a determinate organizational form. In this regard, we shed light on some governance characteristics encountered in mass production, high tech, franchising and law firms.²²

Knowledge management and production take on increased significance in a knowledge economy. We, therefore, pay special attention to the high tech industry. We build on Gilson's argument²³ that California's statutory prohibition against the enforcement of covenants-not-to-compete affected industry structure in Silicon Valley. Unencumbered by restrictive covenants, employees in Silicon Valley were free to appropriate certain tacit knowledge acquired during the course of employment and to put it to use in direct competition with their former employers. Such "knowledge spillovers" contributed to lowering the cost of knowledge inputs, thereby permitting start-ups to thrive and allowing greater numbers of smaller firms to specialize in developing pieces of the overall technology required for the commercialization of marketable products.²⁴ We then connect California's prohibition against restrictive covenants with the development of alternative contractual means in the Valley to bind knowledge to the firm through the extensive use of employee stock options, thereby encouraging knowledgeable employees to stick with the more promising startups while simultaneously transforming ownership and decisional hierarchies.

The paper is organized as follows. In Part II, we investigate the main economic theories of the firm in some detail and show their shortcomings in providing a convincing explanation of a broad range of firm production organization. We then analyze an alternative view of the firm proposed by knowledge theories developed by economists and management scholars.

In Part III, we propose a typology that distinguishes between three types of knowledge resources used in the production process. We then show that different organizational structures rely on the different types of knowledge resources. We explain some of the governance features in such organizations structures as responses to the necessity of achieving an efficient knowledge allocation and management.

In Part IV, we explain how legal rules impact firm organization, by a) binding knowledge to the firm, b) permitting its diffusion within the firm among employees who need access to this knowledge and c) preventing knowledge transfer outside the firm. We show that certain intellectual property protections can shape firm organization, affecting knowledge production and firm governance structure. We then turn to the example of high tech firms to show how employee contracts, used as knowledge management tools, can alter the governance structure of firms that rely predominantly on knowledge embedded in its employees. We focus specifically on the firm compensation structure.

²² In this stage of the paper we present our arguments just to mass production and high tech firms.

²³ Ronald Gilson, *The Legal Infrastructure of High Technology Industrial Districts*, 74 N.Y.U. L. REV. 575 (1999).

²⁴ *Id.*

Finally, we discuss the potential impact of accounting rules governing stock options on knowledge production within high tech firms. Our discussion speaks directly to the debate about expensing stock options in the U.S. Congress. In December of 2004, the Federal Accounting Standards Board issued its final rule requiring the expensing of employee stock options to promote financial transparency and accountability to shareholders. The changes came into effect starting in January 2005. Technology firms lobbied Congress and the SEC to exempt high tech firms, arguing, among other things, that stock options are important knowledge management tools.²⁵ The theoretical framework we have set forth in the paper helps to make sense of these claims. We present normative considerations, which call into question certain corporate governance policies that have recently been adopted or proposed.

Part V concludes.

II. THEORY OF THE FIRM

In the following, we examine some of the most important economic theories that try to explain firm boundaries and governance structure. It is necessary to return to foundations before we can refocus attention on knowledge-based transaction costs and capabilities. The knowledge-based theory of the firm is viewed as a significant departure from traditional theories of the firm. In order to understand what's new about it we must revisit at least some of the most basic assumptions of the more traditional theories of the firm.

A. Traditional Theories of the Firm

1. *The Neoclassical Theory of the Firm*

Firms are characterized by technological transformations. In neoclassical theory, firms are, in a sense, seen as repositories of productive knowledge. Orthodoxy does not, however, engage in detailed inquiry as to the role of knowledge in the firm's organization. Sidney Winter has pointed out this shortcoming of orthodox economics:

By taking production sets or functions as given ... [orthodoxy] fails to provide a framework for explaining why society's capabilities should be packaged at a particular time in one particular way and not some other way. By treating the storage of a particular knowledge as costless – the analogue in this context of the assumption of costless and perfect contracts- it forecloses to economic analysis the performance of the very role that it claims is central.²⁶

Neoclassical theory posits that all firms have the same knowledge, know-how or capacity to produce. All firms in an industry are assumed to have the same production function in the long-run. But as Winter suggests capabilities and organizational knowledge may vary even among firms that produce in the same industry and rely on similar technologies.²⁷

²⁵ See, e.g., Donna Block, *Stock Options Fight Rages*, The Deal, January 18, 2005, available at <http://www.law.com/jsp/article.jsp?id=1105364116176>.

²⁶ Sidney G. Winter, *On Coase, Competence, and the Corporation*, THE NATURE OF THE FIRM 185 (Oliver E. Williamson & Sidney G. Winter eds. 1993).

²⁷ See also Richard R. Nelson, *Production Sets, Technological Knowledge, and R & D: Fragile and Overworked Constructs for Analysis of Productivity Growth?*, 70 THE AMERICAN ECONOMICS REVIEW 62 (1980) (criticizing the economic theoretical constructs of production sets, technological knowledge, and research and development. Nelson

2. *The Transaction Cost Theory of the Firm*

In *The Nature of the Firm*, Coase proposed a transaction cost explanation of the existence of the firm and its boundaries. The theory was ground breaking and it remains an extremely compelling account of governance structures in the developed form that it has assumed through the work of Williamson. Both Coase and Williamson, however, subscribe to an account of the employment relationship that serves as an impediment to the insights that a knowledge-based theories of the firm can provide.

Coase noted that the distinguishing feature of the firm is the allocation of resources by the entrepreneur, rather than the price mechanism. He explained the supercession of the price mechanism by pointing out that there are costs to using the price mechanism. These costs are the transaction costs associated with establishing a price, and negotiating and concluding contracts separately for each allocation decision.

Coase argued that production takes place in the firm whenever transaction costs involved in firm production are lower than the transaction costs would be for that same type of production on the market. For example, in order to produce a coat on the market, one would have to seek out and contract separately with a tailor, a cloth supplier, a supplier of buttons, perhaps a furrier, and so forth. Each such transaction involves transaction costs in the form of information costs, negotiating costs, monitoring and enforcement mechanisms. By vertically integrating these activities a firm can economize on transaction costs and produce more efficiently. While contracts are not eliminated within the firm, they are greatly reduced by the authority of the entrepreneur. Central to Coase's explanation of the firm is an understanding of the employment contract as an open-ended commitment by the employee to obey the direction of the entrepreneur over the long term (within certain limits). According to Coase, the existence of the firm can be explained by reference to the transaction cost savings associated with the employer's fiat-control over the employee.

We can best approach the question of what constitutes a firm in practice by considering the legal relationship normally called that of "master and servant" or "employer and employee.... it is the fact of direction which is the essence of the legal concept of "employer and employee" . . .²⁸

Coase thus explains how the organization of production within the firm reduces transaction costs that would otherwise occur in the market. But his explanation relies on a very narrow understanding of firm organization, as one that is based on the fiat control of the entrepreneur. Coase uncritically adopts this view of firm hierarchy by generalizing from 19th century conceptions of the relation between employer and employee which indeed obtain in certain types of firm production, as we shall discuss below.²⁹ But Coase thereby fails to appreciate what characterized the fundamental shift between the 19th and 20th century

argues that orthodoxy assumes that technological knowledge is in the form of codified how-to-do-it knowledge as if contained in a "blue print book" which provides sufficient guidance to any firm that has access to the book. However, there is no logical reason why this book will be available to all firms, as if it were in a public library. Furthermore, each firm will learn largely on its own, in an inimitable way, according to its particular organizational features and human capital.)

²⁸ Ronald H. Coase, *The Theory of the Firm*, in *THE NATURE OF THE FIRM* 29 (Oliver E. Williamson & Sidney G. Winter eds. 1993).

²⁹ Coase, *supra note* ___, 30 (citing treatise by BATT, *THE LAW OF MASTER AND SERVANT*).

organization of production in firms, namely the emergence of a new class of salaried managers, who were both employees (i.e. non-owners) and decision makers.³⁰

According to Alfred Chandler, the new type of business enterprise brought the separation of ownership from management: “The enlarged enterprises came to be operated by teams of salaried managers who had little or no equity in the firm.”³¹ These salaried managers were employees, usually with engineering degrees, hired, largely by the families who owned and ran large firms, to share control over a firm’s organization and coordination of production.

History shows that while hierarchy was crucial to the rise of the modern industrial enterprise, *entrepreneurs (owners) did not exercise fiat control over their most important employees*. As Chandler points out:

In production the new middle managers – both line and staff – had to learn intimately the technology of the products made and the processes used in the different factories under their control. So, too, in marketing and distribution middle managers had to come to know the similarities, differences, vagaries, and opportunities of different regional markets. In both production and distribution the line managers had to recruit, train, and motivate their own staffs as well as the lower-level managers under their command – the managers of plants, branch sales and purchasing offices, and laboratories. And even more than these lower-level executives, the middle managers had to learn to administer; that is, they had to learn to coordinate, to evaluate and act on such evaluations, in addition to recruiting, training, and motivating subordinates. For top managers such administrative duties were paramount. They not only had to learn to coordinate and monitor the activities of the functional departments but also to plan, allocate resources for, and implement long-term programs to maintain the enterprise’s facilities and skills, if they were to retain their share of existing markets and to move into new ones.³²

What is striking about the emergence of this new institutional form, as Chandler’s widely accepted account of the managerial revolution describes, is the significant discretion that was given to *salaried* managers in coordinating production within the firm. The salaried managers were accorded considerable discretion, because of their technical knowledge and their training in the coordination and organization of production. Coase’s theory that the fiat relationship between employer and employee was *the crucial source* of the emerging Berle-Means firm’s tremendous advantage and greater efficiency thus does not square well with the historical evidence.

It is true that rigid hierarchical relations frequently existed between employees at lower levels of the firm’s hierarchy and were indeed necessary. More careful analysis, however, shows that the firms in which rigid, top-down authority became the defining feature of the employment relationship engaged in certain types of production. The paradigmatic example of a firm characterized by such authority relations is the Taylorist manufacturing firm that spearheaded assembly-line mass production. In firms that adhered to Frederick Taylor’s principles, production was entirely restructured by the decomposition of the production process into isolatable, repetitive motions. Taylor’s science of production conceived of employees as slightly

³⁰ CHANDLER, *supra* note 20, at 1.

³¹ CHANDLER, *supra* note 20.

³² Chandler, *supra* note 20, at 598.

more complex mechanical instruments, or machines.³³ As we further develop in Section III, Taylorism involved a process of de-skilling shop floor employees and embedding knowledge in the production technology. It is in this type of production, in which employees are treated like replaceable assets, that we find authority relations most resembling those that Coase describes.³⁴ Indeed, the very purpose of Taylorism was to eliminate the entrepreneur's reliance on the judgment of his employees concerning every aspect of the production process, including the movement of their own bodies.³⁵

Such fiat relations in firm hierarchy, however, hardly obtain in the context of other types of firm organization. Take, for example, high-tech firms. High-tech firms are characterized by shared decision making among highly specialized employees, who exercise considerable control over their work agendas and project development.³⁶ High tech firms depend on employees exercising such discretion in their work. And employees could not, and would not, engage in productive cooperation if their reasoned judgments and their thoughtful approaches to problem-solving were supplanted regularly by appeals to authority.³⁷ Coase's fiat theory, therefore, does not supply an universal account of firm structure, although it may account for the organization of a particular type of firm – that engaged in the Taylorist organization of mass production.

Even firms that organized their production according to Taylor's principles, however, were only partially characterized by fiat relations of authority. As already described, at the level of managerial employees such firms depended on expanding the discretion of non-owners.

In addition, as it has been pointed out, another shortcoming of Coase's theory consists in his too general account of transaction costs.³⁸ Coase fails to sufficiently specify the nature of the transaction costs that he has in mind. Any variable can thus be invoked as a determinant of firm boundaries, as long as it is defended as a transaction cost.³⁹ In order to advance a reliable theory

³³ See FREDERICK WINSLOW TAYLOR, *THE PRINCIPLES OF SCIENTIFIC MANAGEMENT* (1916).

³⁴ See also Richard Adelstein, *Knowledge and Power in the Mechanical Firm: Planning for Profit in Austrian Perspective*, (2003). Working paper on file with authors.

³⁵ See Taylor, *supra* note 33.

³⁶ See e.g., Nicolai J. Foss, *Coase vs Hayek* (Copenhagen Business School, Working Paper, Feb., 2001), available at <http://www.cbs.dk/departments/ivs/wp/wp01-08.pdf> (“Overall, a consensus seems to be emerging that tasks and activities in the knowledge economy need to be coordinated in a manner that is very different from the management of traditional manufacturing activities, with profound transforming implications for the authority relation and the internal organization and boundaries of firms.” (5) “[t]he increased reliance on knowledge networks tends to erode authority-based definitions of the boundaries of the firm, because authority increasingly shifts to expert individuals who control crucial information resources” (6))

³⁷ In a study of the retention of human capital in acquisitions of high-tech firms, Ranft and Lord find that granting autonomy and relative status to the management and employees of acquired high tech firm's enhanced retention of key employees, but that economic incentives did not. Annette L. Ranft & Michael D. Lord, *Acquiring New Knowledge: The Role of Retaining Human Capital in Acquisitions of High-Tech Firms*, 11 *THE JOURNAL OF HIGH TECHNOLOGY MANAGEMENT RESEARCH* 295 (2000). See also Julia Porter Liebeskind, Amalya Lumerman Oliver, Lynne Zucker, Marilynn Brewer, *Social Networks, Learning and Flexibility: Sourcing Scientific Knowledge in New Biotechnology Firms*, 7 *ORGANIZATION SCIENCE* 428, issue 4 (Jul./ Ago, 1996) (describing decentralization of management in biotech firms).

³⁸ Harold Demsetz, *The Theory of the Firm Revisited*, in WILLIAMSON & WINTER, *supra* note __, at 164 (arguing that the lack of specification of what are transaction costs deprives transaction cost theory from any predictive content).

³⁹ Coase himself has admitted that his theory is too general to provide specific applications. See Coase, *The Nature of the Firm: Influence*, in WILLIAMSON & WINTER, *supra* note 26, at 73 (“in that article [The Nature of the Firm] I emphasized the comparison of the costs of transacting with the cost of organizing and did not investigate the factors that would make the costs of organizing lower for some firms than for others. This was quite satisfactory if the main purpose was, as mine was, to explain why there are firms. **But if one is to explain the institutional structure of**

of the firm, however, we need to identify the types of transaction costs that are most relevant to explain firm organization.

We argue that the cost of coordinating knowledge turns out to be a significant transaction cost to determine firm structure and size, and increasingly perhaps more significant. In consequence, we focus exclusively on such knowledge costs and ignore (or hold constant) all other transaction costs in our analysis.⁴⁰

Coase himself had a sense of how crucial knowledge requirements are to firm organization, even as he failed to explicitly develop this variable in his analysis of firm boundaries. In explaining why all production is not carried on by one big firm, Coase appears to identify the costs of organizing production within a firm, as primarily the result of bounded rationality⁴¹: “It may be,” Coase speculates, “that as the transactions which are organized increase, the entrepreneur fails to place the factors of production in the uses where their value is greatest.”⁴² And “[o]ther things being equal ... a firm will tend to be larger ... [t]he less likely the entrepreneur is to make mistakes and the smaller the increase in mistakes with an increase in the transactions organized.”⁴³ Coase here appears to suggest that firm size is a function of the problem solving capabilities of the entrepreneur who directs production and of the organization’s ability to provide an effective conduit for the entrepreneur’s problem solving, rather than an impediment to it.

Pursuing this insight further than Coase does himself, we can hypothesize that the knowledge required in the production process imposes limits on firm size, because a single firm cannot coordinate infinite types of knowledge. Each firm has command of a specific body of knowledge that it deploys in its production process. For a firm that produces food products to engage in activities in the pharmaceutical industry would be inefficient as this would require marshalling entirely different knowledge sets, i.e. those appropriate to developing chemical products and drugs. That is also the reason why firms tend to expand the scope of their activities to fields in which the firm’s already accumulated knowledge can afford it a competitive advantage.⁴⁴ It seems clear from this that even if all other transaction costs that Coase sets forth were zero, not all production would be carried out exclusively in the market⁴⁵ or exclusively by

production in the system as a whole it is necessary to uncover the reasons why the cost of organizing particular activities differs among firms.” (emphasis added)

⁴⁰ This is not to say that opportunism is not an important factor for it can raise many hazards in knowledge exchanges as we will see.

⁴¹ Adelstein, *Knowledge and Power in the Mechanical Firm*, 7.

⁴² Coase, *The Nature of the Firm* in *THE NATURE OF THE FIRM*, 23.

⁴³ Coase, *supra note* _____ (emphasis added).

⁴⁴ See Sidney G. Winter, *On Coase, Competence and the Corporation* in *THE NATURE OF THE FIRM* 190-91: “Of course, when a firm grows by vertical integration, it is not just a question of “more of the same.” But it is more of something closely related, something about which the firm already has some degree of relevant knowledge.”

⁴⁵ Transaction costs economics tends to argue that if transaction costs are zero, there is no firm as a collective entity. This is because it is assumed that each individual will act as a firm. However, Demsetz already highlighted the weakness of that argument.” See Harold Demsetz, *The Theory of the Firm Revisited* in *THE NATURE OF THE FIRM* 163: “the inference...that all production is individualized if transaction costs is zero, is wrong. Multiperson firms are fully consistent with zero transaction cost if management is subject to scale economies. Zero transaction cost inform us only that these cooperating efforts will be organized with greater reliance on explicit negotiations than would be true if transaction cost were positive(...). ...the substance of the firm is reflected in the style of cooperative behavior that obtains.” We argue that knowledge gained through the coordination process within the firm will make production within the firm efficient even if transaction costs were zero.

one big firm,⁴⁶ because the cost associated with possessing and coordinating the relevant knowledge for organizing every type of transaction within the firm would be prohibitive. No entrepreneur could have enough knowledge to manage every type of production within a single firm.

Knowledge costs are, therefore, a very important determinant of firm boundaries and must be studied separately. They cannot simply be subsumed within the general concept of transaction costs advanced by Coase.⁴⁷

3. *Nexus of Contracts and Agency Cost*

In *A Theory of the Firm*, Jensen and Meckling treat the firm as a nexus of contracts subject to agency costs. The firm is viewed as a “nexus of a set of contracting relationships . . . mak[ing] clear that the . . . *firm is not an individual* . . . [but] is a legal fiction which serves as a focus for a complete process in which the conflicting objectives of individuals (some of which may ‘represent’ other organizations) are brought into equilibrium within a framework of contractual relations.”⁴⁸ *Agency costs* are those transaction costs of contracting that result from the irreducible difference of interest between the principal(s) and the agent(s). While the self-interested activity of the well-chosen and properly incentivized agent can be sufficiently aligned with the interest of the principle so as to render the agent’s employment profitable, there is always remain a residual cost.

That residual cost is a “agency cost.” Agency costs can be reduced through monitoring (and enforcement) mechanisms. The monitoring costs themselves, however, would not have been incurred, but for the need to limit the agent’s pursuit of his own interest to the detriment of the principal’s interest. As such, monitoring costs count as agency costs. Similarly, the agent

⁴⁶ See Coase, *supra* note ____, “Why is not all production carried on by one firm?”. See also Demsetz, *supra* note ____, 173 (arguing that “[t]he process of product . . . refinement is halted when the next version of the product will be put to many multiple uses downstream that rely on different bodies of knowledge. A single firm if it was vertically integrated would have difficulty acquiring and maintaining the stocks of knowledge necessary to control cost and quality and to make good managerial decisions when downstream uses are multiple in this sense Roughly speaking . . . **the vertical boundaries of a firm are determined by the economics of conservation of expenditures on knowledge.**”) (emphasis added).

⁴⁷ We can find more passages where Coase implicitly admits the importance of knowledge for determining firm organization structure: “Apart from variations in the supply price of factors of production to firms of different sizes, it would appear that the costs of organizing and the losses through mistakes will increase with an increase in the spatial distribution of the transactions organized, in the dissimilarity of the transactions, and in the probability of changes in the relative prices. As more transactions are organized by an entrepreneur, it would appear that the transactions would tend to be either different in kind or in different places. . . . All changes which improve managerial technique will tend to increase the size of the firm.” (citations omitted) (25). Coase also realized, footnote 31, that inventions will not always make the size of the firm bigger. Giving the example of the telephone, Coase argues that if it reduces the costs of using the market, more than it reduces the cost of organizing production in the firm, then it will contribute to firms be smaller and not larger. And we believe this conclusion derives directly from a knowledge economizing strategy. A firm will not need to produce a telephone, if it wants to use one. This would increase the organization costs of a firm that doesn’t have knowledge or capabilities to produce a telephone to start to producing it. This cost would be prohibitively high. So the firm can buy the telephone in the market. See also the correspondence of Coase with Fowler in Coase, *The Nature of the Firm: Origin*, (“There may be technical advantages in increasing complexity **but it is decreasing returns to managerial ability which seems to set the limit.**”) (emphasis added). In our opinion, therefore, Coase appears to understand the cost of organizing knowledge as a crucial cost in determining firm’s size.

⁴⁸ Jensen & Meckling, *supra*, note ____, 311-12.

herself incurs costs that only arise out of the inability of the principal to fully control her agent. The agent must bond herself in order for the principal to entrust her with her interests. Thus monitoring, bonding, and residual costs are defined as agency costs and are used to explain the organization structure of the firm by Jensen and Meckling. The task of corporate law, in this view, is to minimize these transaction costs by realigning incentives and reexamining the moral hazards involved in the firm's nexus of contracts.

It is important to note that by focusing on agency costs, Jensen and Meckling don't really explain why a firm exists. Instead, they analyze how firms constrain agency costs, and they explain some aspects of the financial structure of the firm.^{49 50} Agency cost is the result of a conflict between the agent's self-interest and the will of the principal. The agency cost framework suggests that the greater the "gap" between the agent and the principal, the greater the agency costs. Greater autonomy for groups or individuals within an organization, on this logic, results in increased agency costs -- all else being equal. If containing agency costs is viewed as the most important feature of successful business organization, then the following prescription appears to follow: Concentrate decision making authority in the hands of as few agents as possible, who are closely monitored and directed by the principals.⁵¹

Interestingly, recent developments in management strenuously question this conclusion. Contemporary CEOs and management theorists champion the value of decentralized decision making. "Traditional industrial corporations concentrated power in top management," writes Peter Senge, who chairs the Society for Organizational Learning at MIT, "yet many of the most successful corporations in recent years have implemented radical changes in governance systems."⁵² These changes attempt to capture the gains of localism. The core dilemma, according to Senge is "how to gain the advantages of local autonomy and decision making while increasing the ability to understand and manage interdependence."⁵³

Shell Oil, for example, engaged in an abrupt, full-scale shift from centralized to decentralized governance beginning in 1994. It chose a federalist governance model in which "power was held as much as possible by independent entities with profit-and-loss accountability."⁵⁴ The separate entities would still have interaction and responsibility to one

⁴⁹ See the criticism of C.K Prahalad & Gary Hamel, *The Core Competence of the Corporation*, Harvard Business Review, 1990, applies: "How strange that SBU managers, who are perfectly willing to compete for cash in the capital budgeting process, are unwilling to compete for people – the company most precious asset. ***We find it ironic that top management devotes so much attention to the capital budgeting process yet typically has no comparable mechanism for allocating the human skills that embody core competencies.*** Top managers are seldom able to look four or five levels down into the organization, identify the people who embody critical competencies, and move them across organizational boundaries." emphasized

⁵⁰ In an article not well-known to the corporate governance law and economics literature, however, Jensen and Meckling, have recognized the crucial role of collocating relevant knowledge with decision making authority in the firm. Michael C. Jensen & William H. Meckling, Specific and General Knowledge, and Organization Structure, in *Contract Economics*, Lars Werin and Hans Wijkander, eds. (Blackwell, Oxford 1992), pp. 251-274. They explicitly say: "Knowledge considerations are one cause for the emergence of firms."

⁵¹ This is not necessarily what agency-cost theory posits, but note that this is the logic behind some current proposals for strengthening shareholder power, that is, let's contain agency costs by making the principals have more power in business decisions. Bebchuk, *supra note 15* and ____.

⁵² SENGE, THE DANCE OF CHANGE, 361.

⁵³ SENGE, *supra note* ____, 363.

⁵⁴ Peter Senge, THE DANCE OF CHANGE, 385. *But see, Shell Structure Has to Change, Investor Says*, NEW YORK TIMES, February 9, 2004 at C3 (reporting that investors called for greater centralization of Shell's organizational hierarchy).

another and to the center, but they had their own capital structures and internal debt levels, and could make their own investment decisions. Shell created internal boards of directors for advice and oversight and for sharing ideas. These boards were linked through interlocking membership. Further structures were put into place to ensure business alignment and overarching mission. In this way Shell Oil “pushed decision making, including capital decisions, down to four newly formed autonomous business units.”⁵⁵

This development does not square well with traditional proposals that rely on agency-cost theory. How can a firm contain its agency costs by devolving decision making authority down onto an increasing number of agents with local autonomy? Would this not raise agency costs? Would opportunism not increase? The most plausible argument that could explain whatever success such organizational structures produce would be by pointing to a cost-benefit relationship. If the benefits of having such a decentralized organization outweighs the agency costs stemming from the process, this outcome will be possible.⁵⁶ But such an answer still begs the question why decentralization encompasses such benefits.

Agency cost theory does not provide a sufficient theoretical framework to explain why this movement towards granting agents greater autonomy is occurring at all, without a proportional increase in ratification and monitoring mechanisms that would imply the containment of agency costs in Fama and Jensen’s view.⁵⁷ Clearly, however, the location of greater dispersion of decision making authority within the firm, is a result of the increasing knowledge intensity of productive activity, forcing companies that want to remain competitive to make use of their human capital at every level of the company hierarchy. This development away from traditional hierarchical governance structures by companies like Shell cannot be fully understood without reference to a knowledge theory of the firm.

4. Property Rights Theory

The property rights theory assumes that the ownership of non-human assets explains firm boundaries. A firm “consist[s] of those assets that it owns, or over which it has control.” The property rights theory, therefore, does not distinguish between ownership and control, but defines ownership as the capacity to exercise control.⁵⁸ Furthermore, it posits that control is achieved through the ownership of physical assets.

⁵⁵ SENGE, *supra* note__

⁵⁶ Eugene Fama & Michael C. Jensen, *Separation of Ownership and Control*, 26 JOURNAL OF LAW AND ECONOMICS 301, 301-302 (Jun. 1983). When trying to explain the survival of organizations in which agents make important decisions and do not bear a significant share of the wealth effect of such decisions, Fama and Jensen said: “We contend that separation of decision and risk-bearing functions survives in these organizations in part because of the benefits of specialization of management and risk bearing but also because of an effective common approach to controlling agency problems caused by separation of decision and risk-bearing functions. In particular, our hypothesis is that the contract structures of all these organizations separate the ratification and monitoring of decisions from initiation and implementation of the decisions.” Nonetheless, when we nowadays observe the decentralization trend in some organizational structure, it is not clear that the process of separation between initiation and ratification occurs at all levels where important business decisions are taken. In many instances, agents may have enough power so as to initiate, implement and ratify decisions which will not even reach, for example, the board of directors, which is the organ to which Fama and Jensen attribute the ratification and monitoring authority.

⁵⁷ Id.

⁵⁸ Sanford J. Grossman & Oliver D. Hart, *The Costs and Benefits of Ownership: a Theory of Vertical and Lateral Integration*, 94 J. POLIT. ECON. 691, 693-694 (1986) (“We define the firm to consist of those assets that it owns, or over which it has control; we do not distinguish between ownership and control and virtually define ownership as

The property rights theory derives its appeal from being elegantly formalizable in mathematical models which can shed light on firm structure in some specific cases. For example, Hart & Grossman's theory may be most useful in the context of a mass production system, and more specifically regarding Taylorist production. In a Taylorist firm, the physical ownership of machines is very important and employees are replaceable. But this circumstance is very particular to a type of production that permits the deskilling of workers, such that the knowledge necessary to produce the product is embedded in the production process, or rather in the machines, -themselves.

The theory assumes that ownership gives the owner all rights to dispose of physical asset that the owner hasn't given away, or that the government hasn't taken by force.

However this theory fails to perceive that, as we know from law, ownership does not necessarily give the legal control to dispose of the property. As property law tells us, ownership consists of a bundle of rights. For example, I may own an easement on a property. But suppose that easement was donated to me, with some clause that does not give me the right to dispose of the property as I wish. If I inherited the easement, it is also not some right that I have shaped on my own terms. This is clear in corporate law, in that the shareholders own the corporation, but do not have the legal right to control the everyday business decisions of the corporation. The average shareholder also never gave away such right! Moreover, even if he wanted to retain it, or ask for it back, he would not be entitled to do so under corporations law.⁵⁹ Ownership, therefore, does not always provide the right to exercise control.

Hart and Grossman define the firm "as being composed of the assets (e.g., machines, inventories) that it owns."⁶⁰ Their entire focus is on physical assets. They fail to recognize that in many situations physical assets cannot be used independently of expertise. Suppose an entrepreneur who owns a chemical laboratory, what is the purpose of owning this physical asset without having sufficient knowledge of how to develop drugs and therefore extract value from these assets? In the pharmaceutical industry, in the chemical industry, you might buy lots of assets, but if you do not have the knowledge capabilities to use the assets, you are making a dead investment.

Later, Hart has argued that the property rights approach can explain how the purchase of physical assets will lead to control over human assets.⁶¹ He defended that a worker will better pursue the objectives of an actor, if that actor is the worker's boss. This happens, says Hart, because the boss controls the assets the worker works with. Hart considers that the logic underlying this conclusion is different from the Coasian explanation: Coase thinks a boss can tell a work what to do, while Hart argues that it is in the worker's self interest to obey his boss, because this will put the worker in a better bargaining position with his boss later on. "[T]he employer can deprive the employee of the assets he works with and hire another worker with these assets."⁶²

the power to exercise control. In a corporation the shareholders as a group have control and delegate this control to the board of directors (i.e., management).")

⁵⁹ Hart has admitted that the property rights approach cannot account for the separation of ownership and control of large publicly held corporations. Oliver Hart, *An Economist's Perspective on the Theory of the Firm*, 89 COLUM. L. REV. 1757, 1173 (1989).

⁶⁰ Grossman & Hart, *supra* note 58 at 692.

⁶¹ Hart, *supra* note 59 at 1170-1171.

⁶² *Id.*, at 1171. See also, Oliver Hart & John Moore, *Property Rights and the Nature of the Firm*, 98 J. POLIT. ECON. 1119 (Dec. 1990). Oliver D. Hart, *Incomplete Contracts and the Theory of the Firm*, in WILLIAMSON & WINTER, *supra* note 28, 151 ("Authority and residual rights of control are very close and there is no reason why our analysis

He argues that the control over physical assets can lead to control of human assets that are embedded in the organization capital. This is a serious shortcoming of the property right theory. There are many cases, when the employees themselves are the most important assets for firm production. If employees are the most important assets, as it tends to happen in law firms, or high tech firms, for example, the physical assets simply are not key if the employee leaves, he can potentially take with him the main important asset for the development of certain products or services.⁶³ Hart's theory is incomplete for it can only explain the type of relationships that exist between boss and employees in a Taylorist firm.

Our theory provides a different explanation. Based on different forms of knowledge applied in the production process, we can offer a more complete explanation and fulfill the gaps left by the traditional theories described above. As we will explain in the next part, knowledge can be embedded in 1) physical assets such as machines, 2) in the organization itself, and 3) in individuals. When knowledge is embedded in physical assets, our explanation has many similarities with Coase's and Hart's account of the Taylorist firm described. Where physical assets are important for firm production, the control of physical assets can lead to control of human assets, at least to some extent, because the knowledge necessary to the production process is embedded in the physical assets. Therefore, both Coase's fiat notion and Hart's physical asset control explain a part of the story. However, when knowledge is embedded in individuals, as it happens in law firms and high tech firms, a boss cannot "control" in the traditional terms an employee even if he is the owner of the physical assets, for these assets will not be the determinant assets for firm production. The type of knowledge important to the production process explain important features of law firms organizational structure and why high tech employees have much more discretion over the production process when compared to their mass production employees counterparts. In these knowledge intensive settings, both Coase's and Hart's theory do not make much sense. So, we argue that the particular type of knowledge applied in the productive process (being it kp, ko, or ki) will shape firm governance and organization, as we further develop in the next section.

B. Knowledge Resources in the Theory of the Firm

In the previous section we have examined gaps in traditional theories of the firm, concerning their ability to account for knowledge-intensive production in human capital-intensive firms. Proponents of the knowledge-based theory of the firm point out that this one-sided concentration on incentive conflicts in the economics of organization literature overlooks the production side of the firm.⁶⁴ Langlois and Foss, for example, argue that the literature has unreflectively relied on a dichotomy between productive aspects and exchange aspects of the firm, that is, on a dichotomy between production costs and exchange costs. In analyzing

of the costs and benefits of allocating residual rights of control could not be extended to cover human, as well as physical, assets. In fact, residual rights of control over employees and over physical assets are likely to be related. In particular, an important difference between an employment contract and a contract between independent parties is that the former allows the employer to retain the use of assets used by the employee on the event of a separation (he can hire another employee to operate them). In contrast, an independent contractor would typically own some of these assets and would be able to decide how they should be used if the relationship terminates.”)

⁶³ We imply here that there are no intellectual property protections that could bind knowledge to the firm.

⁶⁴ Langlois & Foss, *supra* note __, __.

exchange costs the literature recognizes that exchange itself is not costless, but involves transaction costs from imperfect information and opportunism. But in analyzing production costs, there has been an implicit agreement that price theory tells us all we need to know about production. As Langlois and Foss point out, however, it is very likely that knowledge about how to produce is imperfect and that knowledge about how to link together one person's (or organization's) productive knowledge with that of another is imperfect.⁶⁵ These twin issues of capabilities and coordination are distinct from the hazards of contracting that other traditional theories have focused on. But oddly, as Langlois and Foss point out, theories of economic organization have, until recently, largely ignored these costs of production.

Both knowledge resources and (imperfect) production costs can be said to differ depending on the attributes of a production process, in the same way that transaction costs differ depending on the asset attributes of investment projects.⁶⁶ Thus, instead of holding technology constant across alternative modes of organization as a useful strategy for explicating, for example, the influence of transaction costs on the decision to integrate, or on monitoring structures and control, we suggest holding transaction costs constant as a strategy to assess the differential impact of (imperfect) production costs on the decision to integrate.

Harold Demsetz, for example, points out that:

Two firms facing the same labor transaction costs may choose different employment arrangements because the benefits they derive from these arrangements differ. Particularly important in determining these benefits are knowledge-based considerations. Continuing association of the same persons makes it easier for firm-specific and person-specific information to be accumulated (see the large literature on specificity of human capital). Knowledge about the objectives and organization of the firm is learned "cheaply" through continuing association, and so is knowledge about the capabilities and limitations of the persons involved in this association. Continuing association, however, implies commitment, and commitment has the disadvantage of inflexibility. The benefits to be derived from continuing association must be set against the cost of inflexibility in determining the best manner in which to acquire the talents and services of many persons.⁶⁷

As Demsetz explains, the savings that result from knowledge transfer within the firm influence considerations of firm structure and must be balanced against the costs associated with firm production, whether such costs are due to the inflexibility of certain retention policies or monitoring.

In the following section, we briefly recall the changes that have been shifting economic paradigms from scale-based competition to knowledge-based competition. We discuss some of the special features of knowledge resources identified by knowledge-based theories of the firm.

1. The Rise of the "Knowledge Economy": the New View of the Firm and the Profound Changes in Organizational Structure

With the rise of the knowledge economy, organizational structures and relations of production have been undergoing significant changes. Economists show that there has been an

⁶⁵ Langlois & Foss, *supra* note __, at 4.

⁶⁶ See, e.g., Williamson, *The Logic of Economic Organization in THE NATURE OF THE FIRM* 90, 97 (1993).

⁶⁷ Harold Demsetz, *The Theory of the Firm Revisited in THE NATURE OF THE FIRM* 174 (1993).

increasing demand for education and skill since the mid-twentieth century.⁶⁸ Scholars are speaking of an industrial revolution that makes knowledge production an ever increasing share of gross domestic product.⁶⁹

The financial structure of “knowledge companies” can differ dramatically from the financial structure of more traditional industrial companies. Microsoft and IBM provide a striking example. IBM, “the talismanic corporation of the fifties, sixties, and seventies,”⁷⁰ has sales more than fifteen times greater than those of Microsoft, and its fixed assets at the beginning of 1996 (net of depreciation) were \$16.6 billion worth of property, plants, and equipment, with a market capitalization of about \$70.7 billion. In contrast, Microsoft’s net fixed assets totaled just \$930 million. But Microsoft’s total capitalization was \$85.5 billion, despite its much lower sales. As Thomas Stewart points out, “an investor who buys Microsoft is clearly not buying assets in any traditional sense. For that matter, he is not purchasing much in the way of assets if he buys IBM or Merck or General Electric. A dollar invested in a corporation buys something different from the same dollar invested in the same corporation a few years ago.”⁷¹ In other words, in many industries ownership of physical assets has become less and less important while the significance of human resources has increased tremendously.

2. *Some Basic Characteristics of Knowledge Resources*

This predominance of “intangible assets” in a firm’s market value calls for a revision on traditional theories of the firm. Firm structure is now widely regarded as a significant factor in developing and nourishing a firm’s productive knowledge. In the organizational management literature, an increasing emphasis is placed on knowledge production. Books on “the learning organization,” “intellectual capital,” “human capital” and “knowledge management” abound. The knowledge based theories of the firm in the economics literature connects up with these perceptions in management theory.

⁶⁸ Kelvin M. Murphy and Finis Welch, *Occupational Change and Demand for Skill, 1940-1990*, 83 THE AMER. ECON. REV. 122, (1993) (arguing there was a huge increase in the demand for skill and education between 1940 and 1990). See also Chinhui Juhn, Kelvin M. Murphy & Brooks Pierce, *Wage Inequality and the Rise in Returns to Skill*, 101 J. POL. ECON. 410 (1993) (finding a consistent increase in wage inequality favoring the most skilled workers).

⁶⁹ We don’t provide an exhaustive bibliography of scholarly work that has addressed the special features of the knowledge economy, but some of the important references include: FRITZ MACHLUP, *KNOWLEDGE, ITS CREATION, DISTRIBUTION, AND ECONOMIC SIGNIFICANCE* (1980); THOMAS STEWART, *INTELLECTUAL CAPITAL*; Joseph Stiglitz, *Public Policy for a Knowledge Economy*, World Bank, January 1999 at 1 (“the movement to a knowledge economy necessitates a rethinking of economic fundamentals.”); PETER F. DRUCKER, *POST-CAPITALIST SOCIETY* 39 (“far too few people realize that the application of knowledge to work created developed economies by setting off the productivity explosion of the last hundred years. Technologists give the credit to machines, economists to capital investment. Yet both were as plentiful in the first hundred years of the capitalist age, before 1880, as they have been since. With respect to technology or to capital, the second hundred years differed very little from the first one hundred. But there was absolutely no increase in worker productivity during the first hundred years – and consequently very little increase in worker’s real incomes or any decrease in their working hours. What made the second hundred years so critically different can only be explained as the result of *applying knowledge to work.*”); DALE NEEF (ED.), *THE KNOWLEDGE ECONOMY* (1998).

⁷⁰ STEWART, *supra* note __, __.

⁷¹ STEWART, *supra* note __, 33.

A crucial insight of knowledge-based theories of the firm is to see firms as repositories of productive capabilities. As just one example, we cite Langlois and Foss' interpretation of the capabilities perspective as:

as reaching for a distinct theory of economic organization, one that is based on a conceptualization of the firm as a repository of productive knowledge with certain non-standard characteristics,In this story, incentive issues are suppressed in favor of a focus on problems of coordinating knowledge and expectations.⁷²

Accordingly, Demsetz says:

“ Economic organization, including the firm must reflect the fact that knowledge is costly to produce, maintain, and use. In all these respects there are economies to be achieved through specialization. . . . [W]e generally identify industries, and firms in these industries, as repositories of specialized knowledge and of the specialized inputs required to put this knowledge to work. Steel firms specialize in different stocks of knowledge and equipment than do firms in investment banking or industrial chemicals, and even firms in then same industry differ somewhat in the knowledge and equipment upon which they rely.”⁷³

Production in a competitive economy requires different use of knowledge resources. Knowledge resources are both purchased on the market and produced by the firm. But the special nature of knowledge resources presents unique characteristics that provide powerful reasons for differentially structured firm production. The way a firm develops the knowledge it will use in its production process and the extent that the firm can bind this knowledge to its structure will influence it governance and organizational structure.

a) The Public Good Nature of Knowledge

A public good has two critical characteristics: non-rivalrous consumption and non-excludability. The first implies that the consumption of the good by one individual does not detract from the ability of others to enjoy its consumption. The second means that it is difficult, if not impossible, to exclude an individual from enjoying the good.⁷⁴

Knowledge has public good characteristics. It thus raises classic public goods' problems of non-excludability and non-rivalry. These problems enhance the occurrence of moral hazard, making market transactions very costly.⁷⁵ If knowledge production and development is to be

⁷² Richard Langlois & Nicolai Foss, *Capabilities and Governance; the Rebirth of Production in Theory of Economic Organization*, available at www.isnie.org/ISNIE98/Langlois-Foss.doc.

⁷³ Harold Demsetz, *The Theory of the Firm Revisited*, in *The Nature of the Firm*, at 171-172.

⁷⁴ Joseph E. Stiglitz, *Knowledge as a Public Good*, at <http://www.worldbank.org/knowledge/chiefecon/articles/undpk2/>, gives the following example: “Knowledge of a mathematical theorem clearly satisfies both attributes [non-rivalrous consumption and non-excludability]: if I teach you the theorem, I continue to enjoy the knowledge of the theorem at the same time you do. By the same token, once I publish the theorem, anyone can enjoy the theorem. No one can be excluded. They can use the theorem as the basis of their own further research. The “ideas” contained in the theorem may even stimulate other to have an idea with large commercial value”.

⁷⁵ Joseph Stiglitz, *Public Policy for a Knowledge Economy*. World Bank, January 1999, at 13, points out the problem of markets transactions with knowledge: “there are real problems in market transactions: How can I sell knowledge? I have to tell you at least something about what I will disclose to you, something that you presumably did not know before; thus, in the process of trying to engage in a market transaction, **I lose some of my property**. In practice,

conducted in firms, with expenditure of significant resources, firms must have mechanisms available to avoid these moral hazards. If firms were unable to exclude potential free-riders, they would not engage in knowledge development. Firms have to exclude other individuals from enjoying or appropriating the benefits of the knowledge they produce. It follows, therefore, that a firm must be able to bind the knowledge it uses in its production process to its structure, in order to retain (or achieve) its competitive advantage. ***It is precisely this capacity to bind knowledge to the firm, and within the structure of the firm, that makes production within firms boundaries advantageous.***⁷⁶

How can a firm bind knowledge in this way? Firms use different mechanisms for this purpose. Knowledge can be made exclusive in an imperfect manner by the crude method of hiding its content (e.g. Coca Cola's formula). In addition, specific legal mechanisms, such as patents, trade secrets and copyright law, play a crucial role in fixing ownership of intellectual property. Although these mechanisms are not exclusively used by firms, they are in fact most important in joint production and have historically emerged together with the rise and development of large modern business entities.⁷⁷ Other legal mechanisms, based of private contracting, such as restrictive covenants specific to employment relations, also bind knowledge to firm structure. We will develop the contribution of law in binding knowledge to the firm in part IV and argue that such mechanisms will significantly shape firm's particular governance structures.

But structural solutions are equally important in binding knowledge to firm's structure. Different forms of hierarchy promote the centralization, and thus the consolidation and control over proprietary information and firm knowledge. (It is no accident that R & D facilities were typically located close to headquarters).

Because such mechanisms permit the exclusion of potential free-riders from the enjoyment of knowledge resources, even if imperfectly, knowledge is distinguished by Stiglitz and others as an *impure public good*.⁷⁸

b) Centralization vs. Decentralization of Decision Making and Knowledge Allocation

Different and somewhat contradictory approaches have been taken with regard to the impact that knowledge resources have on the organization of the production process.

Some scholars have proposed that the centralized organization of a firm is conducive to knowledge transfer and diffusion within the firm. Kenneth Arrow, for example, argues that "authority, the centralization of decision-making, serves to economize on the transmission and

markets for knowledge and information depend critically on reputation, on repeated interactions, and on trust." emphasized

⁷⁶ See C.K Prahalad & Gary Hamel, *The Core Competence of the Corporation*, Harvard Business Review, 1990 (arguing that the production of knowledge – core competencies – inside the firm is key to competitiveness for that embedded skills that give rise to the next generation of competitive products cannot be "rented in" or easily acquired: "In our view, too many companies have unwittingly surrendered core competencies when they cut internal investment in what they mistakenly thought were just "cost centers" in favor of outside suppliers.")

⁷⁷ See Catherine L. Fisk, *Working Knowledge: Trading Secretes, Restrictive Covenants in Employment, and the Rise of Corporate Intellectual Property, 1800-1920*, 52 Hastings Law Journal 441, 442-443 (2001).

⁷⁸ Stiglitz, *Knowledge as a Public Good*, ("because the returns to some knowledge can, to some extent, be appropriated there is some degree of non-excludability, knowledge is often thought of as an *impure public good*.").

handling of knowledge.”⁷⁹ Similarly, Coase’s reliance on the superior allocation of resources through the fiat-control of the entrepreneur within the firm hierarchy appears to endorse the virtues of centralization for the efficient use of knowledge resources. As one scholar contends, “Coase’s notion of authority” after all “assumes that a directing principal is at least as knowledgeable about the relevant tasks as the agent being directed.”⁸⁰

One of the ways in which firms economize in deploying knowledge resources is by “knowledge-substitution.” If X and Y are independent contractors in the market, then Y’s own knowledge is the final guide to his behavior. If Y requires X’s knowledge, then he must first internalize it, before he can use it. In contrast, if X and Y are coordinating their productive activities within a firm, Y can act on the basis of X’s knowledge without internalizing it. In the firm, “knowledge-substitution” can thus allow an employee to perform a particular job relying on the knowledge of others without first engaging in laborious internalization.⁸¹ This expands the employees’ productive capabilities. According to Conner & Prahalad:

knowledge substitution is a fundamental response to cognitive limitations, having the effect on economizing on them A primary effect of firm organization – of the authority relationship – is to cause an individual to use the knowledge of another *before* the former fully understands or agrees with it. Conversely, a main effect of market contracting – of an autonomous relationship – is to oblige knowledge to be internalized before the individual agrees to modify its actions on the basis of that knowledge.⁸²

Knowledge substitution is even more important in the case of tacit knowledge, which cannot be easily assimilated. “[D]irection substitutes for education (that is, for the transfer of the knowledge itself).”⁸³ In this way, a manager’s knowledge can leverage the productivity of an employee. And more generally, it is possible “to generate more and richer coordinative activity [within the firm] than can be accomplished in markets.”⁸⁴

In contrast, Hayek argued that the market mechanism is superior and more efficient in producing goods, because knowledge is distributed throughout society and there are significant cognitive limitations faced by any set of decision makers in a centralized coordination process. Hayek tried to explain the superiority of market production by reference to the characteristics of tacit knowledge. He argued that the ability of the market to allocate knowledge resources was superior to their allocation in a managed economy, because of the inherently local and tacit character of much of the knowledge required in the production of goods.⁸⁵ Tacit knowledge is

⁷⁹ KENNETH J. ARROW, *THE LIMITS OF ORGANIZATION* 69 (1974).

⁸⁰ See Nicolai J. Foss, *Coase vs Hayek*, Copenhagen Business School, 2001, at 22, <http://www.cbs.dk/staff/njf.html>

⁸¹ Kathleen R. Conner & C. K. Phakalad, *A Resource-Based Theory of the Firm: Knowledge Versus Opportunism*, 7 *Organization Science* 477, (Sept./Oct. 1996). There are instances where knowledge substitution does not need to take place. Supposed I am using a product that was built relying on the knowledge of a third party. In this case, as the knowledge is embedded in the product (as we shall call Kp), knowledge substitutions is not necessary unless I really want to learn how the product was developed.

⁸² *Id.*, at 485. Conner & Prahalad believe that “Contrary to Williamson, frictions between economic actors can occur without opportunism, because of inevitable irreducible differences in their knowledge. Expressed in another way, even in the absence of opportunism, knowledge-based transaction costs can exist.” At 484

⁸³ Demsetz, *supra* note 38, at 172.

⁸⁴ R. P. Rumelt, *Inertia and Transformation in (C.A. MONTGOMERY, ED.) RESOURCE-BASED AND EVOLUTIONARY THEORIES OF THE FIRM* 124 (1995).

⁸⁵ F.A. Hayek, *The Use of Knowledge in Society*. 35 *AMER. ECON. REV.* 519, 521-522 (Sep. 1945) (“It is with respect to this that practically every individual has some advantage over all others in that he possesses unique information of which beneficial use might be, but of which can be made only if the decisions depending on it are left

not easily communicable, but is locally specific and can only be acquired through experience. Tacit knowledge, therefore, cannot be readily gathered by a centralized decision making authority in the manner that data can be gathered and stored in a centralized computer. As a consequence, Hayek argues, decentralization achieved through the market is necessary, because it assures that the knowledge of particular circumstances of time and place will be promptly used by means of the price mechanism.⁸⁶

The market coordinates knowledge exchanges by means of specialization. The firm, however, uses two mechanisms to coordinate knowledge exchange within its boundaries: specialization and knowledge-substitution. Connor and Prahalad conclude that:

firm organization and market contracting each create a particular relationship between people that stands in for the expanded individual abilities that otherwise would be needed to accomplish a similar outcome. An essential function of market contracting ... is to enable individuals to specialize in different aspects of business activity. Each person need not possess the full range of understanding or skills necessary to complete all aspects of the work by itself. The provisions of the market contract coordinate the individuals' efforts, so that a unified product (and hence specialization itself) can emerge.

On the other hand, firm organization also enables specialization, since it too provides a means for coordinating individual efforts. However, unlike market contracting, the firm entails a second means for minimizing the impact of limited cognitive abilities. Again looking at polar cases, because the employment contract creates the authority necessary for knowledge-substitution, but a market contract does not, an employee need not internalize all the insights required to choose and carry out an action, while an independent contractor must. The firm organization economizes on cognitive limitations through two methods: specialization and knowledge-substitution. In contrast, market contracting economizes through specialization alone.⁸⁷

Summarizing the discussion, some scholars such as Arrow and Coase seem to point out the benefits of firm authority centralization in economizing knowledge resources by means of a process that can be described as “knowledge substitution.” Other scholars point out the benefits of a decentralized structure that relies on knowledge specialization and which can occur either on firm structure or in markets.

So, the contributions of the literature so far just partially explain the problem of knowledge allocation. Firm structure alters relations between producers, and replaces market transactions with something else. The relations between producers that are rearranged within the

to him or are made with his active cooperation. We need to remember only how much we have to learn in any occupation after we have completed our theoretical training, how big a part of our working life we spend learning particular jobs, and how valuable an asset in all walks of life is knowledge of people, of local conditions and special circumstances.”).

⁸⁶ Hayek, *The Use of Knowledge in Society*, at 528: “Though [the price system] not only a division of labor but also a coordinated utilization of resources based on an equally divided knowledge has become possible.” However Hayek does not explain why there is organization of production inside firms at all, and what implications firm organization would imply for knowledge development. Hayek treats large firms, which do not use the price mechanism to allocate knowledge resources in their internal structures, as individuals. We believe this is so because Hayek, at the time he wrote, was concerned with pointing out the virtues of market allocations when compared to centralized allocations performed by the State in the function of an economy planner. This was a current theme in his writing, reflecting the debate posed by the Socialist regime at that time. See Friedrich A. Hayek, *The Road of Serfdom*.

⁸⁷ Kathleen R. Conner & C. K. Prahalad, *A Resource-Based Theory of the Firm: Knowledge Versus Opportunism*, 7 ORGANIZATION SCIENCE 477, 485-86 (Sept./Oct. 1996).

firm also include the division of knowledge among different persons involved in a production process.⁸⁸ Firms restructure the decision making procedures of a production process, *centralizing* certain decisions and *decentralizing* others. Indeed, the decentralization achieved through specialization in the firm is at least as important as the centralization of decision making achieved through steeper hierarchies. As Jensen and Meckling point out, “[t]he bundle of decision rights owned in the name of [a firm] . . . is vested *nominally* in its board of directors and CEO, and the rights are then partitioned out among decision agents in the organization. Those organizations that accomplish this partitioning in a fashion that maximizes their value will tend to win out.”⁸⁹ The efficient use of knowledge resources requires decentralized decision making under some circumstances – in markets or firms – and centralized decision making under others. Both can occur in firm production.

The *degree* to which knowledge-substitution takes place within a firm will certainly affect firm organization. The potential for knowledge substitution is a necessary condition for greater centralization and steeper hierarchies. But it is not a sufficient condition. Where knowledge substitution is counterproductive or impossible, employees must rely on their own knowledge and firm organization will tend to be characterized by greater decentralization and flatter hierarchies.⁹⁰ Law firms, architectural firms, and partnerships are, more generally, examples of the latter, as we shall see.

So the question that should be addressed is, after all, when is centralization or decentralization the most desirable organization process so as to promote efficient knowledge allocation in the firm structure. An important contribution in this regard, was advanced by Nickerson and Zenger.

i) The Nature of the Problem

Knowledge requirements differ, depending on the nature of the problem that must be solved in the production process. Jack Nickerson and Todd Zenger argue that markets are best at handling one type of problem (*low-interaction/decomposable problems*), whereas hierarchies are best at handling another type (*high interaction/non-decomposable problems*).⁹¹

Nickerson and Zenger describe the difference between *decomposable problems* and *high-interaction problems* as follows.

⁸⁸ Hayek was the first to point out the importance of the division of knowledge: “Clearly there is a problem of the *Division of Knowledge* which is quite analogous to, and at least as important as, the problem of the division of labour. But while the latter has been one of the main subjects of investigation ever since the beginning of our science, the former has been as completely neglected, although it seems to me to be the really central problem of economics as a social science . . .” F.A. von Hayek, *Economics and Knowledge*. ECONOMICA, NEW SERIES, volume 4, issue 13, February 1937, 33-54, at 49.

⁸⁹ Jensen & Meckling, *Specific and General Knowledge, and Organizational Structure in* (WERIN & WIJKANDER, eds.), CONTRACT ECONOMICS, 271 (1992).

⁹⁰ See Joseph Stiglitz, *Public Policy for a Knowledge Economy*, World Bank, January 1999 at 19: “In the firm, moving from simple repetitive work under central control (Taylorism) **to more complex knowledge-based** work requires a move towards a more decentralized and participative workplace.”

⁹¹ Jack A. Nickerson & Todd R. Zenger, *A Knowledge-based Theory of Governance Choice—A Problem-Solving Approach*, Working Paper, October, 2001.

A problem is a *low-interaction/decomposable problem*, if its solution depends very little on interactions among different knowledge sets. In searching for solutions to such problems, groups of individuals can independently apply their knowledge. The aggregation of their independent efforts with the independent efforts of others who possess different knowledge sets can be expected to uncover a valuable solution to the problem. One example of such a problem is the design of a higher-performing personal computer. Performance can be increased by independently improving any number of subsystems, such as the disk drive, the monitor, the CPU, etc. Such problems “can be subdivided into subproblems each of which draws from rather specialized knowledge sets.”⁹² A method of “directional search” is appropriate to the solution of such problems. In directional search, individuals independently pursue trials and independently observe performance. Individual actors perform multiple searches, altering design features associated with their knowledge sets, and then observe whether performance is increasing or declining as a result of the variation. This method of problem-solving is efficient when there are low-interaction problems that are fully decomposable into subproblems.⁹³

A problem is a *high-interaction/non-decomposable problem*, if its solution is highly dependent on interactions among different knowledge sets. Such problems cannot be separated into subproblems and therefore cannot be addressed by individuals familiar with one particular knowledge set. The design of a leading edge microprocessor circuit is currently such a problem that “demands numerous knowledge sets that extensively interact in determining the value of solutions the value of any particular design change will interact with a host of other potential design changes determined by actors possessing distinctly different knowledge sets.”⁹⁴ In order to solve such problems, directional search is inadequate, and instead, what Nickerson and Zenger call “heuristic search” must be used.⁹⁵ Heuristic search requires the development of heuristics about the patterns of knowledge interactions, which will permit the selection of trials that maximize the probability of finding a high-value solution. Thus extensive communication and knowledge transfer are required to solve such problems.

The authors argue that the nature of the problem that needs to be solved for production to take place will require the use of a specific knowledge set or problem-solving capability. The different types of problems identified above are handled most efficiently by different governance structures. Markets are ideally suited to conduct directional search for the solution of decomposable problems. Markets support directional search, encouraging specialists to pursue trials that exploit their particular expertise. This division of knowledge could be used to explain why, for example, the personal computer is produced from components created worldwide. In his account of the development of the computer industry, Chandler explains how IBM outsourced the production of the components that would compose the personal computer: “...Estridge completed contracts with suppliers of components. Tandom made the disk drives in California; Zenith the PC power supplies in Michigan; the Silicon Valley division of SCI systems (a contract manufacturer) the circuit boards; a Japanese firm, Sieko Epson, the printers; IBM’s plant at Charlotte, North Carolina, the board assemblies; and its plant at Lexington, Kentucky, the keyboards.”⁹⁶

⁹² Jack A. Nickerson & Todd R. Zenger, *A Knowledge-based Theory of Governance Choice—A Problem-Solving Approach*, Working Paper, October, 2001, at 4-5.

⁹³ *Id.*, at 6.

⁹⁴ *Id.*, at 5.

⁹⁵ *Id.*, at 7.

⁹⁶ ALFRED D. CHANDLER JR. INVENTING THE ELETRONIC CENTURY 137-138 (THE FREE PRESS, 2001).

According to Nickerson and Zenger the costs of using markets increase, however, when problems become increasingly non-decomposable.⁹⁷ In that case, their solution will require a mechanism that mitigates knowledge based exchange hazards that arise from the public goods nature of knowledge. This mechanism is the firm hierarchy:

Markets are efficient when knowledge transmission is directed at solving decomposable problems. When problems are decomposable, knowledge is embedded in products and services and knowledge transmission is largely limited to that which can be contained in prices and bundled into products and services. However, bundling knowledge sets within a single firm and exercising authority to direct search becomes efficient when problems become complex and efficient search demands extensive knowledge sharing and coordinated action. Authority in hierarchies economizes on the extensive and costly knowledge sharing and education that would need to occur were the governance of solution search for complex problems organized through a market interface.⁹⁸

Nickerson and Zenger further distinguish between two distinct solutions to the governance of knowledge formation: authority-based hierarchy and consensus-based hierarchy. Authority-based hierarchy is consistent with centralized management of knowledge by individuals who supposedly are more knowledgeable. Centralized management is appropriate to solving problems of relative complexity, while economizing on knowledge transfer. In contrast, the solution of highly complexity problems requires greater decentralization and thus consensus-based hierarchy, as no particular actor will be knowledgeable enough to direct heuristic search:

As problems become more complex and nondecomposable, the cognitive limits of managers to develop useful search heuristics emerge, which, combined with a manager's propensity to meddle, contaminates the efficiency of search. As Weber and a host of organizational theorists remind us "authority does not imply expertise". When authority is exercised in the absence of knowledge, it contaminates rather than accelerates search. Direction effectively substitutes for knowledge transfer only when managers have valuable knowledge with which to direct subordinates. However, as Simon has highlighted, human minds are limited in the rate at which knowledge can be assimilated, accumulated, and applied. Thus, when solving highly complex problems, the distinct knowledge sets needed for solution search are likely to be widely dispersed within the organization. When search dictates extensive recombining of knowledge, it is quite unlikely that ABH [authority based hierarchy] is well suited to govern solution search. If subordinates possess the knowledge required to define the path of search and a central authority is incapable of absorbing that knowledge in a timely manner, then the choice of trials demands knowledge sharing and a consensus-based decision process to order trials.⁹⁹

Therefore firm organization will differ depending on the nature of the problem that a firm needs to solve and its underlying knowledge requirements. The degree of interaction among

⁹⁷ The authors argue that markets exacerbate knowledge exchange hazards, discouraging investments in co-specialized knowledge and development of a common language that are essential to a heuristic search. Individuals don't have appropriate incentives to deal with the public good nature of knowledge.

⁹⁸ *Id.*, at 13.

⁹⁹ *Id.*, at 15 (internal quotations omitted).

knowledge sets required for the solution of problems encountered during the production process will influence whether firm production is more efficient than market production, and if so, whether steeper or flatter decisional hierarchies are appropriate.

Before we turn to our contribution to the debate of how knowledge resources shape firm governance and vice-versa, we will address another important feature of knowledge resources.

c) Standardized vs. Tacit Knowledge

Knowledge as with regard to how it is embodied has two basic forms: standardized (codified) or tacit. Standardized knowledge is formalizable knowledge such as the knowledge found in books, pieces of papers, graphics, tables, drafts, or even by means of spoken messages. This body of knowledge is suited to the public good hazards described above. For example, if a hacker intercepts my e-mail that contains important codified knowledge, he might free-ride at my ideas without paying for using them. To the extent that knowledge can be made *explicit*, it is no longer embodied in an individual, but articulated and codified in the form of manuals, blueprints, and other documented material (including, for example, scientific papers). Codification permits the dissemination of knowledge. Note also that all codified knowledge was once tacit.

However, not all knowledge can be codifiable.¹⁰⁰ As Polanyi said: “*we can know more than we can tell.*”¹⁰¹ The assumption that economic actors are bounded rational leads to an important corollary: not all knowledge will be possible to standardization, and considerable knowledge will remain tacit.¹⁰²

According to Williamson:

“Language limits refer to the inability of individuals to articulate their knowledge or feelings by use of words, numbers, or graphics in ways which permit them to be understood by others. Despite their best efforts, parties may find that language fails them (possibly because they do not possess the requisite vocabulary or the necessary vocabulary has not been devised), and they resort to other means of communication instead. Demonstrations, learning-by-doing, and the like may be the only means of achieving understanding when such language difficulties develop.”¹⁰³

Tacit knowledge is the knowledge embedded in the individual, acquired through personal experiences, learning-by-doing and particular insights and skills. Tacit knowledge, is, therefore, suited to opportunistic appropriation to a smaller extent, because it is much personal in nature.

¹⁰⁰ It is important to remark that all codified knowledge has been firstly conceived as a tacit knowledge. We will further develop this issue in part. III.A.2.

¹⁰¹ MICHAEL POLANYI, *THE TACIT DIMENSION* 4 (1966).

¹⁰² See Richard R. Nelson, *Production Sets, Technological Knowledge, and R & D: Fragile and Overworked Constructs for Analysis of Productivity Growth?*, 70 *The American Economic Review* 62, 65 (1980) (“What if whatever it is that permits a firm to operate a technique in a particular way and with particular outcomes is only in small part describable in a blueprint, or teachable by example, or purchasable in the form of a machine? Then the fact that firm A can operate a particular technique with a particular outcome does not mean that firm B or firm C can, even if firm A helps out their learning in every way it can. The presence of particular and rather special personal talents, or important organizational features, signals that codified aspects of technique may only be a part of the story.”)

¹⁰³ Oliver E. Williamson, *Markets and Hierarchies: Analysis and Antitrust Implications* 21-22, 1975.

Consequently, tacit knowledge may not be readily transferred through an exchange, but may require context-specific learning.¹⁰⁴ The non-communicable character of tacit knowledge requires that it must be obtained by integrating individuals, who possess it, into the production process as, for example, employees. The production of knowledge resources may require extensive communication and exchange of ideas and personal experience,¹⁰⁵ and therefore it seems to us that tacit knowledge can be better shared in the structure of a firm, as opposed in the market, as we shall develop.

III. KNOWLEDGE AND FIRM STRUCTURE – A FIRST TYPOLOGY

A. The Location of Productive Knowledge (K_p, K_o, K_i) and the implications for Firm Structure

In this section we present a typology of knowledge resources used in the production process. This typology will enable us to suggest an alignment of knowledge resources used in a firm's production with that firm's governance structure. We thereby hope to move towards operationalizing some of the insights of knowledge based theories of the firm and applying these insights to corporate governance.

1. *A First Typology: K_p, K_o, K_i*

Firms depend on knowledge resources.¹⁰⁶ Knowledge formation within the firm is crucial to production in competitive markets. Firms that compete in mass production, however, have different knowledge requirements than firms that compete in high-technology fields.¹⁰⁷ In

¹⁰⁴ Scientific-technological knowledge has both public goods and tacit knowledge characteristics. To the extent that it can be articulated with (mathematical) precision in a language that specialists in the discipline understand, a significant breakthrough can be communicated very quickly, sometimes in hours or in a few days. On the other hand, mere understanding of the theoretical insights may simply not be enough to grapple with the complexities of integrating new theoretical understanding into silicon chip production. But presumably competitors in an industry would have the capacity to do so.

¹⁰⁵ Kenneth J. Arrow, Classificatory notes on the production and transmission of technological knowledge. AMERICAN ECONOMIC REVIEW, vol 59, issue 2, Papers and Proceedings of the Eighty-first Annual Meeting of the American Economic Association (May 1969), 29-35. See C.K Prahalad & Gary Hamel, *The Core Competence of the Corporation*, Harvard Business Review, 1990, attributing significant importance to communication in their concept of "core competence" ("Core competencies are the collective learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technologies...Core competence is communication, involvement, and a deep commitment to working across organizational boundaries. It involves many levels of people and all functions.... The skills that together constitute core competence must coalesce around individuals whose efforts are not so narrowly focused that they cannot recognize the opportunities for blending their functional expertise with those of others in new and interesting ways").

¹⁰⁶ We distinguish between information and knowledge. Knowledge that is transferable readily and almost without cost is information. Knowledge is the processing and understanding and processing information to some means. Information can be processed into some input. This is what knowledge does. The mere knowledge of facts is likely to be information. The data we currently find in our days is mostly information. But this information can be processed and become knowledge of an individual.

¹⁰⁷ J. Rogers Hollingsworth, *Continuities and Changes in Social systems of Production: The Cases of Japan, Germany, and the United States* in CONTEMPORARY CAPITALISM: THE EMBEDDEDNESS OF INSTITUTIONS 265, 268 (1998) (arguing that "firms that successfully employed a mass production strategy had to engage in a particular form

this paper we defend the thesis that a firm's knowledge resource needs will influence the way in which a firm structures knowledge production, knowledge transfer within the firm, and its internal decision making procedures. Therefore, how a firm structures knowledge production and transfer ("knowledge structure") is an important determinant of its ownership, financial structure and organization. The argument runs in the other direction as well, since we also contend that the way the firm organizes its governance structures can influence the development of knowledge resources in its structure.¹⁰⁸

In order to think more clearly about the way in which knowledge requirements affect firm structure, we distinguish between different forms that knowledge resources take. We use a typology that distinguishes three types of knowledge structures.

We term K_p knowledge embodied in physical assets, like books, manuals, machines or products. Taylorist production provides perhaps the best example of this type of knowledge structure. In assembly-line production, the knowledge required in the production process is embedded in machines. Assembly-line workers are largely "de-skilled." Note that the employee is easily replaceable in this sort of production. But the machine is the principal asset that makes production feasible and embodies the knowledge required in the production process. Products also embody knowledge in this manner, allowing consumers to extract knowledge benefits without themselves having to master the knowledge. For example, most anyone can operate a computer, or software, that performs highly complex and/or labor-intensive procedures without knowing all the stages necessary to produce either the tool or the specific output the tool supplies.¹⁰⁹ In other words, products and machines embody useful knowledge that provides key functions within any production process. They make it possible the process of "knowledge-substitution" because they substitute the application of the knowledge necessary to build the machine by the use of the knowledge which is already embedded in them. An employee performing routine work mostly depends on the knowledge embedded in machines and other products to perform his job satisfactorily. It is required, in many instances, that he knows merely

of industrial relations, use specific types of machinery, and relate in particular ways to other firms in the manufacturing process"); Demsetz, Comments on Jensen & Meckling, *supra* note __ at 276, advanced that different types of firms rely on different types of knowledge. "Because their activities are so dissimilar, biotechnology firms, steel firms, and retail establishments, by design, inventory different stocks of knowledge. Generally, these stocks are "housed" in the people employed. These firms locate control within their organizations in ways that are appropriate to these different distributions of knowledge." *See also*, CHANDLER, SCALE AND SCOPE 45 (arguing that the rise of the multidivisional modern industrial enterprise was limited to "those industries where technologies of production had the potential for extensive economies of scale and scope and where product-specific marketing organizations provided further competitive advantages).

¹⁰⁸ Chandler, *supra* note 96, at 85-86, for example, attributes the failure of Remington Rand in the computer business to its failing in built an integrated learning base. So, according to Chandler a problem in the management of knowledge resources led to the failure of the business.

¹⁰⁹ See Demsetz, The Theory of the Firm Revisited, at 173: "Because it is uneconomical to educate persons in one industry in the detailed used in another, recourse is had to developing or **encapsulating this knowledge into products or services** that can be transferred between firms cheaply because the instructions needed to use them do not require in-depth knowledge about how they are produced...The economical use of industrial chemicals by steel firms does not generally require knowledge of how these chemicals are produced; similarly, the use of steel by industrial chemical firms does not require transfer of knowledge of how the steel is produced. A production process reaches the stage of yielding a saleable product when downstream users can work with, or can consume, the "product" without themselves being knowledgeable about its production."

limited and perhaps crude technical expertise in order to operate the machine.¹¹⁰ We call this knowledge embedded in machines and other products K_p .

We term K_O knowledge embodied in the organizational structure, in the group of individuals that constitute the firm. Nelson and Winter identified this knowledge structure in their evolutionary model of economic institutions.¹¹¹ It comprises the habits, practices and routines of a firm's organizational structure and organizational culture. Sherwin Rosen, similarly, refers to such knowledge as knowledge vested "in the firm."¹¹² Generally this asset is transferable only by selling the firm or a part of it.¹¹³ The knowledge, in this case, inheres in the organization of an efficient "production team," that can operate and be maintained in the absence of the owner or any one specific employee.¹¹⁴ Individual employees are replaceable because knowledge resources are dispersed across many different co-workers and managers. In contrast, K_O is collective knowledge created through, and residing in patterns of interaction among individuals within the organization. We assume for reasons of simplification that collective action costs are high and employees cannot organize themselves to leave the firm in a group, which will conserve K_O in the firm even if a certain amount of turnover exists.¹¹⁵

We term K_I knowledge embedded in the individual. The skills of a craftsperson, an artist, or a professional athlete are paradigmatic examples of such knowledge. Individuals accumulate such knowledge "of the particular circumstances of time and place" through personal experience in the Hayekian sense. Knowledge of this sort cannot be costlessly transferred from one person

¹¹⁰ Note that while this is true in many instances, for example, as when we use our microwaves, personal computers or cars, there are some occasions where K_p will give rise to the advancement of our knowledge, when we interact with such machines or products. An example would be an art designer learning and developing skills to work with Photoshop. We discuss this below.

¹¹¹ RICHARD NELSON & SIDNEY WINTER, *AN EVOLUTIONARY THEORY OF ECONOMIC CHANGE*, (1982).

¹¹² Sherwin Rosen, *Learning by Experience as Joint Production*, 86 *The Quarterly Journal of Economics* 366 (1972) issue 3, at 367. See also, Annette L. Ranft & Michael D. Lord, *Acquiring New Knowledge: The Role of Retaining Human Capital in Acquisitions of High-Tech Firms*, 11 *J. HIGH TECH. MANAGEMENT RESEARCH*, 295, 298 (discussing the acquisition of knowledge sets that are "embedded in relationships among individuals, or in a firm's more general social and organizational fabric, rather than in any particular person.").

¹¹³ There is, of course, an overlap between knowledge embedded in the individual employee and knowledge embedded in the organizational and organizational structure. See Ranft & Lord, *Acquiring New Knowledge: The Role of Retaining Human Capital in Acquisitions of High-Tech Firms*, at 298 ("Critical organizational competencies are often embedded in relationships among individuals, or in a firm's more general social and organizational fabric, rather than in any particular person. A significant portion of a firm's knowledge may be located in the formal and informal networks of relationships within the organization and even across organizational boundaries. In other words, a firm's valuable knowledge-based resources may reside not only in particular individuals, but also in socially complex relationships among different individuals and organizational subunits. Socially complex knowledge 'resides primarily in specialized relationships among individuals and groups and in the particular norms, attitudes, information flows, and ways of making decisions that shape their dealings with each other'. In the case of socially complex knowledge, no single person has the full set of skills and capabilities required to create a commercially viable product or service. This social complexity makes knowledge difficult to manage because critical interrelationships can be easily disturbed, such as when key individuals or teams leave the firm. Consequently, retention of key employees is not only a critical issue for retaining individual knowledge, but also for preserving valuable types of knowledge that are socially complex.") But increasingly firms that acquire certain productive capabilities have also served as vendors of their own know-how. STEWART, *supra* note __, __.

¹¹⁴ *Id.* In the corporate law literature, from a somewhat different perspective. Margareth Blair and Lynn A. Stout have contributed to the development of this idea. See, *A Team Production Theory of Corporate Law*, 85 *VIRGINIA L. REV.* 247 (1999).

¹¹⁵ An actual problem of mergers and acquisitions is maintaining K_O , that is, the production team responsible for knowledge development in the organization *ex post*. See Ranft and Lord, *supra* note __.

to another.¹¹⁶ And often the cost of knowledge transfer between persons is very high because the relevant knowledge is based on experience and is tacit.¹¹⁷ Where knowledge is tacit, relocating individuals to the site where such learning takes place is necessary to achieve knowledge transfer. K_I is defined as specialized knowledge. Its loss has a measurable effect on firm structure.¹¹⁸ Knowledge that has been formalized, standardized and is thus easily transferable generally does not qualify as K_I . But the capacity of an individual to assimilate such specialized knowledge due to formal or other education is considered K_I . This last distinction is straightforward in theory but clearly very hard to apply. Nevertheless, we think it is worth making.

Note that the bright line categories we have created here are fluid and can blur in reality. Knowledge of the K_O and K_I type is most like to overlap. This occurs, for example, where the knowledge possessed by one individual is also possessed by other individuals that comprise the organization. In this situation, K_I will be similar to or overlap with K_O to a considerable extent. Rosen notes, for example, that one important difference between K_I and K_O is the length of the horizon/time required for rational decision making. K_I implies a finite horizon, as the capital will vanish when the owner of the knowledge dies. K_O implies a infinite horizon, since the knowledge can be preserved within the structure of the firm and transferred with the firm.¹¹⁹ Note also that these variables are interdependent to some extent. K_O may depend on K_p , for certain routines arise in order to manage certain machines and products. So K_O cannot be easily transferred from firm to firm. Routines that work in some environments may not work in other environments. Furthermore, K_I may vary depending on different individual's experiences with the same products or machines. This will be further developed in the next section.

Below we present a table that systematizes these concepts.

¹¹⁶ Sherwin Rosen, *Learning by Experience as Joint Production*, 86 *The Quarterly Journal of Economics* 366 (1972) issue 3., at 367. Rosen, for example, refers to *knowledge completely vested in the owners* (or managers) of the firm. Knowledge, has to do in this case with pure "entrepreneurship". The asset is not salable, though the owners may rent the services of their knowledge to the firm and elsewhere. This is what we mean by K_i , the knowledge is embedded in the individual, whether this be the owner of the firm, a manager or a employee.

¹¹⁷ See POLIANYI, *supra note* _.

¹¹⁸ As Ron Gilson points out in his discussion of interfirm knowledge spillovers in the high tech industry, "[t]acit information associated with an employer's technology is embedded in the human capital of its employees. When an employee changes jobs, that tacit information is available to the new employer." Gilson, 74 *N.Y.U.L. Rev.* 575, 585. See also, at 595 ("This [tacit] element of the employer's intellectual property is embedded in the employee's human capital, and can be most effectively transferred through proximity and, in particular, by an employee changing jobs.").

¹¹⁹ Rosen, *supra note* __, at 368.

KNOWLEDGE TYPES

	KNOWLEDGE		
Type	K_P	K_O	K_I
General Description	Knowledge “directly” embedded in machines and products.	Knowledge embedded in the firm’s organizational structure (not codified)	Specialized, technical, particular knowledge and skills “embedded” in individuals
Examples	<ul style="list-style-type: none"> • Books, manuals • Codified production technology • Machinery • Products • New combinations of existing knowledge sets that yield sellable products. • Legal opinions 	<ul style="list-style-type: none"> • Structuring of decision-making processes. • Coordination and division of work • Management of knowledge • Monitoring structures • Quality control procedures 	<ul style="list-style-type: none"> • Scientific training • Professional training • Craft and skill • Knowledge of professional networks • Personal experience • Client’s knowledge

Source: authors’ elaboration

2. *The Dynamics of Productive Knowledge*

The typology of knowledge structures given so far presents a static picture. Knowledge structures, however, change over time and we must, accordingly, incorporate such dynamics into our analysis.

Such transformations will depend, among other things, on the standardization process that knowledge deployed by organizations and individuals typically undergoes.¹²⁰ Standardization is the process through which tacit knowledge is made explicit, formalized, and then codified or instantiated in physical processes and products.¹²¹ For example, standardization takes place, where knowledge previously embedded in an individual (K_I) is formalized, reconfigured, and embedded in a newly created machine or product (K_P). In the mature stage of the industry life cycle, “most of the technical aspects of the product have become standardized,

¹²⁰ See, e.g., Robin Cowan & Dominique Foray, *The Economics of Codification and the Diffusion of Knowledge*, 6 INDUS. & CORP. CHANGE 595, 604-05 (1997) (discussing the process of codification of tacit knowledge). But see MARYANN P. FELDMAN, THE GEOGRAPHY OF INNOVATION 53 (1994) (“Some aspects of knowledge have a tacit nature and cannot be completely codified and transferred through blueprints and instructions.”).

¹²¹ For one attempt to theorize knowledge creation dynamics in firms, see Ikujiro Nonaka, et al., *Managing and Measuring Knowledge in Organizations: Three Tales of Knowledge Creating Companies*, in KNOWING IN FIRMS (Georg von Krogh, et al, eds. 1998) 146, and Ikujiro Nonaka & Hirotaka Takeuchi, *A Theory of the Firm’s Knowledge-Creation Dynamics* in (CHANDLER, ET AL., EDS.), THE DYNAMIC FIRM 214. Nonaka et al. focus on the effects of organizational structure on knowledge creation and try to understand the constraints (and opportunities) that the dynamics of knowledge creation represent for structuring organizations. Their focus is thus somewhat different from ours. They also do not isolate standardization as a distinct process, preferring instead to talk about “externalization” (from tacit to explicit) and “combination” (from explicit to explicit), and, more generally, a “knowledge spiral.” *Id.*, at 220-224.

and the nature of demand is well known.”¹²² The focus of the industry becomes standardized production.¹²³ In such circumstances, tacit knowledge becomes relatively less important to the production process and in the organization of the firm. The transmission of tacit knowledge both within and between firms benefits from proximity,¹²⁴ while explicit or codified knowledge renders the cost of transmitting information over geographic space trivial.¹²⁵ One result of codification and standardization of knowledge in products (Kp), for example, is that constraints on the production and distribution of products across large geographical areas (and internationally) are thus significantly reduced, enabling reproduction of this knowledge on a much greater scale, as the case of mass production industries.

The reverse transformation may also occur. The creation of a new machine or product, such as a software, may educate the worker/user, slowly weaning her from reliance on help screens, aids and by-the-book routines to a more efficient and sophisticated deployment of the tool’s core functions by means of user-defined short-cuts and creative applications. Employees may develop routines to operate the machine in a way that avoids depreciation and affords it a longer life cycle. In such circumstances Kp will give rise to Ki, and probably to Ko, as this knowledge is spread from a single employee to the firm through the refinement of the firm’s organizational routines.

In addition, engagement with physical assets will yield entirely new knowledge in the form of Ki that was not initially contemplated by the creator of the machine or embedded in the product. Such a transformation occurs where, by observing how the machine operates, an employee conceives of new ideas for the creation of a different type of machine.¹²⁶ In other words, the employee develops ideas for new technologies, which, at this stage, will still be tacit and thus embedded in this particular employee. Hence Kp gives rise to Ki.

In the following, we discuss the possible types of knowledge transformation.

a) Ki can be transformed into Ko

A routine or a process developed by an individual or small team can spread to the entire organization and beyond, if others find this knowledge useful. An example in this case is the Japanese system of “just in time”. Because of its efficiency, this process was soon transmitted to other organizations and became embedded in the structure of organizations.¹²⁷

¹²² David B. Audretsch & Maryann P. Feldman, *Innovative Clusters and the Industry Life Cycle*, 11 REV. INDUS. ORG. 253, 259 (1996).

¹²³ Ronald Gilson, *The Legal Infrastructure of High Technology Industrial Districts*, 74 N.Y.U. L. REV. 575 (1999), at 575, 585.

¹²⁴ See RICHARD NELSON & SIDNEY WINTER, *AN EVOLUTIONARY THEORY OF ECONOMIC CHANGE*, (1982), at 76-82, 115-116 (describing tacit nature of skills).

¹²⁵ Robin Cowan & Dominique Foray, *The Economics of Codification and the Diffusion of Knowledge*, 6 INDUS. & CORP. CHANGE 595, 604-05 (1997).

¹²⁶ CHANDLER, *The Large Industrial Enterprise in BIG BUSINESS AND THE WEALTH OF NATIONS* 27-8 (Chandler, et al. eds. 1999).

¹²⁷ Going further, the technique of just in time is now codified in management books, being transmuted into a “product” with the characterizes of Kp. However, the specific way in which a firm applies this technique may change a little bit from firm to firm, which still characterizes a type of Ko.

b) Ko can give rise to Ki

A new employee will come into contact with organizational knowledge which is dispersed in the firm structure. She will have formal and informal orientation sessions, learn organizational routines and receive specialized training in the use of communication technology and the division of work. As she begins to share work experiences in the firm, this employee will assimilate a lot of organizational knowledge which will become Ki, knowledge embedded in the individual. She may even leave the organization and start up a business based on similar organizational routines and processes and thus take this knowledge with her.

c) Ki can be transformed into Kp

As knowledge becomes formalized and standardized it becomes embedded in physical objects. An idea for a tool is thus developed into a machine. In this case, the knowledge that was embedded in the individual becomes embedded in the machine. This process of embedding knowledge in the machine has important consequences: the other actors that subsequently operate the machine do not need to *know how* the machine was *conceived and developed*. They will merely need a specialized technical knowledge of *how to operate* it. The result is that less educated employees are able to operate the machine in order to produce the final product envisaged by perhaps yet a different inventor, without having to acquire the knowledge sets of the machine's inventor or that of the product developer. This knowledge embedding process, therefore, effects a knowledge-substitution; it is therefore a highly economizing process that permits the use of a highly complex knowledge sets by others who do not possess them.

d) Kp can give rise to Ki

Use of a product or a machine in the production process will give rise to large and small improvements on the equipment itself. New and different applications for the technology will be devised. Problems posed by the new product spur the development of knowledge to improve it. Thus, Kp gives rise to Ki.

e) Kp can give rise to Ko

The classical example here are the routines that were developed by Ford in order to operate an efficient assembly line. A highly specialized organizational knowledge specific to the production of cars was developed on how to operate many machines and tools efficiently. This organizational knowledge is shaped by the characteristics of each machine and other physical assets required to operate the assembly line. In this example, Kp thus gives rise to routines and other organizational knowledge Ko.

f) Ko can be transformed into Kp

Imagine that the team operating the assembly line realizes that they can save time by developing a specific tool to aid in their work. The tool will be a form of Kp that originated from

knowledge of the organizational routines of this assembly line, that is, from Ko. Moreover, the development of the new tool presupposes knowledge of these particular organizational routines.

The processes described give us a rough idea of how different types of knowledge can transform over time. They provide a stylized picture of how firms can change together with the nature of the knowledge they develop and deploy over time.¹²⁸ A typical mass production firm (mainly based in Kp) might engage in more knowledge intensive activities as the operation of its machinery spurs research and development in order to maintain or improve it. The level of Ki in the firm will thus rise. A high tech firm (mainly based on Ki) might develop a product, and then engage in its mass production (mainly based on Kp) thus eventually decreasing its necessity of Ki. In both situations the change in the degree of types of knowledge (more Ki in the first example and a predominance of Kp in the second example) will give rise to changes in the *governance structures* of these firms.

3. *Propertized Knowledge*

The variables discussed so far reflect where the knowledge is embodied (Kp, Ko and Ki). Now, we would like to propose another variable that has to do with the property of each type of knowledge. We define Kpr as knowledge which is propertized and therefore is protected by the legal system. This knowledge can be protected by intellectual property law in its broad sense (encompassing patents, trade secrets, copyrights) and by private contracting as it happen with non compete agreements, or confidentially agreements. All types of knowledge can become propertized, in more or less imperfect ways. This is so, because as we will see, intellectual property does not protect all types of knowledge. And the extent that intellectual property provides such rights will also help shaping firm governance structure, as we shall develop in Part IV. In addition, the protections of knowledge rights are also connected to the level of enforcement of intellectual property rights rules and contracts. So whether the legal system provides such protection, and the way this protection will be enforced will lead firms to develop specific governance structures and mechanisms to cope with the special hazards that knowledge resources pose.

We here present a table that explicates types of legal mechanisms that bind knowledge and propertize it. We will leave a more complete presentation of our arguments to part IV.

¹²⁸ For discussions of the coevolution of technology and institutions, see also, RICHARD NELSON, *THE SOURCES OF ECONOMIC GROWTH* (1996) 100-119.

KNOWLEDGE STRUCTURES AND MECHANISMS THAT PROPERTIZED KNOWLEDGE

Kpr (Propertyzed knowledge)			
	Kp	Ko	Ki
Legal rules and private contracts that propertize knowledge structures	Patents Copyrights ¹²⁹	Trade secrets law Corporate law rules that centralize control in a board of directors ¹³⁰	Restrictive Covenants Copyrights Confidentiality Agreements

Source: authors' elaboration

4. *Efficient Knowledge Allocation*

In order to develop specific hypotheses about firm structure, we develop the following theoretical assumption: Firms will try to maximize the efficient use of knowledge resources in the production process. This assumption is similar to the assumptions underlying certain economic models that firms will maximize profits and consumers will maximize their utility. In order to maximize the efficient use of knowledge resources, we now posit that firms should collocate decision-making authority with the relevant knowledge available within or to the firm. A firm uses its knowledge resources most efficiently when it allocates decision-making authority to those (persons or groups) that have the relevant knowledge to make such decisions at the various levels of the firm hierarchy.¹³¹

Knowledge resources are costly. All else being equal, knowledge resources are wasted where decision-making authority is withheld from those with the knowledge required to make certain decisions. There will be knowledge available in the organization without putting it to its most value-enhancing use. Conversely, where a particular task or position within the firm

¹²⁹ Copyrights can both support Kp and Ki, depending on to whom the legal systems assigns property of copyrightable assets. The American legal system assigns property to the firm while the German legal system assigns property to the employee. These different legal rules may contribute to shaping different firm governance structures.

¹³⁰ Chandler, *supra* note ___, 73. Rules that centralize decision making in the board of directors can support or undermine knowledge structures depending on the type of knowledge structure that exists in the organization. As we have been arguing if K_i is the predominant type of knowledge, a decentralized system of control is likely to produce more efficient results.

¹³¹ See Michael C. Jensen & William H. Meckling, *Specific and General Knowledge, and Organization Structure*, in *Contract Economics*, Lars Werin and Hans Wijkander, eds. (Blackwell, Oxford 1992), pp. 251-274. ("When knowledge is valuable in decision-making, there are benefits to collocating decision authority with the knowledge that is valuable to those decisions. There are two ways to collocate knowledge and decision rights. One is by moving the knowledge to those with the decision rights; the other is by moving the decision rights to those with the knowledge. The process for moving knowledge to those with decision rights has received much attention from researchers and designers of management information systems. But the process for moving decision rights to those with the relevant knowledge has received relatively little attention in either economics or management." at.5-6)

hierarchy can be accomplished by substituting the knowledge of a supervisor/manager for that of an less knowledgeable employee, i.e. through direction of the employee, there is no need to pay the higher wage for the manager, because (from an economizing perspective) the task could be performed by a lower level employee. To put it differently, if a position in the firm is occupied by someone who has more knowledge than is required to perform his work, knowledge resources are being wasted through inefficient allocation of knowledge resources.¹³²

From these observations it follows that: *Decision-making authority should be collocated with relevant knowledge within the organization in an economizing way.*¹³³ We call this the *Principle of Efficient Knowledge Allocation*.

Note that this principle is a principle of governance structure entirely independent of the question of agency costs, incentive structures, or opportunistic behavior. It derives from focusing on production costs, rather than contracting costs. It is thus also quite independent of questions of information asymmetry in contract analysis. To be sure, such considerations necessarily come into play in the efficient allocation of decision-making rights within an organization, for there are hazards associated with knowledge use. An employee, for example, may shirk by failing to apply, or even deliberately concealing her knowledge in performing her work. But the principle of efficient knowledge allocation identifies an independent, irreducible feature of a firm's governance structure.

Several other relationships between decisional hierarchies and knowledge distribution within the firm emerge in connection with this principle. The first is that the firm hierarchy should be flatter and more decentralized, the greater and the more complex the knowledge distribution among the firm's personnel.¹³⁴ In contrast, decisional hierarchies should be steeper, and decision-making authority should be more centralized, the less knowledgeable the firm's personnel and the less complex the organization's knowledge capabilities. In this situation, we will expect to find people who are more knowledgeable exercising top executive functions and therefore the pyramid of hierarchy will have a large base with few persons in the top positions.

We believe that even if the principle of maximizing the efficient use of knowledge resources is frequently ignored, that is, in instances where managers or employees perform tasks poorly correlated with their knowledge resources, the principle is still a valuable tool for explaining how governance structures are shaped, from a positive perspective, or how governance structures should be shaped, from a normative perspective. Indeed, Chandler's account of the rise of the large modern corporations does highlight the allocation of knowledge resources in an economizing or a wealth-maximizing way. As Chandler has insisted, the significance of the emergence of the managerial class is that it established the allocation of decision-making rights to a new class of educated non-owners who were hired because of their

¹³² This assumes, of course, that the employee is being fully compensated for her skills.

¹³³ Jensen & Meckling, at 19 argue: "The key to efficiency is to assign decision rights to each agent at each level to minimize the sum of the costs owing to poor information and the costs owing to inconsistent objectives."

¹³⁴ See, e.g., Stephen R. Barley, *The Turn to a Horizontal Division of Labor: On the Occupationalization of Firms and the Technization of Work*, paper prepared for the Office of Educational Research and Improvement, U.S. Department of Education, January 1994, pp. 21, 32 ("As firms hire increasing numbers of professionals, as professions spawn specialties, and as new technologies create work that requires esoteric knowledge, expertise becomes more balkanized and firms begin to resemble confederacies of occupations rather than sleek pyramids of control When those in authority no longer comprehend the work of their subordinates, chains of command should cease to be viable for coordination.").

expertise in engineering and business management,¹³⁵ rather than because of their loyalty or social class. The large modern corporation displays the co-existence of decision structures.¹³⁶ Thus the same organization that promoted the devolution of decision-making authority from the entrepreneur/owner to a knowledgeable professional class of managers, subordinated, at a different level of firm hierarchy, the decision-making by workers to the direction of management and management's design of the production floor. The Taylorist firm thus economized on knowledge resources by hiring de-skilled workers at the production level and hiring skilled personnel at the management and R&D level. The success of this type of internal governance of the firm thus again suggests that knowledge resources are extremely costly, if not the most costly resources.

Knowledge inputs in the form of human capital, as suggested by our discussion so far, directly affect the governance structure of an organization in a way that other inputs, such as physical assets, capital and raw materials, do not. The value of knowledge consists in solving problems and making good decisions.¹³⁷ Purchasing knowledge, but not making full use of it, or relying on those less knowledgeable to make the relevant decisions, is inefficient, and may well bring about failure in a competitive environment. The purchase of knowledge is efficient only if it gets reflected in the governance structure or allocation of decision making authority of the organization, just as the purchase of a physical asset only makes sense if it is used in a productive way, or the borrowing of capital if applied to its best rate of return.

However, knowledge resources are not allocated in the firm by the price mechanism. Therefore, the efficient allocation of decision making authority within organizations is subject to special difficulties that have to do with the nature of hierarchical organizations themselves, that is, with their relative rigidity. As Jensen and Meckling point out, the fact that intrafirm decision making rights are typically not themselves alienable may, over time, lead to the inefficient allocation of knowledge resources:

[T]he internal organization of the capitalist firm is also an instance of the absence of alienable decision rights. Indeed, we distinguish activities within the firm from activities between the firm and the rest of the world by whether alienability is transferred to agents along with the decision rights. In this *view transfers of decision rights without the right to alienate those rights are intra-firm transactions*. While firms can sell assets, workers in firms generally do not receive the rights to alienate their positions or any other assets or decision rights under their control. They cannot pocket the proceeds. This means there is no automatic decentralized process which tends to ensure that decision rights in the

¹³⁵ Chandler, *supra* note __. Demsetz mentions that those who are to produce but don't have knowledge must have their activities directed by those who possess more knowledge. *The Theory of the Firm Revisited*, at 171-172.

¹³⁶ Diego Puga & Daniel Trefler, *Knowledge Creation and Control in Organizations*, NBER Working 9121, Sept. 2002 at 29.

¹³⁷ The most significant economic value of knowledge consists in its problem-solving potential. And problem-solving ultimately results in decision. Problem-solving capabilities, for the most part, are only fully engaged and sharpened when the problem-solver is confronted with real choices. Problem-solvers must therefore be genuinely engaged in a decision-making process, even if they do not have the last word. While decision-makers do not need to have a grasp of all the details of a decision, and thus can delegate some, or even much or the problem-solving, good decisions require a good grasp of the alternatives, or on the reliance of those better informed. While formally a decision might be ratified at a higher level of hierarchy, boundedness of rationality necessarily implies the diffusion of actual decision-making within an organization if this is the approach that will efficiently allocate knowledge resources. The contract-based explanation of the firm, explaining its transaction cost savings by the fiat relationship between employer and employee as advanced by Coase simply ignore those considerations.

firm migrate to the agents that have the specific knowledge relevant to their exercise, and that there is no automatic performance measurement and reward system that motivates agents to use their decision rights in the interest of the organization. Explicit managerial direction and the creation of mechanisms to substitute for alienability is required.¹³⁸

Because there are no clear property rights in knowledge assets inside the firm, the assignment of decision rights to promote efficient knowledge allocation faces special difficulties. Problems of information (or knowledge) asymmetry make it difficult to evaluate knowledge resources. In the case of tacit knowledge, the asymmetry problem is exacerbated: individuals themselves do not have information about what and how much they actually know. Thus, one of the most important, and perhaps most difficult, problems that a firm has to solve, and one which can lead to its success or failure in a competitive environment is: the collocation of decision making authority with relevant knowledge.

There are additional hazards that may impede collocation of decision making authority with relevant knowledge. Actors may fail to share knowledge in order to secure their decision making authority or to extract other advantages. Such hard to detect opportunistic behavior could potentially provide very significant gains for the individual and lead to significant inefficiencies for the organization. Moreover, such hoarding failure to share knowledge may increase with increasing flexibility of the decision making authority within an organization. Knowledge resources existing within the firm may, therefore, be underutilized.¹³⁹ Thus, even if decision rights are collocated with the most appropriate knowledge, there are opportunism costs peculiar to the use of knowledge resources.¹⁴⁰ The use of knowledge is not frictionless and will always generate a certain amount of waste. There are also costs due to mistaken decisions. These are exacerbated where decision making authority is not collocated with the relevant knowledge. These costs have to be taken into account in assessing the efficient allocation of knowledge resources.¹⁴¹

5. Correlating Knowledge Structures and Governance (Decisional/Ownership) Structures

In this part, we apply our typology to different types of firm production. We advance the hypothesis, for which we then produce evidence in subsequent sections, that firm governance

¹³⁸ Jensen & Meckling, supra note __, at 14-15.

¹³⁹ Note that we are not referring here to the problem of bounded rationality, which, per se, will generate constant underutilization of knowledge. We refer a particular situation where the knowledge could be effectively used if disclosed by its donor.

¹⁴⁰ Jensen & Meckling, supra note __, at 24 argue: "Because all individuals in a firm are self-interested, simply delegating decision rights to them and dictating the objective function each is to maximize is not sufficient to accomplish the objective. A control system that ties the individual's interest more closely to that of the organization is required. The control system specifies (a) the performance measurement and evaluation system for each subdivision of the firm and each decision agent, and (b) the reward and punishment system that relates individual's rewards to their performance."

¹⁴¹ Jensen & Meckling at 28. Thus, if knowledge valuable to a particular decision is to be used in making that decision, there must be a system for assigning decision rights to individuals who have the knowledge and abilities or who can acquire or produce them at low cost. In addition, self-interest on the part of individual decision-makers means that a control system is required to motivate individuals to use their specific knowledge and decision rights properly.

structures are influenced by the knowledge types that predominate in their particular production process.

Different firm structures, we thus argue, are required to manage different types of relevant knowledge required by different types of production.

For example, we argue that if the knowledge type that predominates in the production process is K_p , the firm structure most likely to handle it efficiently will be one similar to the Taylorist mass production firm. If the knowledge type that predominates in the production process is K_i , a different firm structure with a more decentralized management will be most conducive to efficient knowledge allocation, and, consequently, to efficient production.¹⁴² This latter governance structure would be characterized by greater autonomy, greater assignment of decision rights and less monitoring.

We argue that production will be organized within a firm (as opposed to the market), as long as it can sell some kind of knowledge or expertise, or it can add some type of knowledge or expertise to a product or service which is already being sold in the market. This reasoning may become clearer with an example. Suppose I am a tailor and my business is to sew clothes for my clients. The type of knowledge I will add to the final product I will sell is essentially tacit in its nature, for I will use this tacit knowledge (K_i) of “how to do” in order to generate, let’s say, a coat. I will use the sewing knowledge I might have learnt from seeing my father’s sewing. However this knowledge I have will suffer a transformation for it will give rise to a product – the coat – in which this knowledge will be finally embedded - K_i gives rise to K_p - enabling me to sell the coat as a final product of my knowledge. Note however, that the materials I will use for confectioning the coat will be bought in the market, for I don’t have any tacit knowledge with which I could contribute to those products themselves. I don’t know how to produce a button or cotton, which are the materials that will be used in my production process. It follows that if I will not add any knowledge to these products, I would rather better buy them in the market, from third parties who do add some type of knowledge in the confection of cotton and button.

This stylized example says something about the boundaries of the firm. If I am a car producer and I can add some knowledge to the production process of building a car I will produce it inside the firm. However, if I am a consumer and I will just use the car as a product itself, I would rather just buy the car without trying to produce it (for I don’t have any knowledge to do it).

Holding all the other variables constant, then, we argue that the level of knowledge specialization will delimit firm structures.

Therefore, we advance the following hypotheses:

¹⁴² Harold Demsetz, *Comments on Michael C. Jensen & William H. Meckling, Specific and General Knowledge, and Organization Structure*, in *CONTRACT ECONOMICS* 275, 279-280 (Lars Werin & Hans Wijkander eds. 1992). Demsetz has advanced some of the relations between knowledge resources and firm governance structure: “Some firms, for example, earn revenues by performing repetitive and routine activities most of the time. Others are preoccupied with highly innovative activity. The difference in the tasks faced by these firms, I believe, dictates differences in their organization structures and compensation systems. Less hierarchy can be tolerated by firms engaged in innovative activity, and decision rights are probably dense in the middle of the hierarchy that exists. This is because the problems faced by such a firm, relative to one engaged in repetitive activities, cannot be solved as easily as routinizing procedures with rules and regulations. It should also be the case that a difference in compensation methods is required because decisions must be more decentralized for firms that engage in, for example, genetic research. Greater reliance on profit-based compensation is required to bring objective functions of dispersed holders of decisions rights into closer accord.”

Hypothesis 1: The more the production relies on Kp/Kpr, the more we will expect production being organized by means of market mechanism.

Hypothesis 2: The more the production relies on Ko and Ki, the more production will be suitable in a firm structure - in opposition to the market.

So, if we imagine a continuum of knowledge structures that in one extreme have a Kp form and in the other extreme have a Ki form, we would expect to find organization of production through markets in the first extreme and in firms in the second extreme.

But this is not the whole story. Suppose that there is some level of tacit knowledge that will be applied in the production process, so that we will have a firm. What can explain whether this firm will have a more centralized or decentralized decision-making structure? Because tacit knowledge is embodied in an individual, and because the more the knowledge is embodied in an individual, the less effective it will be the management of knowledge structures characterized by centralized governance structures based in the process of knowledge substitution through authority – as we have adduced from our principle of efficient knowledge allocation in the previous part - then it follows that:

Hypothesis 3: The more the production process relies in Ki, the more we expect the production in the firm by means of a governance structure which is decentralized.

Hypothesis 4: The more the level of Kp/Kpr, and the less reliance in Ki, the more the production inside the firm will be centralized.

So in the continuum that explains governance structure inside the firm, we can expect that, if in one extreme we have a firm that predominantly relies in Kp in its production process, this firm will have a centralized governance structure. In the other extreme, there is a firm where the knowledge used in the production process is exclusively Ki, then this firm will have a more decentralized governance structure.

In the table below we distinguish some basic types of industries according to the nature of the knowledge that they use. The knowledge type that is used (viz. Kp, Ko, Ki) varies depending on the different production technologies/techniques in a particular industry, and the organizational and legal structure reflect the deployment of different knowledge types.

THE STRUCTURE OF KNOWLEDGE AND THE STRUCTURE OF THE FIRM

Firm Structure	Example	Knowledge Structure
1. Taylorist Mass Production	General Motors	Kp + Ko + Ki -
2. High Tech Engineering	Microsoft	Ki + Ko - Kp -
3. Low level service industry	McDonalds	Kp + Ko + Ki -
4. High level Professional Services	Law firms	Ki + Ko Kp -
6. Risk Management/ Venture Capital Firms	Venture Capital Firms	Ki+ Ko + Kp -

Of course there is a mixture of Kp, Ko and Ki in all types of firms. What changes is the degree to which these variables enter into each firm type as suggested above.

In the following, we closely look at different firm structures, the different knowledge resources that predominate in each, and examine organizational consequences that their respective knowledge structures have for the firm's governance structure.

B. Revisiting the Choice of Form from the Knowledge Perspective

Choice of form in the law of business entities is usually traced to a variety of issues, such as the limited liability, taxation, cost of capital, the cost of disclosure regimes, etc. But the coordination of knowledge resources in the productive process has been viewed only as an afterthought when it comes to explaining corporate structure in the law.¹⁴³ Proponents of the knowledge-based theory of the firm, however, argue that the choice of form is heavily influenced

¹⁴³ See, e.g., ROBERT CHARLES CLARK, CORPORATE LAW (1986), *Appendix A: A Special Note on Hierarchies*.

by the knowledge resources used in the production process.¹⁴⁴ In this part we discuss the characteristics of different types of firm production, focusing on their use of knowledge resources. We here begin to adduce some evidence for how firm governance structures are shaped by the knowledge types that predominate in the production process.

1. The Sole Proprietorship and Small Partnerships

The typical American enterprise before the Civil War, was the sole proprietorship or small partnership. These forms of business organization had easily identifiable individuals who were fully responsible for the obligations of the business.¹⁴⁵

The system that was common in small factories prior to 1870 had certain particular features: large investments were seldom required; there were no formal employment contracts; work rarely required complicated or costly machinery; work was mainly done at home by workers who owned their tools; workers had a considerable degree of personal autonomy; timing and pace of work, within limits, were left to workers; there was no need to tie up capital in expensive equipment.¹⁴⁶

We attribute the fact that we observe personal autonomy and decentralization in the production process to the type of knowledge required in the production process. Workers were artisans who had command of their work. They had the tools and, most importantly, the knowledge necessary to perform the work. As the knowledge required to perform the handiwork was, relatively speaking, not very complex or technologically sophisticated, most of the manufacturing process depended on the expertise and work experience embedded in each worker (Ki). Because of this, the governance structure of the production process was significantly decentralized and workers were assigned autonomy to control their tasks. This governance structure was the most efficient considering that the artisans had sufficient knowledge to perform their tasks independently.

There also existed at the time systems of apprenticeship, where an artisan controlled and managed the production process and exercised decision making authority. This governance structure also can be explained in terms of the nature of the knowledge resources necessary for the production. Here, the older artisan who had more technical knowledge (Ki) retained the decision rights as the apprentices were in the process of learning the skills and abilities necessary to develop the product.

2. Mass Production Firms

The governance structures which were typical of small manufacturing partnerships started to change with the advent of new production technologies after 1870.¹⁴⁷ These

¹⁴⁴ *Se, supra note 11. See also* Diego Puga & Daniel Trefler, *Knowledge Creation and Control in Organizations*, (CEPR Discussion Paper No. 3516, Aug., 2002), available in Social Science Research Network at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=335982.

¹⁴⁵ Richard Adelstein, *Knowledge and Power in the Mechanical Firm: Planning for Profit in Austrial Perspective*, Working Paper, March 2003, p. 25,29-30

¹⁴⁶ Id at 31-32.

¹⁴⁷ Id. From 1870 to 1910, there was a growth in the number of engineers, and a new emphasis on formal science. There were efforts to rationalize the operations of the machine shop. The role played by engineers in the development of American manufacturing became extremely significant. At this time there was a rationalization of

technologies made it possible to develop new inventions and products. Small factories gradually became manufacturing companies, their focus changed to large-scale production and governance structures became more hierarchical.¹⁴⁸ The ownership of large amounts of immobilized capital in the form of special machinery located on the production floor (Kp) became a key asset in mass production system. We argue that this predominance of Kp in the productive process.

Once knowledge became embedded in machines and routines, workers increasingly became more replaceable. Taylor's system of scientific management perfected the use of machines and their operators and took this logic of mass production further than anyone had before him. Taylor's idea of scientific management was to embed all of the knowledge previously decentralized among employees into machines and production routines:

Taylor's alternative solution to the planner's problem in the shop was to break the worker's monopoly with the hammer of science and replace the decentralization of power based on craft knowledge with a hierarchically organized workplace in which expert managers told ignorant workers precisely what to do and how to do it. Every task in the shop would be reduced it to a series of minute "elementary operations" performed by a man on a machine, and with the aid of a stopwatch and a strong, agile worker, the time needed to complete each such operation would be computed...

Management could gain possession of all the knowledge needed to control the shop. It could then systematize and codify it, and return it to workers in the form of detailed instructions It was this underlying philosophy, not the specific method of time-and-motion studies, that Taylor hoped would be his lasting legacy, and he was not coy in explicating it. It was about control in the workplace, exercised by professional managers for the benefit of all firm's constituents. Taylor would seize ownership of the worker's most valuable asset and, with the power over the organization of work this gave managers, solve the planner's problem in the interests of workers and owners alike.¹⁴⁹

This "physical separation of thinkers and doers" required a separate class of managers. At the top, of the hierarchy were well-educated employees – the managerial class – who planned, executed and controlled production and operators with the help of scientific knowledge. These highly skilled employees were responsible for the organization of the firm dispersed among individuals with technical expertise. They were assigned most of the legal decision making rights. At this level of the hierarchy, we thus find significant levels of Ki. In contrast, the heavy use of machines (Kp) and organizational routines (Ko) permitted the deskilling of workers on the production floor, requiring very little in the way of production specific knowledge of these workers (Ki). This governance structure was successful in efficiently allocating knowledge and decision rights within the firm and thus was adopted in those industries where production permitted the heavy use of Kp and Ko.

the accounting processes, necessity of coordination and scheduling, operational scale, monitoring and coordination by managers, creation of formal procedures in a hierarchized structure. It is important to note that this is also the beginning of rationalization of Ko. There was a development of professional management tools, development of the knowledge embedded in the organization, knowledge of the organization process in the improvement of routines.

¹⁴⁸ Id.

¹⁴⁹ Id., at 41-42. See also at 46: "The general principles of 'working smarter' and the practical core of scientific management - the institutionalization of systematic analysis in the workplace, the division of mental as well as physical labor, the emphasis on planning and the separation of thinkers from doers, the substitution of theory for intuition and rules of thumb quickly took root in American industry and formed the conceptual basis for the nation's emerging system of mass production."

A more recent example of such a hierarchical and centralized firm structure is that of IBM in the 1980s and 1990s. While IBM initially defined the path of the computer industry, its business strategy for the personal computer was to develop expertise on mass production.¹⁵⁰ Instead of developing all the required components, IBM decided to purchase most components from outside suppliers in order to rapidly benefit from new inventions and products available on the market.¹⁵¹ Thus IBM heavily relied on knowledge/technology embedded in products (Kp) that it purchased from suppliers, while still adding their own know-how in organizing the assembly, marketing and servicing of the personal computers it produced (Ko) and (Ki). IBM created a service force to provide national support for its clients and developed a worldwide marketing strategy, spreading its franchised dealers worldwide.¹⁵² Thus focusing on mass production where profits largely come from increasing returns to scale and scope,¹⁵³ IBM also developed a highly centralized organizational structure similar in certain respects to other mass production industries to manage its large structure. Important decisions were typically initiated by Central Management Committee.¹⁵⁴ As Compaq and Apple began to build their global enterprises, IBM's Entry Level System Division was becoming integrated back into the long-established, relatively centralized operating structure of one of the world's largest industrial enterprises."¹⁵⁵ IBM's focus on mass production and reliance on Kp, acquired from its suppliers in the form of technology embedded in products, thus made a more centralized, hierarchical structure the most efficient allocation of knowledge and decision rights.

IBM's open system based on market outsourcing created a demand for other companies to enter this market, in order to supply the components that IBM required. These companies had to master a demand for increasing innovation. Because these suppliers of innovation and technology relied heavily on the scientific knowledge and skill of their employees, they had to resort to a very different governance structure in order to manage their knowledge resources and remain competitive.

3. *High-Tech Engineering*

The governance structure of firms that are engaged in constant innovation is different from the governance structure of mass production firms. These firms are concerned with solving non-decomposable problems, which require heuristic search based on high levels of interaction and knowledge exchange.¹⁵⁶ The knowledge necessary for achieving these tasks is mostly embedded in employees' (Ki).

When Ki is the predominant knowledge resource, we suggested that firms should develop more decentralized business structures so as to try to maximize their gains from an efficient knowledge allocation. Successful problem-solving thus requires decentralization of the decision

¹⁵⁰ Chandler, *Inventing the Electronic Center*, at 132.

¹⁵¹ Chandler, *id.*, at 136.

¹⁵² *Id.*

¹⁵³ *Id.*, at 139.

¹⁵⁴ *Id.*, at 136: "IBM's Central Management Committee approved Lowe's report, upgraded the task force to a full-scale project development group, appointed Philip "Don" Estridge its chief, and gave him precisely *one year* to have the product on the market. (...)" See also at 137: "In 1983 IBM's Central Management Committee created an entirely new Entry Level System Division to manage his explosive growth."

¹⁵⁵ *Id.*, at 146.

¹⁵⁶ Nickerson & Zenger, *supra note*

making process. Employees will enjoy more autonomy in performing their tasks. Moreover, because such employees are very highly skilled, and the nature of the problem they are solving is very complex, traditional monitoring devices tend to fail in this context, because of knowledge asymmetry between the monitor and the monitored.

Scholars have already studied the changes required in organizational structures in order to stimulate knowledge creation and knowledge retention.¹⁵⁷ The success of new biotechnology firms, for example, depends on their ability to create rights over scientific knowledge. These firms need continuous innovation to find valuable and patentable products. The asset necessary for product development is an intellectual resource characterized by “severe immobility,” because there are few star researchers who have made commercially valuable discoveries, and many of them work at universities.¹⁵⁸

Scholars argue that in these cases, where scientific knowledge is critical, different organizational arrangements are necessary. By permitting scientist-employees to maintain exchanges with universities, new biotechnology firms have turned out to be flexible organizations where the knowledge used is mainly managed in a decentralized way by its key knowledge assets (employees).

Knowledge production in the university structure to which such firms are thereby linked, is itself characterized by a unique governance structure. This has influenced the structure of biotechnology firms. In order to “attract and retain such scientists . . . each [New Biotechnology Firm, or] NBF needed to maintain a ‘university-like’ organizational context as it developed. That is, the NBF’s organizational policies had to support both the formation and maintenance of boundary-spanning social network relationships as well as numerous other complementary activities such as rapid publication of research results and freedom of scientific inquiry.”¹⁵⁹ (internal quotations omitted)

Not just the New Biotech Firms, but Silicon Valley firms more generally avoided hierarchies, creating organizations with considerable dispersed decision-making and flat authority structures.¹⁶⁰ These more flexible “learning organizations” replace traditional forms of hierarchical decision making by decentralized decision making. Decision making and coordinating activity by managers is reallocated in favor of self-coordination among experts.

IV. LAW AND KNOWLEDGE MANAGEMENT

We now turn our attention to the relationship between law and the knowledge structure of corporations. In the following we examine legal rules and contractual arrangements that directly or indirectly regulate knowledge and thereby affect firm structure. We consider how law and contract can both sustain and undermine the efficient allocation of knowledge resources.

¹⁵⁷See e.g., Tomas Hellström, Ulf Malmquist, John Mikaelsson, *Decentralizing Knowledge: Managing Knowledge Work in a Software Engineering Firm*, 12 *Journal of High Technology Management Research* 25 (2001) (Arguing that top-down management decisions may be misleading in software engineering firms).

¹⁵⁸ Julia Porter Liebeskind, Amalya Lumerman Oliver, Lynne Zucker, Marilynn Brewer, *Social Networks, Learning and Flexibility: Sourcing Scientific Knowledge in New Biotechnology Firms*, *Organization Science* 428, vol 7, issue 4 (Jul. Ago 1996)

¹⁵⁹ *Id.*, at 439.

¹⁶⁰ Saxenian, *supra note*, at 143.

One obvious way in which law affects corporate organization is by binding knowledge to the firm, thereby enabling the dispersion and transfer of knowledge within the firm, while preventing, or at least containing, the threat of transferring knowledge assets outside the firm to competitors.

Binding knowledge is crucial, for otherwise firms would not invest in innovation. The capacity to bind knowledge to the firm is key to competitiveness, especially in a knowledge intensive environment.¹⁶¹ As inventions are made firms receive exclusive legal rights to them so that they can recover the investment made and benefit from their invention. This will prevent other firms for making use of the new technology without having invested in its development and will create incentives for pursuing new creations.¹⁶² As employees engage in increasing research and product development they also necessarily become privy to important privileged and confidential knowledge applied in product creation, marketing and commercialization previously restricted to high-level management. In an increasingly knowledge intensive environment, where firms not only rely on knowledgeable employees, but provide significant training, the loss of employees to competitors thus represents a significant threat to a firm's competitive edge.¹⁶³

The easiest way to bind knowledge to the firm is structurally, by restricting access to valuable knowledge to all but a handful of insiders who run the firm. This is one of the benefits of family owned businesses.¹⁶⁴ In its early years (just after 1800), the Du Pont company, for example, guarded most of the economically valuable knowledge about the chemistry and manufacture of gun power by restricting it to Du Pont family members and their close associates.¹⁶⁵ "The Du Ponts managed the company and supervised its research throughout the nineteenth century. Thus, the company's approach to employee intellectual property depended on close family control supported by informal sanctions and self-help."¹⁶⁶

Geographically isolating the firm provides another structural means to restricting the unwanted dissemination of knowledge. Thus, Du Pont's Brandywine mills, for example, were located in a remote and self-contained enclave along the banks of the river, which along with power and water, supplied security from unwanted visitors.¹⁶⁷

Companies still jealously guard their business methods and other secrets by restricting access to information through a variety of structural means. But the drawbacks of the above-described structural approaches are evident. Restricting access to business knowledge to but a

¹⁶¹ See, e.g., William Lynch Schaller, *Jumping Ship: Legal Issues Relating to Employee Mobility in High Technology Industries*, 17 LAB L. 25 (2001).

¹⁶² Quote literature on patenting and incentives to ...

¹⁶³ See, e.g., Katerine V.W. Stone, *Knowledge at Work: Disputes Over Ownership of Human Capital in the Changing Workplace*, 34 CONN. L. REV. 271 (2002) (arguing that disputes over human capital have increased and that courts should attend to the new "implicit contract" between knowledge workers and their employers when they enforce intellectual property rights). Stephen L. Sheinfeld & Jennifer M. Chow, *Employees' Duties and Liabilities: Protecting Employer Confidences*, 582 PLI/Lit 347 (1998) (detailing the "rapidly evolving" law of intellectual property and the "veritable explosion in non-competition and trade secrets disputes in the employment area"); William Lynch Schaller, *Jumping Ship: Legal Issues Relating to Employee Mobility in High Technology Industries*, 17 LAB. LAW. 25 (2001) (examining the legal implications of accelerated job hopping by employees in the high tech sector).

¹⁶⁴ Catherine L. Fisk, *Working Knowledge: Trading Secrets, Restrictive Covenants in Employment, and the Rise of Corporate Intellectual Property, 1800-1920*, 52 HASTINGS L. J. 441, 442-443 (2001), at 469.

¹⁶⁵ Id, at 468-69.

¹⁶⁶ Fisk, *supra* note 164, at 489.

¹⁶⁷ Id, at 470.

few members in the firm seriously restricts the potential improvements and innovations and therefore the competitiveness and growth potential of the organization. Relevant knowledge is centralized at the highest levels of the organizational hierarchy, leaving little room for decentralized decision-making. Thus, learning and joint knowledge production among employees at lower levels of the organizational hierarchy is diminished and the benefits of knowledge substitution are decreased. Similarly, isolating the company geographically is often undesirable. Economists have long recognized the importance of regional clusters for economic and technological development.¹⁶⁸ Regional agglomeration of firms can result in significant positive externalities, including knowledge spillover, causing input costs to decline. Thus securing a firm's knowledge from competitors by isolating its employees is likely to be a poor strategic decision.

As already discussed, once firm organization becomes more complex, dispersion of knowledge within the organizational hierarchy is unavoidable and highly productive. And once production becomes more knowledge intensive, the simple division of tasks and power in a hierarchical structure and the management of people through financial or other abstract criteria alone, becomes ineffectual.¹⁶⁹ Legal and contractual solutions thus exist to address the natural constraints of the efficient allocation of knowledge resources in extended hierarchies, including their public goods characteristics. These various solutions, in turn, have an impact on the decisional, as well as the financial structure, of firms.

A. Law and Contracts as Mechanisms to Manage Knowledge

One way in which law and contract affect corporate organization is by binding knowledge to the firm. The law provides a variety of legal doctrines that contain knowledge inside the firm structure. These doctrines include misappropriation of trade secrets, breach of duty of loyalty, industrial espionage, and where restrictive covenants have been signed, breach of nondisclosure agreements and covenants not to compete. The various legal doctrines frequently work together and complement one another in offering different types of protection. At the same time, new norms, implicit agreements, and positive legal controls have emerged in order to address the challenges (and opportunities) that increasingly knowledge intensive environments represent for firms.

In the following we reinterpret the existing legal framework and show that its development has affected the knowledge structure and thereby the governance structure of firms. Several bodies of law, which are generally not considered in the corporate governance debates,

¹⁶⁸ See Michael J. Enright, *Regional Clusters and Firm Strategy* in Peter Hagström & Alfred D. Chandler, Jr., *Perspectives on Firm Dynamics*, in *THE DYNAMIC FIRM 2* (Hagstrom & Chandler, Eds. 1998), 315, 331 (“Spillover of innovation from firm to firm is likely to be greater in regional clusters than among dispersed firms Local suppliers, buyers, family members, friends and acquaintances can all become sources of industry and company-specific information.”). Ronald Gilson, *The Legal Infrastructure of High Technology Industrial Districts*, 74 N.Y.U. L. REV. 575 (1999), at 580-81 (arguing that “[k]nowledge as an input is subject to increasing returns as a result of geographic proximity” in certain types of Marshallian agglomeration economies).

¹⁶⁹ See, e.g., Peter Hagstrom and Gunnar Hedlund, *A Three-Dimensional Model of Changing Internal Structure in the Firm* in HAGSTROM & CHANDLER, *id.*, at 169, 179. Indeed, as Chandler has pointed out, the rise of a salaried managerial staff that shares decision-making authority and thus necessarily shares in the requisite knowledge is the hallmark of the modern corporation.

have important consequences for corporate structure. The influence of intellectual property laws and covenants not compete on firm structure has, as we shall see, been implicitly taken for granted by current corporate governance literature.

As we shall see, intellectual property law helps firms address the problems of unwanted knowledge transfers that arise with the increased diffusion of knowledge within a less hierarchical firm structure. The connection between the new employment relationship and the expansion of intellectual property law has become the object of increased attention.¹⁷⁰ But the effect of such regulation on firm governance and firm boundaries, while it has begun to be recognized,¹⁷¹ has not been made the object of analysis.

1. Intellectual Property Evolution

Intellectual property laws do not at first appear to be connected with firm structure. Patent and copyright protections were already written into the U.S. Constitution at a time when modern firms and corporations did not yet exist.¹⁷² Individuals can hold patents and copyrights just as firms can. Patent and copyright laws address the public goods problems of knowledge resources faced by all who would market such resources. These protections permit the conversion of ideas or techniques or other intangible intellectual products into marketable goods. This benefits firm production as well as market production of such goods.¹⁷³

Patent and copyright rules, however, become more relevant to firm structure when the law or contract specifies who holds ownership rights to economically valuable knowledge gained at work – the firm or the employee. It is increasingly recognized that the tremendous economic development experienced during the late 19th and early 20th Centuries was very much fueled by technological development,¹⁷⁴ and that the rise of modern corporations played a crucial role in technological development.¹⁷⁵ *Intellectual property*, conceived in the broadest sense, accomplishes one of the most important tasks required to permit the effective use of knowledge.

¹⁷⁰ See, e.g., Katherine V.W. Stone, *Knowledge at Work: Disputes of the Ownership of Human Capital in the Changing Workplace*, 34 CONN. L. REV. 721 (2002) (Arguing that disputes over human capital have increased and that courts should attend to the new “implicit contract” between knowledge workers and their employers when they enforce intellectual property rights). Stephen L. Sheinfeld & Jennifer M. Chow, *Employees’ duties and Liabilities: Protecting Employer Confidences*, 582 PLI/Lit 347 (1998) (detailing the “rapidly evolving” law of intellectual property and the “veritable explosion in non-competition and trade secrets disputes in the employment area”); William Lynch Schaller, *Jumping Ship: Legal Issues Relating to Employee Mobility in High Technology Industries*, 17 LAB. LAW. 25 (2001) (examining the legal implications of accelerated job hopping by employees in the high tech sector).

¹⁷¹ Gilson

¹⁷² Such protections were seen as the hallmark of individualism. See, e.g., Lincoln’s pronouncement that “In anciently inhabited countries, the dust of ages--a real downright old-fogyism--seems to settle upon, and smother the intellects and energies of man.” But America had broken the “shackles” of the “slavery of mind” and had established “a habit of freedom of thought” that was necessary to the “discovery and production of new and useful things.” The patent law nourished this habit of free thought by allowing the ingenious to profit; it added “the fuel of interest to the fire of genius.” Abraham Lincoln, *Second Lecture on Discoveries and Inventions* (Feb 11, 1859), in Roy P. Basler, ed, 3 *The Collected Works of Abraham Lincoln* 356, 363 (Rutgers 1953).

¹⁷³ Indeed, such protections may be much more important to promote market production. (Hayek).

¹⁷⁴ See generally, RICHARD NELSON, *THE SOURCES OF ECONOMIC GROWTH* (1996) 100-119, *supra* note 128; HAGSTROM & CHANDLER, *supra* note 168.

¹⁷⁵ See, e.g., Alfred Chandler, Jr. & Takashi Hikino, *The Large Industrial Enterprise and the Dynamic of Modern Economic Growth in* (CHANDLER ET AL., EDS.) *BIG BUSINESS AND THE WEALTH OF NATIONS* (1997) 26.

It binds knowledge to its proper owner. Now consider the typology developed in Section II above. The different types of knowledge, Kp, Ko, Ki, raise different kinds of challenges for rules that would bind knowledge to its proper owner (presumably owners are those who have invested in knowledge production or its purchase).¹⁷⁶ Legal personality gave corporations the ability to own intellectual property. And legal doctrine increasingly evolved to favor corporate ownership of property over ownership by the employee.

In the area of patent and copyright ownership “the early nineteenth century rule that employees usually owned the entire right to their inventions [gave way to] . . . the later nineteenth century rule that employees owned their inventions but employers often had a license to use them (an arrangement known as a “shop right”).”¹⁷⁷ Only in the mid-1880s did courts thus begin to award employers a license to use employee inventions because the employee had devised the invention on the job.¹⁷⁸ Finally, in the twentieth century, the rule became that employers own most employee inventions.¹⁷⁹

Given our thesis that knowledge regulation influences firm structure and vice-versa, it should not be surprising to learn that legal regimes governing patents and copyright changed significantly during the period of the development of new organizational forms of production in the 19th and 20th Centuries. Significant changes occurred just around the time that modern limited liability corporations were created by new laws, that is in the 1880s and 1890s.

Modern trade secrets doctrine and the enforcement of covenants-not-to-compete in the employment context only developed in the late 19th Century.¹⁸⁰ In the antebellum period patents and copyright protections were the only intellectual property protections available.¹⁸¹ Property in ideas was thought of only to the extent that it manifested itself in a physical thing, e.g., as embedded in a machine or secret recipe or process. Moreover, copyright and patent protections required that technologies were made explicit before they could secure protection. The concept that property could be had in the intangible ideas and even in the tacit, not-explicit knowledge embedded in another’s mind was not accepted by American courts in the antebellum period. Enticement laws existed, imposing penalties for soliciting another firm’s employees. Such laws,

¹⁷⁶ See Fisk, *supra* note __ (“A foundation of the modern law of intellectual property is that firms own some of the ideas that exist in the minds of their employees. Ownership of employee knowledge is a legal construct that is now an accepted part of our culture and economy.(...) Today’s practices and doctrines developed in the context of radical changes in the American law and workplace culture, which were brought about by the nineteenth-century industrial revolutions. The conflict between employee freedom and corporate control of intellectual property sharpened as courts realized the importance of knowledge to economic development and began to recognize workplace knowledge as an asset of the firm rather than an attribute of the employee. (...)The invention of the trade secret doctrine in the mid-nineteenth century enabled employers to enjoin revelation of secret information by current or former employees. At the same time, courts expanded the permissible uses of post-employment covenants not to compete so as to prevent dissemination of knowledge. Together, these doctrinal developments created a new obligation--sometimes articulated as an express or implied contract, and sometimes expressed as a “duty of trust and confidence”--not to use knowledge acquired on the job elsewhere.” At __)

¹⁷⁷ Catherine L. Fisk, *Removing The 'Fuel Of Interest' From The 'Fire Of Genius': Law And The Employee-Inventor, 1830-1930*, 65 U. CHI. L. REV. 1127, 1128 (1998).

¹⁷⁸ *Id.*, 1151.

¹⁷⁹ *Id.*, 1128. The Supreme Court’s decision in *Standard Parts Co. v. Peck*, 264 U.S. 52 (1924), ended a period in which courts would apply a set of presumptions in favor of employee ownership of inventions in a dispute, in accordance with the “shop right” doctrine. Instead courts would now look to the intended terms of the employment contract. At the same time, employers increasingly used pre-invention assigning agreements. *Id.*, at 1179.

¹⁸⁰ See generally Fisk, *supra* note 164.

¹⁸¹ See generally Fisk, *supra* note 164.

however, applied regardless of whether employees had any valuable knowledge and did not prevent free employees from leaving after their contract term had expired and taking knowledge acquired at work to a competitor.¹⁸² There was also a long history of restrictive covenants. But prior to the Civil War, these were enforced only insofar as they concerned the protection of good will associated with the sale of a business, not as post-employment restrictions. Trade secrets doctrine and the use of contracts to control knowledge first emerged during the last two decades of the 19th Century, together with the rise of the modern corporation.¹⁸³

These developments in intellectual property law reflected radical changes in the structure of workplace organization and workplace culture. They mark the dramatic shift from artisanal modes of production to industrial and mass production in large firms.

In the artisanal model, it was possible for individuals or families to own their own workshops. Craft knowledge was recognized as a prime resource and was transmitted from master to apprentice. While the apprentice was not prohibited by law from exercising his craft and using the knowledge so obtained at a later date, the apprenticeship indenture governed the use and guarded the secrets of the craft knowledge during the apprenticeship relation. The duty of the apprentice to guard the master's secrets during the training period was a standard term of apprenticeship agreements, corresponding to the duty of the master to instruct the apprentice. The duration of the apprenticeship period can be seen to have performed a similar function to that of a restrictive covenant, in that it permitted the master to recuperate the training invested in the apprentice before the latter could leave and begin his own workshop.¹⁸⁴ It thus secured the explicit knowledge conferred in virtue of a confidentiality agreement, while it secured the tacit knowledge for a time only by agreement to a limited – typically seven year -- duration of the relationship.

The governance structure of the apprenticeship agreement was designed to preserve the knowledge within the firm structure. The nature of the firm knowledge structure, based on the knowledge of the master (Ki) shaped the governance structure so as to prevent that apprentices walk away with the knowledge before the end of the apprenticeship relationship. Thus the master was permitted to recover on his investment in training, but so was the apprentice. The knowledge was also the criterion that determined the hierarchy between masters and apprentices in the firm. The apprenticeship agreement, however, did not confer the same type of static property status on craft knowledge as did the later trade secrets doctrine,¹⁸⁵ which permitted, at

¹⁸² See generally Fisk, *supra* note 164, at 450 (citing Boston Glass Manufactory v. Binney, 21 Mass. (4 Pick.) 425, 428 (1827)). See also John Nockleby, Note, *Tortious Interference with Contractual Relations in the Nineteenth Century: The Transformation of Property, Contract, and Tort*, 93 HARV. L. REV. 1510, 1514-15 (1980).

¹⁸³ See, e.g., MORTON HORWITZ, *TRANSFORMATION OF AMERICAN LAW, 1870-1960* (1992) 90 (“The first sustained effort to reconceptualize the corporation in light of the triumph of general incorporation laws began during the 1880s.”).

¹⁸⁴ See generally Fisk, *supra* note , at 451.

¹⁸⁵ According to the UTSA, which has been adopted by many states, including California, a trade secret is: “Information, including a formula, pattern, compilation, program device, method, technique, or process, that: 1) Derives independent economic value, actual or potential, from not being generally known to the public or to other persons who can obtain economic value from its disclosure or use; and 2) Is the subject of efforts that are reasonable under the circumstances to maintain its secrecy. Cal. Civ. Code § 3426.1(d). A court may enjoin “actual or threatened misappropriation” of a trade secret. Cal. Civ. Code § 3426(a). A corporation misappropriates a trade secret when (1) it discloses or uses the trade secret of another without express or implied consent, and (2) at the time of the disclosure or use, it knew or had reason to know that its knowledge of the trade secret was derived from a person who owed a duty to the entity seeking relief to maintain the trade secret’s secrecy or limit its sue. Cal. Civ. Code § 3426.1(b)(2)(B)(iii).

least in principle, the indefinite exclusion of the employee or any competitor. Interestingly, the apprenticeship relation did, however, also allow the expansion of the “firm” to include a broader circle of initiates.¹⁸⁶

Industrialization changed the production process through new technology and dramatically different organization. Work performed in the work shop in several steps coordinated by the master was scaled up and mechanized. Craft knowledge previously embedded in master and apprentice now became embedded in machines and work routines.¹⁸⁷

Therefore, legal mechanisms were required that could make possible the propertization of knowledge embedded in physical assets (Kp). Such propertization was achieved through the development of intellectual property law. Entrepreneurs were thus able to rely on the protection afforded by patents in order to bind technology and expertise to the firm.¹⁸⁸ Such propertization, however, also afforded toolmakers to sell their technology on the market thus encouraging investment in such products and their ready supply. The new law thus supported a new form of governance structure in mass production firms.

Work on the factory floor required less skill and knowledge, substituting machine specific work routines for craft knowledge.

However, certain types of knowledge could not be simply stored in a product. Mechanics and engineers with significant expertise were required to build and maintain machines used in production. Chemists and other experts in the sciences were needed to develop and oversee new production processes. And the coordination of production required increased managerial and technical knowledge and experience.

¹⁸⁶ “The secrecy of recipes and techniques that passed from generation to generation enabled a family or a firm to gain a reputation and to retain exclusive control of production. Apprenticeship indentures recognized the value of guarding secrecy while ensuring the passage of knowledge by specifying that the master was to instruct the apprentice and to reveal his “mystery” to him, and, in return, the apprentice pledged to keep these techniques secret during the term of the apprenticeship.” Fisk, *supra* note 164, __ (citations omitted)

¹⁸⁷ The industrialization changed the production process, permitting that the “master knowledge” (Ki) become embedded in machines (Kp). After industrialization, the work that was coordinated by the master became largely standardized, due to the application of scientific methods to the production process. With the division of work, non-skilled employees became able to operate machines that produced various units of the product which was previously hand made. An unprecedented change in knowledge organization in the firm took place. The type of knowledge necessary to be bound changed.

“As the concentration of production associated with industrialization eliminated the possibility of owning a workshop in most trades, the master-apprentice relationship eroded and soon was no longer the dominant form of work organization. One of the most significant consequences of the decline of the artisan relationship by which the master was obligated to train the apprentices was a change in the way that knowledge was transmitted among generations and within trades. The mutual obligations to instruct and to guard the secrets of the craft were eventually supplanted by a new set of rules.”

Fisk (quotations omitted).

¹⁸⁸ See, *id* at 447. “The expansion of scientific and technological research at universities and the first corporate efforts to systematize the development of new technology through research and development also made their mark on the law. These profound changes in the organization of knowledge both contributed to the new legal rules and were made possible because judges and lawyers were prepared to regard knowledge as a business asset to be bought, managed, and sold.”(quotation omitted).

Trade secrets law originally recognized only the existence of property rights in physical things, but not in intangible information. Until the mid-nineteenth century, there was no standard legal protection that would allocate to firms the value of an employee's knowledge.¹⁸⁹ Courts were initially hostile to the enforcement of restrictive covenants, as a reflex of the tradition of the guild system.¹⁹⁰ Judges were reluctant to understand intangible knowledge to be a firm's asset. But seminal cases in the development of intellectual property law began during the mid- to late 19th Century to recognize complaints by factory owners seeking to restrain machinists, designers, engineers and chemists from taking their knowledge to competitors or using it to set up their own factories in competition with their former employer.

For example, the first case in which a court articulated the duty of an employee to protect the trade secrets of his employer, involved a machinist. In *Norfolk v. Peabody* (Mass. 1968), plaintiff shop owner sued defendant machinist whom he allegedly had employed to assist in inventing and developing certain machinery. The machinist, Norfolk, had agreed in writing not to reveal information about the machinery used in Peabody's factory, which produced gunnery cloth from jute. Norfolk, however, had quit his employment and had joined others in building a factory. Peabody sought and obtained an injunction against Norfolk, restraining him from revealing "any knowledge of said machinery or of the models and plans of the same, from building any such machinery for any other person or persons, from communicating said secret process of manufacturing Jute cloth from Jute butts as aforesaid, and from using said process in company with any other persons or persons or by himself."¹⁹¹ Norfolk had misappropriated certain drawings, which he was also ordered to return. Norfolk's new employer sought to dismiss the complaint, arguing that the confidentiality agreement was void as a restraint of trade in that it prevented Norfolk from ever using his skill and knowledge acquired at work during his life at any time or place. He further argued that the design and operation of the machinery was not secret because it could be observed by anyone who visited the factory. The court here saw the injunction as solidly within the tradition of patent law, given that theft of particular drawings was involved.¹⁹²

The development of trade secrets protections and the enforcement of restrictive covenants beginning in the 1890s accompanied and reflected the new shape of industrial organization in the modern corporation. The new legal protections and doctrines of contract were directed at engineers and other experts with access to explicit and with tacit knowledge critical to a corporation's competitiveness. Drafts of machine designs and other knowledge embedded in machines received protection in addition to patents and copyright protection. The move to implying duties of trust, confidentiality and to guard trade secrets into employment contracts "fit

¹⁸⁹See generally Fisk, *supra* note 164, at 466 (arguing that: "The court's belief that patent was the only legal protection for technology reflects a widely held view during much of the nineteenth century". Fisk discusses the case of Du Pont which as early as 1904 started to require employees to assign patents to the firm. The Du Ponts were one of the pioneers to realize that knowledge was a valuable asset and to engage in activities that would protect it. Du Pont's attention to the value of maintaining the secrecy of its production methods is not typical of all nineteenth-century firms. Fisk argues that "The difference may be attributable to the fact that Du Pont's chemistry-based industry, as compared to an industry where employee skills are mechanical, used knowledge which was most easily characterized as secret information rather than as general skill or technique. The difference may also be attributed to the Du Ponts' view that they were more likely to be innovators than imitators, and thus they were generally likely to be more at risk from others learning their methods than from being unable to learn methods of others.")

¹⁹⁰ *Id.*, p. 455

¹⁹¹ Fisk, *supra* note 164, at 486 (citing *Peabody v. Norfolk*, 98 Mass. 452 (1868) (internal citations omitted)).

¹⁹² Fisk, *supra* note 164, at 484-85.

closely with the courts' new understanding that firms, not individuals, had now become pioneers of new technology and that firms hired employees precisely for their knowledge . . ."¹⁹³

A new type of "contract" thus became part of the nexus of contracts shaping firms, but especially the modern corporation. Factory workers in mass production, however, were largely de-skilled, thus rendering them exchangeable. Shop floor workers acquired limited machine and process specific skills, which were not of much value to a competitor.

Gradually, courts started to recognize a firm's property rights to general knowledge of its business activities.¹⁹⁴ From 1890 to 1930, there were profound doctrinal changes expanding trade secrets and accepting restrictive covenants doctrines as a means to control the use of a broad range of workplace knowledge. The duty to protect trade secrets came to be considered an implied term in employment agreements, where previously it depended in an express agreement. The type of knowledge to be protected by this doctrine expanded from physical things to know-how embedded in the structure of the firm that had originated in improvements made by employees. Employers were assigned ownership not only of drawings or objects, but also of ideas and mental concepts expressed in them.¹⁹⁵ Thus trade secrets came to be applied to bind knowledge of organizational processes (Ko) to the firm. To the extent that restrictive covenants prevented employees from using their own tacit knowledge in potentially competing activities after leaving their firms, restrictive covenants now succeeded in binding knowledge embedded in individuals (Ki) to the firm's structure as well.

As this brief history suggests, intellectual property protections were not neutral with regard to firm structure, but accompanied changes in firm structure. Modern intellectual property protections, such as patents, copyright, trade secrets protections bind knowledge to the firm. Patents and copyright protections mainly secure knowledge or technology embedded in physical things or products (Kp). Trade secrets protections also secure knowledge embedded in the organization (Ko), such as business methods, that are not amenable to patenting or copyright protection, and knowledge embedded in the individual (Ki) but acquired during the course of work . Finally, intellectual property protections based on contract, such as covenants not to compete and confidentiality agreements are solely focused on securing knowledge embedded in the individual (Ki). It is, further, worth noting that patents and copyright protections are only effective in order to secure explicit or codified knowledge, but not tacit knowledge. In contrast, restrictive covenants, especially covenants not to compete, are aimed at securing tacit knowledge. Trade secrets protections lie somewhere in between.

The expansion of technological research and the increased use of different forms of knowledge (Kp, Ko, Ki) in the production process made their mark on the law. Legal developments have shaped the internal organization and governance of firms by assuring that

¹⁹³ Fisk, *supra* note 164, at 500. *See, e.g.*, *Eastman Kodak, Co. v Reichenbach*, 20 N.Y.S. 110, 116 (Sup Ct. 1892) (finding that it was Kodak's "exercise of much skill and ingenuity [that built the business,] the capital of which consists largely in certain innovations and discoveries made by its officers, servants and agents").

¹⁹⁴ "The judges' growing understanding of the alienability and the value of employee skill led courts to recognize ever more legitimate uses for restrictive covenants. Courts eventually agreed that covenants could be used to protect "trade secrets," a concept that became more capacious over time. Some courts further recognized that covenants could be used to protect an undefined category of "proprietary information" in addition to trade secrets. Similarly, courts changed their assessments of which relationships with customers were business goodwill, and hence company property, and which were simply an aspect of an employee's personality or experience. Moreover, in applying the Mitchell rule that a covenant must be reasonably limited, the scope of a permissible covenant expanded to keep pace with the expanding category of knowledge that could be deemed as corporate asset." Fisk, *supra* note 164, at 458.

¹⁹⁵ Fisk, *supra* note 164, at 493-494, 504.

they could bind employee knowledge developed during the course of work.¹⁹⁶ The development of trade secrets, post-employment covenants not to compete, and non-disclosure agreements contributed to preventing the dissemination of knowledge outside the firm. All these legal developments have not only affected competition, as is frequently claimed by scholars, but also internal firm structure. If the law had not permitted such extensive appropriation of knowledge by the firms, we would expect to find different mechanisms to encourage employees to stay longer in the firm, and to bind themselves voluntarily to the firm in order to prevent knowledge losses or a different type of firm structure.

We suggest that not just ownership rights to intellectual property were implicated by this shift in the law, but ownership of the corporation itself was implicated. Without the ability to tie valuable knowledge resources to the corporation, the purchase of shares would have been considerably less attractive to investors. Conversely, without the ability to pool financial resources to acquire machines, technologies and physical assets, which provided a fertile environment for further knowledge creation within the firm, technological advances could not have been accomplished as rapidly, or perhaps at all.¹⁹⁷

One effect of creating a legal presumption in favor of corporate ownership of employee knowledge, however, and of enjoining employees from taking that knowledge with them to create their own new firms, was to reduce the stake that knowledge workers could demand in the corporate enterprise, thus favoring the separation of (stake) ownership and control. Where the partnership model explicitly contemplated that a firm eventually would have to make an employee into a partner, if it wanted to retain his skill and expertise, the corporate model did not contemplate conferring such an ownership stake as an employee rose through the ranks. For this reason, we suggest, firm structures would not have developed in quite the same way had it not been for the development of the above described legal doctrines of intellectual property that have helped bind knowledge to the firm. The fact that such a relationship between intellectual property regimes and the separation of ownership and control obtains can be supported with the help of the following example: the relationship between stock option grants in Silicon Valley and California's prohibition against restrictive covenants. We develop this thesis in item B.

¹⁹⁶ Fisk, "In devising new rules to govern ownership of ideas and skill, judges, treatise-writers, and lawyers perceived the issue as one of economic policy and used the law to achieve certain economic goals. In enforcing contracts--at first, only if they were express, and later by recognizing such contracts as implied--to maintain secrecy of the employer's methods, courts created a new species of "intellectual" property at the expense of older notions of artisanal independence." At 445

As courts became aware of the value of employee knowledge to firms, they sought an expanded role for the law in facilitating economic development by allocating rights in that knowledge. Contract was rapidly becoming the dominant legal construct for analyzing the rights and obligations of all employment relations. At the same time, when the popularity of Frederick Winslow Taylor's scientific management made it seem imperative that firms rationalize and control every detail of employment and production, contract provided the most powerful legitimating discourse for the significant loss of workplace autonomy that Taylorism entailed. at 503.

¹⁹⁷ Alfred Chandler, Jr. & Takashi Hikino, *The Large Industrial Enterprise and the Dynamic of Modern Economic Growth in* (CHANDLER ET AL., EDS.) *BIG BUSINESS AND THE WEALTH OF NATIONS* (1997) 26 ("An understanding of how the large industrial firm came to play the aforementioned roles requires an awareness of the complementary relationship between investment in plant and equipment (physical or tangible capital) and the human skills and knowledge developed in their operation (intangible capital). Extensive investments in large-scale plant and equipment created a fertile ground for managers and other personnel to educate themselves about both the technical skills and the organizational process of new technology."). This was also recognized by courts in the late 19th Century.

Below we provide a quick summary of the intellectual property protections and the types of knowledge that they bind according to our typology.

a) Patents and Copyrights bind Kp

Recall our distinction between codified (standardized) and tacit knowledge. Codified knowledge is knowledge that has been expressed in mathematical formulas, graphics, drawings, books, writing notes, or even by voice. When the knowledge is codified, it becomes easier to transfer it: a person who has never studied or heard of that knowledge is able to understand its basics by having access to the formal information regarding the knowledge. But, when knowledge becomes codified, it also becomes a public good. This means that people may engage in free-riding, extracting benefits from the knowledge without paying its value. Suppose that I want to sell some knowledge to you, and for our deal to take place you expect me to explain what you are going to buy. Meanwhile I try to qualify the knowledge, it will, at least partially, immediately become in the public domain. So perhaps you don't need to buy the knowledge anymore to have what you desired. This makes it hard to sell knowledge without losing some part of its value. One imperfect way to solve this problem is through intellectual property protection. Patents and copyrights provide ownership rights to codified knowledge.

According to the statute, any person who “invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent,” subject to the conditions and requirements specified in the law.

In order to obtain a patent, it is necessary to codify all the know how, knowledge and processes. The right conferred by the patent grant is “the right to exclude others from making, using, offering for sale, or selling” the invention in the United States or “importing” the invention into the United States. In exchange of making the knowledge codified, and available to the public at large, the person receives from the government exclusive rights to use the patent for a limited period of time. Patent law permits that codified knowledge embedded in new products, Kp, is bound to its proper owner. Patent rights solve the appropriability problem that come from the “impure public good” nature of knowledge, even in an imperfect way. As explained, any person, by having access to the codified knowledge could steal the knowledge, without paying its value and use it. Patents provide a means so that the firm can bind the new knowledge to its structure, and extract economic value. These intellectual property protections enable the creation of a market for propertized knowledge.

b) Trade Secrets bind Kp and Ko

Tacit knowledge is the knowledge embedded in the organization and in the employee which have not been codified yet. Much of the increasing critiques to covenants not to compete is that they are trying to transform tacit knowledge embedded in the employee in codified knowledge.¹⁹⁸

¹⁹⁸ For a critique of current policy regarding covenants not to compete see Katherine V. W. Stone, *Knowledge at Work: Disputes Over the Ownership of Human Capital in the Changing Workplace*, 34 Connecticut Law Review 271.

The organization embodies knowledge of processes and routines. Specific know how is protected by trade secrets doctrine. The courts increasingly prevent employees from revealing the knowledge that they have acquired through learning and sharing knowledge while part of a firm's organization. As Fisk says regarding the doctrine preventing the disclosure of trade secrets:

“The focus shifted from the drawings of a machine to the design innovations contained in them; from the list of the customers to the knowledge of their identities, locations, needs and their goodwill; and from the precise written formula for a substance to the **general knowledge of the process and techniques for making it**. Negative knowledge (i.e., what does not work to achieve a particular purpose) came to be recognized for the first time as a trade secret so that an employee could be restrained not only from using knowledge about what works to make a product, but also from using knowledge of what does not work. Compilations of publicly available facts gained protection. As the category of trade secrets expanded, the category of general knowledge, or even specialized skill and experience, diminished.¹⁹⁹ (emphasis added)

As we explained, from a historical point of view the law of trade secrets has been changing and is being interpreted more expansively by courts since the end of the nineteenth century. Where previously trade secret law was concerned with the protection of technical information, the definition now covers all commercially valuable information.²⁰⁰

The Uniform Trade Secrets Act, which now has been adopted by more than 30 jurisdictions,²⁰¹ has broadened the definition of a trade secret to include “any formula, pattern, device, or compilation of information which is used in one's business, and which gives one the opportunity to obtain advantage over competitors who do not know or use it.”²⁰² ²⁰³ ²⁰⁴ Agreements to refrain from using or divulging trade secrets in competition are frequently made. And courts will enforce such contracts if they are deemed “reasonable.”

Courts have used a variety of factors in determining whether information is a trade secret which a former employee is not entitled to use when he leaves the firm. These factors include: “the extent to which the information is known outside of the employer's business; the extent to which it is known by employees and others engaged in his business; the measures which have been taken by the employer to ensure the continued secrecy of the information; the value of the information to him and to his competition; the amount of money and effort expended in

¹⁹⁹Quotations omitted. Fisk, *supra* note __ at 504.

²⁰⁰ Stone, *supra* note __, 757.

²⁰¹ WILLISTON ON CONTRACTS, § 13:14 (4th Ed.), WILSTN-CN § 13:14, n.69.

²⁰² Restatement of Torts § 757, comment b.

²⁰³ Uniform Trade Secrets Act, 14 Uniform Laws Annotated 50.

²⁰⁴ According to the UTSA, which is adopted by many states, including California, a trade secret is:

“Information, including a formula, pattern, compilation, program device, method, technique, or process, that: 1) Derives independent economic value, actual or potential, from not being generally known to the public or to other persons who can obtain economic value from its disclosure or use; and 2) Is the subject of efforts that are reasonable under the circumstances to maintain its secrecy. Cal. Civ. Code § 3426.1(d). A court may enjoin “actual or threatened misappropriation” of a trade secret. Cal. Civ. Code § 3426(a). A corporation misappropriates a trade secret when (1) it discloses or uses the trade secret of another without express or implied consent, and (2) at the time of the disclosure or use, it knew or had reason to know that its knowledge of the trade secret was derived from a person who owed a duty to the entity seeking relief to maintain the trade secret's secrecy or limit its sue. Cal. Civ. Code § 3426.1(b)(2)(B)(iii). Courts may order affirmative acts to protect a trade secret in appropriate circumstances.

developing the information; the ease or difficulty with which the information could be properly applied or duplicated by others.”²⁰⁵

In order to be enforced a trade secret must be secret. When information is deemed “general knowledge” available to outsiders then it cannot be property enforceable at law. The requirements that should be met for the enforcement of trade secrets may restrict the application of trade secrets doctrine in the task of binding knowledge to the firm. The diffusion of knowledge throughout the firm that is needed for production vitiates to some extent the ability of the employer to prevent the employee from transferring it outside the firm by the threat of law suit. So, to the extent that trade secrets bind only “specific knowledge”, other methods are necessary to bind more “general” knowledge to the firm, including structural solutions. These will be discussed next.

Trade secrets are legitimate to protect business interests that can be enforced where there is a restrictive covenant.²⁰⁶ So, when combined with a restrictive covenant, the threat of revelation of trade secrets can very well allow an employer to restrain an employee from working for a competitor. This connection between trade secrets law and restrictive covenants does not only expand restrictive covenant law, but also the scope of the enforcement of trade secrets. Trade secrets law complements and works together with restrictive covenants to bind knowledge to a firm.²⁰⁷

So, it is interesting to observe that the “specialized knowledge” which the courts aimed at protecting has been becoming more general knowledge in the sense that it is not codified but tacit. So trade secrets doctrine aim nowadays at protecting *tacit knowledge that an employee acquired when he was sharing experiences inside de firm’s organization* (Ki). To be sure, trade secrets also protect Kp, such as drawings and design of machines which don’t enjoy the benefits of protection by means of patents.

Trade secrets protect the tacit knowledge developed in the organization (Ko). However, trade secrets still are insufficient to protect the type of tacit knowledge that is embedded in the employee. Covenants to compete play this role. When the firm contracts a covenant not to compete with its employee, it aims at not only protecting the knowledge that is possessed by several members in the organization, but also protecting the specific, tacit knowledge that each employee will develop while participating in the firm’s organization, and which the firm is not yet aware of its content (Ki).

c) *Covenants not to compete bind Ki*

²⁰⁵ Lord, Williston on Contracts, 6 Williston on Contracts §13:14 (4th ed.) citing Uniform Trade Secrets Act 14.

²⁰⁶ A potentially significant change in that general direction has been the acceptance of the “doctrine of inevitable disclosure” by the 7th Circuit in *Pepsico, Inc. v. Redmond*. The doctrine has prevented employees from taking their valuable knowledge to a competitor, even where they had not signed restrictive covenants, 54 F.3d 1262 (7th Cir. 1995). The case has received much attention and criticism, and the doctrine has been rejected by New York and California courts, but it remains good law in many jurisdictions. See, e.g. *Bayer Corporation v. Roche Molecular Systems*, 72 F.Supp.2d 1111, 1112 (N.D. Cal. 1999) (“The theory of ‘inevitable disclosure’ is not the law in California and, at trial, plaintiff will have to demonstrate actual use or disclosure, or actual threat thereof”), is still valid in other states.

²⁰⁷ Generally, in trade secret’s law and in restrictive covenants there’s been stronger enforcement in favor of employers.

Covenants not to compete aim at binding tacit knowledge embedded in the employee to the firm. The firm does not even know what the knowledge will be, but *ex ante*, the firm wants to guarantee that the employee will not disclose his learning and capabilities with a potential competitor.

In increasingly knowledge rich environments a firm's competitive edge significantly depends upon highly knowledgeable and skilled employees.²⁰⁸ Firms compete fiercely to attract and retain "talent." Furthermore, firms are altering their human resources practices, constantly striving to enhance the talents and capacities of their incumbent employees.²⁰⁹ To achieve this purpose, firms thus provide extensive employee training, upskilling and networking opportunities, investing heavily in human capital. In this regard, the R&D policy and the firm organization will pretty much depend on the ability that these firms have to bind their employees (or restrain the employees from using this knowledge outside the firm), and to bind the knowledge produced by them inside the firm's structure. Hence, the importance of laws that regulate ownership of employee inventions and the compensation to be paid to these inventors.

Restrictive covenants now appear in almost every employment contract.²¹⁰ Where previously non-compete clauses and other post-employment restraints were reserved for high-level management, they are now written into the contracts of at will employees and litigated much more frequently.²¹¹ While cases have proliferated, "courts have become increasingly receptive to employer efforts to limit employee use of human capital."²¹²

Restrictive covenants fill important gaps in trade secrets law. They provide protection where the information an employer seeks to protect is non-confidential information relating, for example, to actual customers or prospective customers with whom the employee had sustained contacts. Trade secrets law can, for example, be applied to protect customer lists that have been kept confidential, but not to customer information which has not been kept confidential. The most difficult problem with trade secrets law is the definition of what constitutes a trade secret, and its identification. Restrictive covenants obviate this issue.²¹³ However, with the relaxation of what type of knowledge can constitute a trade secret, there is now a greater overlap.

²⁰⁸ "Information and knowledge are the thermonuclear competitive weapons of our time." STEWART, 3, 4.

²⁰⁹ Stone, *Knowledge at Work*, 722.

²¹⁰ Cavico says that "one now sees these non-compete clauses in practically every employment contract." "employers are fearful that their more ambitious, entrepreneurial, and mobile employees soon will be competing against them. Employers contend that they need these restrictive covenants to cope with ever-escalating competitive challenges. Moreover, the increasing amount of mergers and acquisitions, layoffs, bankruptcies, and concomitant 'downsizings,' 'rightsizings,' and 'flexible' staffing arrangements, including the increased use of 'temporary' employees, engenders a growing number of terminated, and very likely disgruntled, employees. These former employees likely are sophisticated and knowledgeable, and were privy to sensitive information....Employers are alarmed, and not without reason, that these ex-employees will possess, and offer a new employer, a significant competitive 'edge.' This 'edge' is perceived as a real threat to a firm's profits, and possibly even its existence. A very volatile and risky business environment thereby is created, and a prudent firm must take care to guard its competitive advantages. Restrictive covenants, therefore, have emerged as a prevalent and efficacious means for an employer to protect its business interests and hard-earned competitive 'edge.'" Cavico (3).

²¹¹ ABA SECTION OF LABOR & EMPLOYMENT LAW, COVENANTS NOT TO COMPETE: A STATE-BY-STATE SURVEY (Brian M. Malsberger et al. eds, 2d ed. 1996); ABA SECTION OF LABOR & EMPLOYMENT LAW, EMPLOYEE DUTY OF LOYALTY: A STATE-BY-STATE SURVEY (Brian M. Malsberger et al. eds. 2d ed. 1998); See also Stone, *supra* note , 739.

²¹² Stone, *supra* note , 739.

²¹³ *See, e.g.,* Water Servs., Inc. v. Tesco Chems., Inc., 410 F.2d 163, 170-71 (5th Cir. 1969) ("[S]ince it may be difficult to determine, as a matter of law, what is a trade secret, the covenant not to compete is a pragmatic solution to the problem of protecting confidential information").

The enforcement of covenant not to compete depends on the observation of some requirements. One example is the rule of reason, which most states came to adopt. Under the rule of reason approach noncompete clauses are enforced if they (1) serve to protect and employer's legitimate business interest, and the restrictions are (2) temporally and (2) geographically narrowly tailored to this purpose.²¹⁴ As a rule, courts would strike down noncompete agreements in their entirety, when they imposed restraints that were broader than necessary to protect the employer's *legitimate* interests, considering them unenforceable contracts in restraint of trade, or unconscionable contracts oppressive to the former employee. This has changed and courts now increasingly reform noncompetition agreements when they are drafted too broadly.²¹⁵ This means that post-termination restrictions are more likely to be enforced.

The most common argument for the enforcement of noncompetition clauses is the disclosure of trade secrets and confidential information.²¹⁶ These are clearly legitimate business interests courts deem worthy of protection when they assess restrictive covenants in employment contracts. Even in California, where Business and Professions Code section 16600 generally prohibits covenants not to compete, and public policy strongly favors employee mobility, covenants not to compete are enforceable if "necessary to protect the employer's trade secrets."²¹⁷

The law of trade secrets (also state law) and restrictive covenants are thus complementary. And in assessing whether to enforce a noncompetition agreement, courts will therefore frequently discuss the factors that apply to trade secret protection. Accordingly, courts will be more willing to enforce a noncompetition clause where an employee has acquired confidential information that would afford a competitive advantage to another business, but less willing where the employee could import only general knowledge of the business or industry.²¹⁸ The law and economics literature of the adequacy of covenants not to compete is now numerous. Many arguments pro or con the enforcement of covenants to compete have been advanced.^{219 220}

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²¹⁵ See, e.g., *Solari Industries, Inc. v. Malady*, 55 N.J. 571, 576, 264 A.2d 53 (1970) (adopting the judicial rule that noncompetitive agreements may receive total or partial enforcement to the extent reasonable under the circumstances).

²¹⁶ See, e.g., *Vender Werf v. Zunica Realty Company*, 59 Ill.App.2d 173, 208 N.E.2d 74,76 (1974) (Legitimate interests is only another term to describe those 'special circumstances' which render employee's restraint necessary, but protection against ordinary competition itself is not sufficient. The authorities indicate that the 'special circumstances' which have been controlling and important in determining the reasonableness of the restraint imposed generally involve elements of trade secrets and unfair dealings").

²¹⁷ *Muggill v. Reuben H. Donnelley Corp.* (1965), 62 Cal.2d 239, 242, 42 Cal.rptr. 107 (opn. Of Traynor, J.). See also *Metro Traffic Control, inc. v. Shadow Traffic Network*, 22 Cal.App.4th at 859. California also does not invalidate a noncompetition agreement that merely prohibits solicitation of the former employer's customers. See generally, *Whyte v. Schlage Lock Co.*, 101 Cal.App.4th 1443 at 1482, 125 Cal.Rptr.2d 277 (2002).

²¹⁸ See, e.g., *Whitmyer Bros. Inc. v. Doyle et al.*, 58 N.J. 25, 28-30, 274 A.2d 577 (N.J. Supreme Court, 1971) ("matters of general knowledge within the industry may not be classified as trade secrets or confidential information entitled to protection nor will routine or trivial differences in practices and methods suffice to support restraint of the employee's competition"; referring to defendant's argument that highway safety construction employee's knowledge of bidding procedures and constituent elements were general business knowledge in the guard rail construction industry).

²¹⁹ Eric A. Posner & George G. Triantis, *Covenants Not to Compete from an Incomplete Contracts Perspective*, John M. Olin Program in Law and Economics Working Paper No. 137 (2d series), University of Chicago Law School, (arguing that the employers have incentives to overinvest in specific training, which is worthless to any other employer, if a third employer is going to reimburse them. Therefore, employers will tend to expand covenants not to

²²¹ However, we advance here a still unexplored connection of the law of restrictive covenants and its impact to firm governance structure (see part B below).

The enforcement of such restrictive covenants affects firm governance in the sense that if these contracts couldn't be enforced in courts, employers and corporations would have to give employees greater incentives to stay in the firm, perhaps even ownership stakes.

2. *Other bodies of law and types of agreements*

While in this paper we only develop the idea of how law binds knowledge of Kp, Ko and Ki type by means of intellectual protections and agreements such as covenants not to compete, it is important to point out that other bodies of law do play a role in this regard as well. Employment regulation, for instance, may establish employee rights, assure job security and therefore help bind the knowledge embedded in an individual to firms structure. Rules that affect co-decision procedures may also cause this effect to some extent. Rules of Professional Conduct such as the ABA Model Rule of Professional Conduct also can function as away to prevent knowledge transfer outside the firm. Other types of agreements such as confidentiality agreements are also largely used in business practice and they do play an effect in helping firms bind knowledge to its structure.

B. Restrictive Covenants and the Structure of High Tech Firms

One striking example of the impact of intellectual property regimes on the ownership and decisional structure of firms has been provided by Ron Gilson's analysis of Silicon Valley high technology firms. Gilson has tried to show that different patterns of economic development between the high tech industrial districts of Silicon Valley, on the one hand, and Boston's Route 128, on the other hand, are connected to differences in intellectual property regimes in California and Massachusetts. While Massachusetts has a long history of enforcing covenants not to compete and other post-employment restrictions, California's civil Code prohibits them. Gilson argues that the inability to enforce non-competes thus supported a high velocity labor market in Silicon Valley, in which employees with significant technological expertise could move rapidly between competitor firms or leave their employer to start up their own companies in direct competition with their former employers.²²² Gilson concentrates on the Marshallian factor

compete to externalize the cost of worker training to as many prospective future employers as possible. To prevent this from happening and to promote the design of efficient covenants, given the possibility of renegotiation, the courts should investigate whether the restrictive covenant protects specific or more general training, enforcing the covenants only in the latter case.)

²²⁰ Katherine V. W. Stone, *Knowledge at Work: Disputes Over the Ownership of Human Capital in the Changing Workplace*, 34 Connecticut Law Review 271. ("the terms of new employment contract – specifically, the promise of training and networking opportunities - are undermined when courts are expansive in their approach to enforcement of restrictive covenants and the definitions of trade secrets.")

²²¹ Paul H. Rubin & Petter Shedd, *Human Capital and Covenants Not to Compete*, 10 J. Leg. Stud. 93 (1981).

Rubin and Shedd consider efficient/inefficient the enforcement of covenants depending on the case.

²²² See also, IN THE COMPANY OF OWNERS 11 (Joseph Blasi et al. 2003) (describing how the Nobel Laureate William Shockley left AT&T's Bell Labs to create a semiconductor lab in Palo Alto, only to lose eight of his young

market externalities that were created in the Silicon Valley region in virtue of interfirm knowledge spillovers.²²³

Because employees could not be prevented by contract from appropriating tacit knowledge resources, the resulting knowledge spillovers, according to Gilson, lowered the cost of knowledge inputs, thereby permitting start-ups to thrive and allowing a greater number of smaller firms to specialize in developing bits and pieces of technology required for the development and commercialization of marketable products.²²⁴

In contrast, Massachusetts's willingness to enjoin employees, who signed noncompete clauses, from competing with their former employers, discouraged employee mobility and knowledge spillovers, leading to the decline of the high tech industry along Route 128. "Route 128 firms, in contrast, developed in a more traditional fashion, imitating the vertically integrated structures of the large mass-production company."²²⁵

In other words, the level of knowledge spillovers, and the ability/inability of firms to bind tacit knowledge embedded in their employees to the firm, led to "strikingly different forms of industrial organization" in the two regions.²²⁶

Gilson's focus is on explaining legal factors that contributed to the creation of Silicon Valley's regional agglomeration economy. Thus, while his focus is on the effect of those rules in the regional industrial organization, we rely on his analysis to establish the relationship between differences in governance structure of high tech firms Silicon Valley and Route 128 on the one

researchers, who walked out on him to start their own company, Fairchild Semiconductors. Fairchild, in turn, was stripped of much of its talent when it shed eight of its most promising researches, who went on to create companies such as Intel. "Fairchild exploded like a seed pod and scattered the germs of new firms throughout the valley. By 1970, forty-two new semiconductor companies had been founded by former Fairchild employees or by the firms they had started . . ."

²²³ Ronald Gilson, *The Legal Infrastructure of High Technology Industrial Districts*, 74 N.Y.U. L. REV. 575 (1999), at 594: "The web of knowledge spillovers, personal relations, start-up businesses, and *absence of vertical integration* owes its existence to the ease with which employee move from employer to employer, from established company to start-up, from customer to supplier, taking their employer's tacit knowledge with them and applying it in their new situations. Lacking the ability to prevent knowledge spillovers, Silicon Valley companies adapted to their environment, and the characteristic Silicon Valley industrial organization evolved". (emphasis added).

²²⁴ Gilson's explains the ability of the legal infrastructure to affect the price of knowledge inputs for firms in high tech industrial districts by promoting Marshallian factor market externalities. A Marshallian factor market externality is the propensity for an input's relative price to be lower when the number of firms in a region that call for that input is higher. Such a region constitutes an "agglomeration economy." Applying the Marshallian theory of agglomeration economies, and more particularly the principle of Marshallian factor market externality, Gilson shows the standard law and economics position that firms should be allowed to capture the gains of their knowledge investments, fails to appreciate the significance that knowledge spillovers played in lowering the price of knowledge inputs for firms in high tech industrial districts. Gilson *supra* note 23, at 581.

²²⁵ Gilson, *supra* note 23, at 591-92: "...In contrast to the Brownian motion of Silicon Valley's high velocity employment, career patterns of employers and managers in Route 128 companies were much more linear. Knowledge workers anticipated long-term employment with a single employer and career development that contemplated rising vertically within an organization, rather than success through lateral movement, as in Silicon Valley... '[t]he practice of leaving a large company to join a small firm or a promising new start-up was virtually unheard of.' Consistent with this pattern, Route 128 gave rise to traditionally vertically integrated companies. In this locality, knowledge transfer took place within, rather than across firms."

²²⁶ Gilson, *supra* note 23, at 590 ("The career paths of Silicon Valley engineers and managers resembled Brownian motion. They moved between companies, founded start-ups, supplied former employers, purchased from former employees, and in the course of their careers developed personal and professional relationships that cut across companies and competition.... 'engineers shifted between firms so frequently that mobility not only was socially acceptable, it became the norm.'").

hand, and the respective legal protections available to employers for binding tacit knowledge embedded in their employees (Ki) to the firm.

The traditional large, vertically integrated and more rigidly hierarchical corporate culture on the East Coast in Massachusetts was supported by a legal regime that bound tacit knowledge embedded in employees to the firm. IBM provides the prime example of such a vertically integrated firm. In contrast, a less integrated, less hierarchical and more fluid firm structure characterized by both competing but also cooperating start-ups was supported by a legal regime that did not recognize a firm's property rights over the tacit knowledge embedded in a firm's employees.

We argue that the regulation of Ki had an effect on firm structure in an industry, which relies heavily on this type of knowledge. Tacit knowledge plays a different role in the different phases of innovation, product development and commercialization in an industrial district's production life cycle. Tacit knowledge is "critical to taking an innovation from conception to commercialization."²²⁷ But it plays a lesser role during later stages in an industry's life cycle once "most of the technical aspects of the product have become standardized, and the nature of demand is well known."²²⁸ Geography proximity thus matters more in the initial phases of a high tech industries life cycle. Tacit knowledge is knowledge embedded in employees. Its transfer from one firm to another thus occurs through interfirm employee mobility and is not subject to the almost instantaneous communication we have come to rely on in the information age. Employees, however, incur significant costs and thus greater risks when they move geographically to take up new jobs. This adds to the costs of tacit knowledge transfer and to the corresponding savings from proximity. Knowledge spillovers are thus much more likely to occur where firms exist in geographical proximity. ??

California's encouragement and Massachusetts' legal hurdles to employee mobility resulted in different outcomes. The much greater level of knowledge spillover in Silicon Valley produced an environment in which the industrial district's production life cycle was "reset" and new start-ups generated new product inventions and commercializations. In contrast, the much lower knowledge spillovers in Route 128's industrial district did not restart the district's life cycle. As the technology was thus standardized and products entered into their marketing phase, the importance of geographic proximity to firms diminished. This also diminished the benefits of location with the district. The result was that firms moved elsewhere and the district's concentration of tacit knowledge resources became dissipated.

There is considerable evidence for the proposition that inter-firm mobility in Silicon Valley is exceptionally high.²²⁹ But clearly Silicon Valley's high tech firms also needed to bind knowledge to the firm. Gilson's account of Silicon Valley knowledge of spillovers leaves us with a critical question: If employee mobility was so pervasive how did the firms survive at all? Key employees must have been retained for significant periods because otherwise most firms would have collapsed. Presumably firms did find a way to keep employees. Gilson does not pursue this aspect of the problem. Firms' adaptation to their regulatory environment and

²²⁷ Gilson, *supra* note 23, at 582.

²²⁸ Gilson, *supra* note 23, at 584-585. See also MARYANN P. FELDMAN, THE GEOGRAPHY OF INNOVATIVE CLUSTERS 254 (1994) ("[T]he propensity for innovative activity to geographically cluster will tend to be shaped by the stage of the industry life cycle....[T]he importance of tacit knowledge in generating innovative activity shapes the degree to which innovative activity will cluster. And the relative importance of tacit knowledge in generating innovative activity varies considerably across the various stages of the industry life cycle.").

²²⁹ See Gilson *supra* note __, at 590-92.

business culture in Silicon Valley was not limited to supporting their employees' transfer of valuable knowledge assets outside of the firm to their competitors. Lacking certain legal protections (viz. enforcement of covenants not to compete), firms were thus relegated to employing alternative devices to bind Ki to the firm. Where the threat of enforcing a restrictive covenant provided disincentives for employees to strike out on their own in Massachusetts, high tech firms in Silicon Valley had to devise a new governance structure to provide incentives for employees to stay. One aspect of this governance structure is compensation packages. Firms employed the substantial incentive of employee stock option plans to bind Ki to the firm. This device, in turn, encouraged and reflected a different type intrafirm decisional structure and different modes of financing.

We argue that there is a reciprocal relationship between non-competes and compensation – and ultimately ownership - structure. If there is no possibility to enforce a covenant not to compete, that is, to bind Ki by means of private agreements, then firms are forced to give greater incentives to valuable employees or greater decision making authority in order to retain these employees. But if firms can enforce a non-compete, then essentially they can blacklist an employee and prevent them from leaving, and make it much harder for them to take the knowledge and information elsewhere. In firms where the use of covenants not to compete are widespread, we hypothesize that stock options should become less common, because the two are related in this way. The necessity of the firm to bind knowledge embedded in its employees can be managed in two ways: (1) through enforcement of these restrictive covenants; or (2) through offer of powerful incentives such as compensated packages and potential ownership rights.

What is more, Gilson seems to attribute the performance deterioration of Route 128 high tech district in Boston to the lack of knowledge spillover effects that were associated with employee mobility in Silicon Valley.²³⁰ While this should be a relevant factor, we believe that this is not the whole story. The predominance of vertically integrated firms in Route 128 which were developed imitating the structure of the large mass-production company²³¹ may well be considered another key factor in this respect. According to our theory, the deterioration of firms performance in Route 128 would be an example of how governance structures can affect the creation of knowledge resources and innovation. Our hypothesis is that the development of firm structures in Route 128 towards a mass production oriented structure, with steep hierarchical and centralized knowledge, may well have constrained new knowledge development and therefore affected innovation patterns. According to Saxenian: “Route 128’s technology enterprises imitated the structure of the traditional mass production corporation. While Silicon Valley’s entrepreneurs rejected the corporate practices of the large, established East Coast producers, the managers along Route 128 saw the same corporations as their models. One senior vice president at Data General (DG) commented: “I constantly study the way larger companies organize themselves looking for ideas. I look at Texas Instruments, at IBM, at ITT, and at GE and GM.”²³² Relying on interviews with industry executives, Saxenian describes what she calls “hierarchy and formalism” in the companies of Route 128. Managers conceived formal decision-making processes, conservative workplace procedures and work styles.²³³ “Vertical lines of decision-making authority ensured that flows of information and communications were formal

²³⁰ Gilson *supra* note __, at 591-592.

²³¹ ANNALEE SAXENIAN, REGIONAL ADVANTAGE. CULTURE AND COMPETITION IN SILICON VALLEY AND ROUTE 128, 70 (HARVARD UNIVERSITY PRESS, 1994).

²³² Id.

²³³ Id., at 73-74.

and hierarchically controlled. Corporate Divisions were generally subject to the final authority of a central office.”²³⁴ There a system of corporate ranks where salaries, benefits, and authority relations created barriers between functions.²³⁵

As we have suggested centralized structures tend to operate by means of knowledge-substitution mechanisms, which may not be efficient to promote the diffusion of knowledge in firm’s structure and to foster knowledge of Ki type. So the governance structure of the firm may well have affected the generation and development of new knowledge and products.

C. Employee Stock Option Plans As An Alternative Means to Binding Knowledge to the Firm

While stock options have become the symbol of corporate executive greed – comprising a substantial portion of the 340 % increase in medium CEO pay from 1992 to 2000 --²³⁶ their wide-spread use originated in Silicon Valley as a means for high tech firms to attract and retain talent (Ki).²³⁷ There is a difference, however, between the rationale for stock options for employees and for executives. While retention is arguably an issue in both cases, executive compensation tends to be justified in terms of aligning managers’ incentives with those of the stockholders, “getting managers to act in ways that ensure the long-term success of their companies.”²³⁸ ²³⁹ Stock options for employees, however, are typically described in the high tech industry in which they prevail as aiming at retention, and not just any retention, but retention of knowledge resources embedded in employees.²⁴⁰ In addition they are viewed as a crucial tool for

²³⁴ Id., at 76.

²³⁵ Id, at 77.

²³⁶ The stock options share of CEO pay rose from 27 % of total compensation in 1992 to 60 % of total compensation in 2000. DONALD P. DELVES, STOCK OPTIONS AND THE NEW RULES OF CORPORATE ACCOUNTABILITY (2004) 1, 7. See also, Brian Hall, *What You Need to Know About Stock Options*, 3/1/00 HARV. BUS. REV. 121 (2000) (“With astounding speed, stock option grants have come to dominate the pay – and often the wealth – of top executives throughout the United States . . . the grants seem to shower ever greater riches on top executives”).

²³⁷ See generally BLASI ET AL., IN THE COMPANY OF OWNERS (2003).

²³⁸ Brian Hall, *What You Need to Know About Stock Options*, 3/1/00 HARV. BUS. REV. 121 (2000), at *2. Hall also believes that options are “the best compensation mechanism we have for getting managers to act in ways that ensure . . . the well-being of their workers and stockholders,” but he lumps together the stock options for executives with broad ESOPs without recognizing their distinct tendencies.

²³⁹ Note that the view that stock options provide incentives to managers (reducing agency costs) is based on an agency-cost explanation of stock options. Paul Oyer & Scott Schaefer, *Why Do Some Firms Give Stock Options to All Employees?: An Empirical Examination of Alternative Theories*. 76 JOURNAL OF FINANCIAL ECONOMICS 99 (2005).

²⁴⁰ The “retention” explanation better explains empirical evidence according to Oyer & Scott, *id. See, e.g.*, the following Associated Press account of the debate on the new FASB requirement that stock options be expensed beginning in 2005:

Proponents of mandatory counting of stock options as an expense, including Federal Reserve chairman Alan Greenspan and billionaire investor Warren Buffett, argue that without it investors will continue to get misleading information on companies’ financial performance. Awarding options to executives, which can be sold within a short time, gives them an incentive to recklessly pump up the stock price without regard to the company’s long-term future, proponents say.

“But business interests -- especially high-tech companies that are generous campaign donors to both parties -- stiffly oppose such a change and their allies in Congress are moving against it. They

startups in the high tech industry and smaller firms with limited capital to attract and retain talent. The knowledge management considerations that motivated Silicon Valley high tech firms to extend ownership rights to employees was neglected in the wake of the recent executive pay scandals. Thus critics who focus exclusively on incentive alignment grouse that the spread of stock option grants to employees “had the effect of transferring a growing portion of the future value of the company from the hands of shareholders into the hands of employees and managers.”²⁴¹ Such critics single out especially the much higher percentage of outstanding stock devoted to stock option plans in the high tech industry, as compared with general industry companies who typically restrict stock options to executives: “the percentage of outstanding stock devoted to stock option plans increased dramatically, rising from 3 to 5 percent in 1990 to 12 to 15 percent among general industry companies in 2001. In high-technology companies the average is much higher – 18 to 25 percent, with some companies as high as 30 to 40 percent.”²⁴²

Authors usually tend to believe that the main explanation for the adoption of a stock options program is related to agency costs and can be explained by the agency cost framework. A recent study by Oyer and Schaefer, however, investigates alternative explanations and rejects the agency cost explanation that has been broadly adopted. The study analyses three alternative explanations for stock options:

1) Agency Theory Explanation. Stock options provide incentives to employees. They attach the employee’s wealth to the value of the firm in order to overcome agency problems and motivate the employee to perform according to the firm’s interest.

2) Sorting Explanation. Stock options induce employees to sort. Employees differ in their beliefs regarding firm’s prospects. Options attract optimistic employees, willing to take the risk, and reduce overall compensation costs for the firm.

3) Retention Explanation. Stock options help firms retain employees. Options are a form of deferred compensation. They have a vesting period attached that increases the costs to employees of departing from the firm. Options thus help firms retain employees.²⁴³

The study sample encompasses firms that offer broad-based stock option plans. The study focus is on options offered to middle-level executives. These plans are more common at small firms. Oyer and Schaefer remark that new economy firms (that manufacture computers, semiconductors, telephone equipment, create software, or computer-related products) make up a substantial portion of the firms with broad stock options plans.²⁴⁴ These plans tend to be adopted by knowledge intensive firms.

are predicting dire consequences for high-tech, biotechnology and startup companies, and the U.S. economy, if businesses are required to treat employee stock options as an expense.

“Rank and file employees would be the ones who lose out,” Rep. Anna Eshoo, a California Democrat whose district embraces Silicon Valley, testified at a House hearing.

“Broad-based stock option plans have turned employees into corporate partners by tying the interest of the employee together with the company and its shareholders,” Eshoo told the House Financial Services subcommittee on capital markets. “Small, entrepreneurial companies with little or no capital use stock options to attract and retain bright and talented employees critical to that company’s success.”

Possible Stock Option Bans Split Congress, AP, June 4, 2004.

²⁴¹ DONALD P. DELVES, STOCK OPTIONS AND THE NEW RULES OF CORPORATE ACCOUNTABILITY (2004), at 39.

²⁴² Id.

²⁴³ Paul Oyer and Scott Schaefer, *Why Do Some Firms Give Stock Options to All Employees?: An Empirical Examination of Alternative Theories*, December 2002, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=361600

²⁴⁴ Id., at 9.

Oyer and Schaefer reject the incentives-based (agency-cost) explanation for broad-based stock option plans, because the risk premium stemming from option-based pay dwarfs the cost to the employee of the associated increase in effort. If effort were contractible, the employee would be willing to exert additional effort for a payment dramatically smaller than the risk costs imposed on the firm by providing stock options.²⁴⁵ Given the existence of other means to evaluate subjective performance and to reward employees for the value they create, the authors conclude that stock options appear to be a very inefficient means to provide incentive to employees. Stock options-as-incentives could perhaps be a sensible explanation under a very limited set of circumstances, where employees have the power to take actions that have large value implications for the firm, at very limited cost to the employees taking such actions, and where it is extremely difficult for firms to monitor such employees.²⁴⁶

Interestingly, sorting and retention explanations are consistent with the data. The authors regard sorting or retention first-order determinants of the decision to adopt a broad-based stock option plan. They believe that “firms that adopt broad option plans are those where the returns to cost effectively attracting and retaining employees is particularly high.”²⁴⁷ The authors argue that some combination of sorting and retention contribute to the decision to adopt stock options firm-wide. Skill-based industries, such as new economy firms, which rely on the intensive use of knowledge to deliver their services, are significantly more likely to grant stock options than other firms.²⁴⁸

New economy firms tend to face more difficulty in hiring enough talented people.²⁴⁹ So firms need to pay special attention in designing incentives and compensation packages that will be suitable to stimulate employees to stay in the firm. While firms may design several packages of deferred compensation, granting options to workers that have higher skill levels is certainly one mechanism that serves the purpose of binding knowledge to the firm.²⁵⁰

In an environment of intensive competition for highly mobile employees trained in hardware and software engineering, stock options in Silicon Valley “act[ed] like financial

²⁴⁵ Id., at 23.

²⁴⁶ Id at 23.

²⁴⁷ Id, at 43. In order for the sorting explanation make sense, it must be the case that employees strictly prefer the observed salary plus options to all-cash package. At a expected return of 25% annual stock appreciation, the employees at nearly all the firms of the sample value their options packages significantly more than they would value comparable all-cash package. Authors believe this explanation to be significant. Cf. Brian Hall, *What Do You Need to Know About Stock Options*, Harvard Business Review (2000)(“Adobe Systems, Apple Computer, E*Trade, Netscape, PeopleSoft, and Sybase have all repriced their options in recent years, despite the bad will it creates among shareholders. As one Silicon Valley executive told me, “You have to reprice. If you don't, employees will walk across the street and reprice themselves.”) This shows that retaining employees is a first-order concern in Sillicon Valley firms.

²⁴⁸Id. “The fact that firms with higher volatility and in the new economy are more likely to have option plans could also be consistent with the retention model if market wages vary more for volatile firms or firms in the new economy.”

²⁴⁹ Id., p. 42.

²⁵⁰*See also* Rebitzer and Taylor, *supra* note _: “In high technology firms, many of the key assets of the enterprise are bound up in the brains of crucial employees. Property rights to some of these intellectual assets can be secured through patents or copyrights. When adequate control *cannot* be attained through intellectual property tights, one should expect to see innovations in the employment relationship that reduce the firm's vulnerability to losing valuable assets. In some instances, high technology companies reduce the incentive of key “knowledge workers” to leave through the use of stock options and other forms of deferred compensation that become dramatically less valuable when the employee exists the firm.” at 27.

magnets, binding employees to their companies for the long term.”²⁵¹ As John Chambers, the CEO of CISCO Systems recognized:

Not long ago . . . the output of machines was the fundamental driver of competitive advantage. We taught our managers to focus on physical assets, the cost of capital, and the value chain. Successful companies built more, for less. In the internet economy, the dynamics are radically different. Intangible ideas – the output of people, in an economic sense – are the drivers of competitive advantage.²⁵²

CISCO’s extensive stock option plans, covering virtually all its employees, was based on the understanding that acquiring and retaining human capital was key to success in the high tech industry: “Each year Cisco gives employees the right to purchase \$25,000 worth of company stock at 15 % off the opening or closing price of the previous six months, whichever is lower.”²⁵³ In stark contrast to the confinement of stock options to executives in the more traditional public corporations, CISCO’s stock options plan typically gives nonexecutives more than 90 % of all options handed out.²⁵⁴

We suggest that this concern with designing compensations packages in a way to retain key employees was knowledge-based driven. Still, it could be argued that the main reason why the firms were adopting broad stock options plans was accounting-driven instead of knowledge-driven. In such reasoning, firms were issuing stock options because they had accounting incentives to do it, because of the non-expensing rule at that time. But then, if this incentive was the same for all the companies why just a few companies really adopted stock options as a broad plan available to non-executive employees as well? Most companies did give stock options to their executives – trend well documented - as there was an explosion in stock options.²⁵⁵ But why some companies, instead, gave options not only to managers, but also to other employees? The accounting-driven view cannot explain why there was a difference in the pattern of stock options distributed- namely to non-executive employees in some high tech firms.

One analysis based on a benchmark group of the top 100 largest internet-based companies by revenue shows that “[ninety-eight] of these companies handed out options to at least 51 percent of their employees, compared with just six percent in a group of comparably sized, mostly non-tech companies traded on the New York Stock Exchange.”²⁵⁶ So the distinction between stock options for executives and stock options for employees deserves particular attention for the use that high tech companies have made of stock options seems very

²⁵¹ BLASI, *supra* note 237, 42; DELVES, *supra* note 130, at 40 (“Like many other technology companies, the chip maker [Intel] has used options heavily as a recruiting and retention tool”) (citing *The Wall Street Journal*).

²⁵² Speech of John T. Chambers, quoted in BLASI, *supra* note 237, 37.

²⁵³ BLASI ET AL., IN THE COMPANY OF OWNERS (2003), 53.

²⁵⁴ *Id.*, at 53-4. Chambers took over as CEO in the mid-1990s after working at Wang Labs and IBM, both traditional corporate hierarchies with top-down cultures, which he regarded as imposing significant constraints on creativity and innovation. At CISCO Chambers was committed to making the Silicon Valley business culture a principal resource. Part of CISCO’s strategy under Chambers has been “to use stock options and a bottoms-up culture of employee ownership to propel phenomenal growth in the late 1990s much of it stemming from the acquisition of other small startups.” *Id.*, at 52. Chambers said in 2000: “Our industry is not like the banking industry where you are acquiring branch banks and customers. In our industry, you are acquiring people. And if you don’t keep those people, you have made a terrible, terrible investment . . .” *Id.*, at 54.

²⁵⁵ Quote studies

²⁵⁶ *Stock Options Benefited Workers*, San Jose Mercury News, 1/10/2003, available at www.mercurynews.com (last visited 7/10/2004).

different than the way options were used mainly as an executive compensation tool in the rest of the economy. .

Employee stock option plans became a central feature of the alternative high tech firm culture in Silicon Valley. The shift in ownership relations resulted from a mixture of intense competition for talent, the need to bind tacit knowledge to the firm, and a drive for recognition on the part of talented scientists and other well-trained employees working in the private sector. The ownership stake afforded to workers in high tech firms supported nontraditional, much less hierarchical decisional structures.²⁵⁷ Cooperation and decentralized decision making in employee teams answered the much greater need and demand for autonomy by knowledge workers.²⁵⁸ Such changes, in turn, reflected the focus on creating fertile environments for knowledge production in an industry in which the survival of the firm depended on constant and rapid innovation in knowledge intensive environments.

The different sense of ownership promoted by the substantial rewards offered by stock option grants furthered bottom up decision making and innovation and frequently blurred the lines between worker and management.²⁵⁹

The change in ownership structure due to the need to bind tacit knowledge to the firm thus altered decisional hierarchies, but also information flows within the firm. Finally, giving employees a greater stake and a voice in the management of the firm can serve as an effective workplace monitoring device. Knowledge of what goes on in the workplace is as crucial to monitoring as is the actual incentive to monitor. But independent monitors don't have the same access to everyday problems as do the employees themselves.

²⁵⁷ See *supra* note Saxenian

²⁵⁸ Stiglitz, *Public Policy for a Knowledge Economy*, (World Bank, Jan. 27, 1999), available at <http://www.worldbank.org/html/extdr/extme/jssp012799a.htm>, at 1 (“the shift towards a knowledge-based economy involves a shift in organization away from top-down hierarchical structures to flatter structures such as networks of semi-autonomous teams. Tayloristic vertical structures were designed to enforce and coordinate certain physical behaviors while knowledge-based work organization involves greater recognition of the autonomy and self-direction of the mind.”).

²⁵⁹ BLASI, *supra* note 134, at 40, 45. The following anecdotal evidence describes what has been termed the new “partnership capitalism” reflected in such high tech firm culture: “Employees come to see taking important issues right to the door of management as appropriate, even to the door of the top executive. In fact, some companies already have a term for walking problems and issues up to management. They call it escalation, as in “She felt she had to escalate the issue, to bring it to the attention of the decision-maker who could sort the problem out.” “Sometimes, if an issue is important enough and involves the broadest interests of the company, an employee may even take it directly to the CEO. Jack, the Portal employee, told us how that very morning he had talked to John Little, the company’s founder and CEO. His advice: Portal desperately needed a chief operating officer, someone to take over the day-to-day job of running the company. Jack felt that the task had become too much for Little now that the company had grown to 1,500 employees.” “My exercise price [on my options] is way lower than some of the other people at this table. So I can make a lot of money even at \$8.81 a share [the price Portal’s stock was trading at that day]. But a fifty- or sixty- or seventy-dollar stock price to me means a hell of a lot. So I’m willing to talk to the CEO and tell him things that might in any other job limit my career. I wasn’t afraid of doing it, escalating it, because of my strong financial stake.” In early 2002, Portal did indeed create the position of President and Chief Operating Officer.” *Id.*, at 46. While Portal was one of the companies that suffered a melt-down in 2000 & 2001, and is cited as an example of a “dark side” the late-1990s tech boom, workers below top management nevertheless benefited. *Stock Options Benefited Workers, San Jose Mercury News, 1/10/2000*, at www.mercurynews.com (last visited 7/10/2004) (“Even when tech stocks were melting down in 2000 & 2001, workers below top management pocketed an estimated \$25 billion – or an average of \$125,000 – at companies that ranged from stalwarts such as CISCO Systems and Yahoo to flame-outs such as Excite@Home and Portal Software.”); *How Portal leaders reaped a Huge Windfall*, Dec. 9, 2002, at www.mercurynews.com (last visited 7/10/2004)

For example, at a Palo Alto, California, company named Tibco Software Incorporated, a thirty-something events planner named Jennifer told us: “When you have ownership in the company, you . . . watch costs. We’re going to Hawaii next week for a sales trip. Well, one person didn’t get their travel [arranged] . . . so I called him and said: ‘What are you doing, book your travel, if you wait your ticket is going to be so much higher.’ You’re constantly watching that stuff when you’re an owner.”²⁶⁰

While such anecdotal evidence has its limits, and the alternative business culture in Silicon Valley, to be sure, generates its own counterproductive tendencies,²⁶¹ it is not in dispute that quite different organizational structures and financial arrangements characterize the Silicon Valley high tech firm.²⁶² Employee stock options are widely regarded as an essential component to the partnership-style organization of high tech firms in Silicon Valley. As already pointed out, wide-spread employee participation in stock option plans evolved in Silicon Valley start-up culture as an alternative means to bind tacit knowledge to the firm in the absence of legal tools such as covenants not to compete and under particularly challenging circumstances for employers.

D. The Potential Impact of Accounting Rules On Knowledge Production

We believe that the availability of stock options and their generous distribution to employees at all levels of the firm hierarchy in the tech industry, was also the result of certain beneficial accounting and disclosure rules that supposedly subsidized their use.²⁶³ In other words, firms use stock options rather than other deferred compensation packages to bind knowledge in light of particularly attractive accounting rules.

Under rules initially published by the Accounting Principles Board (ARB) – the precursor to the Federal Accounting Standards Board (FASB) – stock options did not need to appear as an expense on a corporation’s income statement, so long as they met certain criteria such as having a fixed exercise price and a fixed number of shares.²⁶⁴ This meant that they were essentially free. Allowing companies to take the expense of stock options off their expense sheets to be sure, inflated earnings thus making such companies look much more profitable than they actually were.²⁶⁵ This in effect created a significant subsidy in the form of the correspondingly lower cost of capital available to high tech firms.²⁶⁶

²⁶⁰ BLASI, *supra* note 134, 43.

²⁶¹ See, e.g., DELVES, *supra* note 130, at 40-41 (discussing the “skewed incentive system” set up by the get-rich-quick culture of high tech start-ups).

²⁶² Among the voluminous literature on the subject, see, e.g., ANNALEE SAXENIAN, REGIONAL ADVANTAGE: CULTURE AND COMPETITION IN SILICON VALLEY AND ROUTH 128 (1994) . . .

²⁶³ DELVES, *supra* note 130, at 4-6.

²⁶⁴ DELVES, *supra* note 130, at 44 (citing APB Opinion 25).

²⁶⁵ According to an analysis by *Fortune Magazine*, “the effect of expensing options could result in a 59 percent reduction in Dell Computer’s earnings, a 79 percent reduction for Intel, and a 171 percent reduction for Cisco Systems inc. for the year 2001.” DELVES, *supra* note 130, at 50.

²⁶⁶ [CHECK EMPIRICAL EVIDENCE]

Until recently, attempts made by the FASB to require the expensing of stock options met with stiff resistance by corporate executives.²⁶⁷ Finally, Congress adopted FAS 123 (Financial Accounting Standard 123) in the mid-1990s, which required only that companies that didn't expense stock options were required to disclose the estimated impact of any such plans on earnings in footnotes to the companies financial statements.²⁶⁸ Stock option plans were thus not subject to full disclosure and shareholders were typically left in the dark as to their real impact on a company's finances – before FAS 123. In addition, governance rules did not require that the adoption of stock option plans be put to a shareholder vote.²⁶⁹ Nor was a shareholder vote required to reprice options that were “underwater”.²⁷⁰ Corporate governance rules have thus made it easy for management to distribute stock options even as the increased overhang diminished the share of equity in the company held by shareholders.²⁷¹

After years of fruitless attempts to change the rules to require expensing of stock options in order to correct for the distortion of firm values, the FASB, in the wake of the dot.com bust and corporate compensation scandal in 2001/2002, presented Congress with a rule require expensing since last year - 2005. In addition to the new accounting rules, the SEC has just signed off on new stock-exchange rules (passed by the NYSE and the NASDAQ), that will require putting stock options and other compensation plans to a shareholder vote.²⁷² The new stock-exchange rules will affect Valley practices as follows: (1) Companies will now be required to put the adoption of stock option plans to a shareholder vote; (2) So-called “ever-green plans” that were designed to replenish the inventory of options automatically must come up for a vote every 10 years; (3) Shareholders will have to approve the repricing of options that are underwater; (4) Brokers (who are perceived to side with management) will not be permitted to cast votes on equity-compensation plans without their customer's explicit approval.²⁷³ The new governance rules are expected to “dovetail with efforts by the Financial Accountings Board to require companies to deduct the expense of stock options from their profits – a change that high-tech companies say would force them to slow the flow of options to rank-and-file workers.”²⁷⁴

²⁶⁷ DELVES, *supra* note 130.

²⁶⁸ DELVES, *supra* note 130, at 44, 47.

²⁶⁹ Nyse was an exception???

²⁷⁰ “[M]any corporate boards have approved stock option plans without a shareholder vote, leaving investors with only vague clues about how many shares can be doled out . . . 40 to 60 percent of Valley companies have adopted such plans.” *SEC to Adopt New Options Rules*, June 28, 2003, San Jose Mercury News, available at www.mercurynews.com (last visited 7/10/2004).

Stock options have an exercise price, which is the price at which the owner of the option is entitled to purchase a share of stock. Typically the exercise price is set at the market price on the day the stock is granted. The option is then considered “at the money.” The option vests at a specified future date, giving the holder the right to purchase the specified amount of stock at the exercise price on that date, regardless of fluctuations in the market price. Most employee stock options give employers that right for a period or “term”, of ten years. If the option's exercise price is higher than the current market price of the stock, then the stock is deemed “underwater.” If the exercise price is lower than the current market price, the option is deemed “in the money.” If employee stock options are underwater for too long their ability to incentivize employees and bind them to the firm is eviscerated. As a result, stock options are typically repriced where a company's stock price experiences a decline.

²⁷¹ The “overhang” is the percentage of a company's stock that is devoted to options. The overhang is equal to the number of options granted and outstanding, plus the number of shares reserved for future grants divided by the number of shares outstanding.

²⁷² *SEC to OK New Options Rules*, *supra* note __.

²⁷³ *Id.*

²⁷⁴ *Id.*

A heated debate has accompanied the current dismantling of an accounting, disclosure and governance regime that has significantly boosted the use of stock options by publicly held companies both within the high tech industry but also in other industries as an important executive compensation tool.

Proponents of the new rule point out that it merely requires accurate accounting and honest disclosure, which had long been thwarted by corporate executives lobbying Congress.²⁷⁵ While it is recognized that the high tech industry would be disproportionately affected, proponents of expensing frequently respond that this is “still no reason to maintain bad accounting.”²⁷⁶

But those favoring options in high tech have argued that the new rules should apply only to options for a companies top five executives, because granting options to executives does not fulfill the same purpose as granting options to employees.²⁷⁷ Accordingly, proposals at some of the Silicon Valley firms seek to limit repricing underwater options to employees and to exclude the executives and directors from the deal. Representatives from Silicon Valley firms strongly argued that the new accounting rules would harm their ability to recruit and retain employees.²⁷⁸

While the accounting rules may well diminish the incentives for firms to adopt broad stock option plans as a compensation mechanism, we conjecture that if stock options are an efficient way of binding Ki, they should continue to be used by high techs regardless of the expensing rule. Alternatively, managers may try to design alternative compensation plans based on deferred compensation in order to substitute stock options. If our view is accurate, high tech firms must employ some mechanisms to provide sufficient incentives in order to retain key employees.

E. Normative Conclusions Regarding Stock Options

The knowledge based approach to corporate law has important normative implications for the current corporate governance debate.²⁷⁹ What the example of stock options expensing shows is that the (disclosure) regime governing the principal-agent relationship between management and outside shareholders cannot be isolated in the manner frequently suggested by agency cost theory from the type of contracting that occurs within the firm. This is especially true to the extent that contracting within the firm is not simply a replication of the types of factors affecting contracting on the market. It encompasses additional concerns regarding the production and diffusion of knowledge resources. The question to ask would therefore seem to be: What form of regulation would promote the knowledge management requirements of high tech firms, while still serving to correct the skewed incentives provided to executives by the old accounting rules to which standard agency cost considerations attach? When a firm relies heavily on knowledge embedded in employees, it may very well make sense to give them stock

²⁷⁵ DELVES, *supra* note 130, at 43-51.

²⁷⁶ DELVES, *supra* note 130, at 51 (citing Senator John McCain on the impact on high tech firms).

²⁷⁷ “Tech lobbyists took heart last week, when the House financial Services Committee voted 45-13 to approve a bill that would require companies to deduct only the fraction of options doled out to their five top executives.” *Stock-Options Debate in Valley This Week*, June 21, 2004, available at www.mercurynews.com (last visited at 7/10/2004).

²⁷⁸ Quote media articles

²⁷⁹ The present paper makes merely a beginning in applying this approach to corporate law.

options. Stock options have played a key role in binding knowledge to the firm in knowledge intensive environments that place a premium on knowledge production by employees at many different levels of the firm hierarchy.

Indeed, one of the chief arguments advanced for using options at all is precisely that they are an effective way of attracting and retaining the right kind of managerial talent--the kind that will increase earnings and drive up stock prices. (...).²⁸⁰

Microsoft has now abandoned its employee stock option program. It appears that this has been in response to pressure by shareholders in light of the recent corporate governance scandals. But if the accounting problems that precipitated the recent corporate governance crisis had to do with the failure to expense options – what is not consensus at all²⁸¹ - they were brought about by pernicious incentives generated by the granting of stock options to top level executives. And as we have been arguing, these developments should not be generalized as to propose that stock options should be indistinctly considered as to whom they were assigned. Where stock options have become the object of the most severe criticism, they were used to incentivize opportunistic behavior on the part of top executives. We suggest that top executives were poorly incentivized because the myopic focus on agency cost containment in the corporate governance community enabled a culture of runaway executive compensation that could always be justified in terms of the alignment the top executives' interests with that of shareholders.

Any regulation of stock options should therefore take into account the function stock options serve in retaining knowledge necessary to firm structure in some particular settings. Stock options may provide an important governance solution for this purpose.

F. The Case For Employee Voice

In order continually to produce knowledge resources, employees must engage in extensive knowledge sharing. As employees engage in greater independent decision making, performance monitoring and metering, they also necessarily become privy to important privileged and confidential information.

²⁸⁰ William A. Sahlman, *Expensing Options Solves Nothing*, HARVARD BUSINESS REVIEW (Dec. 2002): “Unfortunately, expensing options by subtracting their full Black-Scholes value from income in the year of the grant does not take into account any of the possible benefits of using stock options as part of a human resource management strategy. Accountants would probably say that because it is difficult to predict many of the future benefits, they prefer to err on the side of caution by ignoring the benefits and taking the maximum hit. For this reason, the accounting profession has compiled an extensive record of treating many expenditures that have the potential to improve expected performance over the long term as current-period expenses. Examples include spending on R&D and staff training. Although companies make such investments only when they expect them to boost performance, conservative dogma demands that the financial statements recognize only their cost. But, again, such treatment ends up distorting the picture. And that is particularly true of options. At least with line items like R&D, there is a real cash outlay, ensuring that the impact on income is the same as it is on cash flows. But no such outlay is made when companies distribute stock options.”

²⁸¹ Some commenters argued that the scandals resulted from the failure to disclose conflict of interest transactions *Id.* (“The real accounting scandal at Enron had nothing to do with the failure to expense options. Rather, it related to a failure to disclose something else entirely on both the income statement and the balance sheet. Enron had taken advantage of some very liberal (and economically nonsensical) accounting rules that allowed the company to transfer assets and liabilities to certain so-called special purpose entities (SPEs).”)

The principle of shareholder primacy has been well established in American corporate governance. At the same time, human capital is widely perceived as becoming the key asset in a firm's competitive advantage and business success. Roberts and Steen question how these trends fit together and conclude that shareholder interests may well be promoted by giving employees an active role in corporate governance. The pursuit of shareholder interest, they suggest, "may require ceding a role in corporate governance to employees in order to motivate their investment in firm-specific human capital."²⁸²

The authors explore the implications of the increasing importance of human capital to corporate governance. Meanwhile CEOs state that the primary corporate goal is the maximization of shareholder value, they are increasingly recognizing that the people and the knowledge they develop are the most important assets of the company they run. This presents a conflict with the argument that a more active participation of employees would raise agency costs in a firm structure. Assuming human capital to be firm-specific, the authors demonstrate that if conflicts between executives and shareholders are assumed away, then it is in the enlightened self-interest of the investors to cede a role in governance to employees.²⁸³ It can be in the investors' interests to take measures in order to protect the employees' interests, such as giving employees a claim on the firm's profits, empowering employees to bargain *ex post* for some of the returns from investments in the firm and giving employees' weight in the firm's strategic decisions. The authors suggest that such protections can be assured by means of employee board representation or employee veto power.²⁸⁴

Roberts and Steen thus share some of the prescriptions that would seem to follow from our knowledge-based theory of the firm:

[Such proposals] can be costly for the original owners, who are giving up some of their returns... But as the importance of human capital relative to physical capital increases, **the net attractiveness of including human capitalists in governance increases**. In the limit, if all that matters is human capital, then, from a wealth-maximization perspective, the human capitalists should control the firm and receive all the returns. If the firm were started up from scratch, it would optimally be employee owned. **Even if investor control the firm, they will find it optimal to cede a large role to employees**. This conclusion is consistent with one of the striking stylized facts of corporate governance. In professional service firms, where arguably only human capital matters, ownership and control is typically vested solely in the human capitalists: These firms are overwhelmingly organized along partnership lines.... As well, employee stock ownership is a significant matter in large numbers of knowledge-intensive and human capital-intensive firms, such as software companies. For example, roughly half of Microsoft's shares are held by employees, and more than half of Merrill Lynch's stock is used by employee option schemes.²⁸⁵

Employees who are high-skilled and have expertise and experience should contribute to the improvement of corporate governance. Where employees *understand* the types of problems

²⁸² John Roberts & Eric Van den Steen, *Shareholder Interests, Human Capital Investment and Corporate Governance*, Research Paper No. 1631, Graduate School of Business, Stanford University, 2000.

²⁸³ *Id.*

²⁸⁴ *Id.*

²⁸⁵ *Id.* at 4-5.

that should be solved for more efficient firm production, their participation on the board becomes meaningful.

G. A Recent Example of the Misplaced Emphasis on Agency Costs

Corporate governance scholars have relied on agency cost theory to emphasize the monitoring role of directors.²⁸⁶ In applying agency cost theory, corporate governance experts focus on making the managers, or agents, more responsive to the interests of the shareholders, or principals, of the corporation. On this view, there should be directors that are independent from management in order to monitor the managers in the interests of shareholders.²⁸⁷ The standard approach is to infer that the board independence is going to increase its efficiency. The NYSE listed companies manual requires a majority of independent directors of the board based on such reasoning.²⁸⁸ The same agency cost framework is also responsible for the idea that the monitoring directors should be residual claimants to give them a strong incentive to prevent shirking. This led to the creation of incentive compensation packages that afforded monitoring director's stock options.

Requiring that directors should be independent, however, does not guarantee that directors would be knowledgeable enough to perform their tasks in the best interests of the shareholders. These actors frequently do not have enough relevant information to make informed decisions.²⁸⁹ Current proposals for corporate governance reform aim at improving the information flow in the firm structure, so that the directors receive more information and do so in advance of board meetings.²⁹⁰ However, assuring that independent directors get the information does not guarantee that independent directors will have enough knowledge to understand the information, especially in a time when the division of knowledge is becoming increasingly more technical and specialized.²⁹¹ In many contexts managers have skills, experience, and tacit as well as other in-depth knowledge that is not easily conveyed to, or understood by, outside directors. The knowledge asymmetry between the managers or agents, and those dispatched to

²⁸⁶ Jensen and Meckling, *Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure*, 3 J. Fin. Econ. 306-60 (1976). See Melvin A. Eisenberg, *The Conception that the Corporation Is a Nexus of Contracts, and the Dual Nature of the Firm*, 24 J. CORP. LAW. 819 (1999) (commenting on the influence of Jensen and Meckling in the law and economics literature in corporate law).

²⁸⁷ Eugene Fama, *Agency Problems and the Theory of the Firm*, 88 J. Polit. Econ. 288-307 (1980); Michael Jensen, *The Modern Industrial Revolution, Exit and the Failure of Internal Control Systems*, 48 J. FIN. 831 (July 1993). Gilson and Kraakman, *Reinventing the Outside Director: An Agenda for Institutional Investors*, 43 Stan. L. Rev. 863, 873 (1991) (describing as conventional wisdom the independent outside directors elected by shareholders are should monitor management in the interests of the shareholders); John Kose and Lemma Senbet, *Corporate Governance and Board Effectiveness*, 22 J. of Banking & Finance 371-403 (1998).

²⁸⁸ NYSE Listed Companies Manual, § 303A (“Effective boards of directors exercise independent judgment in carrying out their responsibilities. Requiring a majority of independent directors will increase the quality of board oversight and lessen the possibility of damaging conflicts of interest.”). See also, NASDAQ Rule 4200 requiring a majority of independent directors. Both the NYSE and NASDAQ submitted rule changes to that effect to the SEC in the fall of 2002. The SEC approved the NYSE and NASDAQ corporate governance rules on November 4, 2003.

²⁸⁹ The NYSE rules thus mandate meetings and information exchanges.

²⁹⁰ The NYSE and NASDAQ corporate governance guidelines each have several provisions dealing with director access to relevant information. See also, Calpers' corporate governance guidelines.

²⁹¹ Alanson P. Minkler, *The Problem with Dispersed Knowledge: Firms in Theory and Practice*, 46 KYKLOS 569 (1993). The NYSE guidelines also give a nod in this direction by providing for continuing education for directors and access to consultants.

monitor them in the interests of the principals or shareholders, thus goes beyond the traditional model of information asymmetry that underlies the agency literature.²⁹² This problem of knowledge asymmetry – not merely information asymmetry – has much more serious consequences for corporate governance than is usually assumed.

If the board possess decision rights, and, by hypothesis, the proper motivation, but lacks sufficient knowledge its ability to effectively carry out its monitoring task is restricted. A case must therefore be made that we should be much more concerned with who occupies the position of the independent board member, and what skills, capabilities, or industry experience such a person ought to have. Furthermore, it emerges from this perspective, that “independence” may be as much a liability as it is a benefit.²⁹³ For the independent director is, by increasingly stricter definitions of independence in corporate governance rules and guidelines,²⁹⁴ most deliberately outside the knowledge loop of the firm. Such independence raises additional knowledge transfer problems that impose real costs on the company.

The Sarbanes Oxley Act (“SOA”) has recognized, at least in part, the first concern – that board members require knowledge suitable to their monitoring task – and has written it into the law of public corporations. SOA Section 407(A) requires that “each issuer . . . disclose whether or not, and if not, the reasons therefore, the audit committee of that issuer is comprised of at least 1 member who is a financial expert . . .” While still consistent with the disclosure philosophy of the federal securities laws, the rule makes it all but mandatory that the audit committee of a public company include an individual with financial accounting experience, who must understand Generally Accepted Accounting Principles and financial statements.²⁹⁵ The Senate Report explicitly noted that “[i]nvestors may find it relevant in making their investment decisions whether an issuer’s audit committee has at least once member who “has relevant, sophisticated financial expertise with which to discharge his or her duties.”²⁹⁶

It is of great interest, from our point of view, that the statute suggests, and the initial SEC rule release required, that the financial expert was to have experience with, or knowledge of detailed, *industry-specific* accounting standards for estimates, accruals and reserves of “*a comparable issuer*.”²⁹⁷ Significant controversy concerning this requirement led, during the comment period, to a revised definition that does not require that a person have previous experience in the same industry, or someone familiar with federal Exchange Act reporting requirements. In addition, the type of experience that qualifies an “audit committee financial

²⁹² Armen Alchian and Harold Demsetz, *Production, Information Costs, and Economic Organization*, 62 *American Econ. Rev.* 777 (1972)

²⁹³ In trying to explain why an independent director would have greater incentives to reveal a fraud than an insider, agency cost theorists have resorted to the reputational incentives of expert monitors. Fama, *supra* note ____, ____, ; Fama and Jensen, *Separation of Ownership and Control*, 26 *J. of L. & Econ.* 301 (1983); *see also* Gilson & Kraakman, *Inventing the Outside Director*, 43 *Stan. L. Rev.* 863, 885. But it is hard to see why a CEO, such as Ken Lay, with a reputation second to none, would be less mortified than an outsider by a financial or accounting fraud.

²⁹⁴ *See* NYSE and NASDAQ corporate governance principles.

²⁹⁵

²⁹⁶ *See* SENATE COMM. ON BANKING, HOUSING AND URBAN AFFAIRS, 107TH CONG., PUBLIC COMPANY ACCOUNTING REFORM AND INVESTOR PROTECTION ACT OF 2002, REPORT TO ACCOMPANY S. 2673 TOGETHER WITH ADDITIONAL VIEWS, S. REP. NO. 107-205 (June 26, 2002), at 32.

²⁹⁷ *See*, SEC Rel. No. 33—8138, *available at* www.sec.gov/rules/proposed/33-8138.htm; SEC Rel. No. 33-8177, *available at* www.sec.gov/rules/final/33-8177.htm. *See also*, <http://www.sarbanes-oxley.com/section.php> for discussion of rulemaking and comment on Section 40; John T. Bostelman, *The Sarbanes-Oxley Deskbook* (2005) §§ 11:6.1 – 11:6.4.

expert” is not limited, in the final rules, as it was in the proposed rule, to someone with an accounting background, but includes “other relevant experience.”²⁹⁸

It is easy to see how the choice of the initial, proposed rule would have given greater voice to the concerns raised by our knowledge based theory of the firm. The initial rule acknowledged that effective monitoring and decision making would benefit significantly from industry specific experience and issuer and industry specific and technical accounting skills. The final, adopted rule, ignored considerations of knowledge asymmetry faced by independent directors in favor of traditional agency cost considerations. “Several commenters,” for example, “debated the merits of defining an audit committee financial expert as a person with strong accounting credentials, given that an audit committee member’s role is one of oversight, rather than direct involvement in the company’s accounting functions, and suggested that the emphasis on technical accounting expertise in the definition was misplaced.”²⁹⁹

However, these commenters failed to perceive that a person that does have enough knowledge to understand cannot exercise the oversight role properly, for she will have insufficient monitoring capabilities.

The independence requirement for the audit committee financial expert raised further knowledge transfer issues that cut against the requirement of more context specific, tangible business experience: Certain commenters were thus concerned that “the requirement that a person have had experience with financial statements presenting issues generally comparable to those raised by the company’s financial statements might have anti-competitive effects if we interpreted this requirement to mean that a financial expert would need previous experience with financial statements of other companies in the same industry.”³⁰⁰ In other words, if the outside director had to be from the same industry, while at the same time being an outsider, he would most likely have to have gained his experience, and thus have loyalties, to competitors of the issuer. The independence consideration was thus credited over any industry-specific knowledge considerations.

And yet, the empirical evidence does not show that increased independence of the board improved profitability of poorly performing companies.³⁰¹ Currently almost all American companies have a majority of outside directors, and most have a supermajority with only one or two inside directors. This practice seems to follow the policy recommendations of the agency-cost literature.³⁰² However, empirical studies suggest that boards with too many outsiders might even have a negative impact on firm performance.³⁰³ When the composition of the audit committee in particular is observed, studies also have not found any relation between independence of the members and performance.³⁰⁴

²⁹⁸ See Regulation S-K, Item 401(h)(3) (iv).

²⁹⁹ See *Discussion - Proposed Definition of Audit Committee Financial Expert*, Sarbanes Oxley Website, available at http://www.sarbanes-oxley.com/displaysection.php?level=2&pub_id=SEC-Rules&chap_id=SEC5&message_id=130.

³⁰⁰ *Id.*

³⁰¹ Sanjai Bhagat & Bernard Black, *The Non-Correlation Between Board Independence and Long-Term Firm Performance*, 27 J. Corp. L. 231 (2002).

³⁰² *Id.*, at 232.

³⁰³ *Id.*

³⁰⁴ Julie Cotter & Mark Silvester, *Board and Monitoring Committee Independence*, Abacus, June 2003, at 211, 228-29; April Klein, *Firm Performance and Board Committee Structure*, 41 J.L. & Econ. 275, 287-301 (1998). See Roberta Romano, *The Sarbanes-Oxley Act and the Making of Quack Corporate Governance*, 114 Yale L. J. 1521,

On the other hand, a review of the empirical evidence finds no support for the proposition that less independent boards undermine company performance.³⁰⁵ Some studies find that having a member with financial expertise on the board improves firm performance.³⁰⁶ Moreover, studies that investigated the relation between audit committee composition and accounting statement quality find that complete independence is less significant than expertise.³⁰⁷ Directors who are generalists – even if totally independent – may lack technical financial knowledge necessary to understanding reports and operations presented to them.³⁰⁸ Furthermore, there is evidence that investors value financial expertise in the audit committee. DeFond et al. analyzed the new appointment of 850 board members assigned to audit committees and find that the market reacts favorably to the appointment of directors with accounting financial expertise.³⁰⁹

By allowing for “other relevant experience,” the final SOX rule does allow for some experimentation, but perhaps in the wrong place. It waters down the requirement for the type of tacit knowledge that can only be gained in the relevant specific context in which such knowledge is applicable and that the original rule provided for.³¹⁰ And, in our view, it misleadingly privileges agency-costs prescriptions regarding independence of directors that are not supported by the available empirical evidence.

1530-1533 (analyzing studies on audit committee composition and reporting that the vast majority concludes that complete independence of the committee is not associated with improved performance.)

³⁰⁵ Bhagat & Black, *supra note* __ at 234.

³⁰⁶ Andrew J. Felo et al., *Audit Committee Characteristics and the Perceived Quality of Financial Reporting: An Empirical Analysis* (Apr. 2003) (unpublished manuscript), available at <http://ssrn.com/abstract=401240>. Anup Agrawal & Sahiba Chadha, *Corporate Governance and Accounting Scandals* (Sept. 2004) (unpublished manuscript), available at <http://ssrn.com/abstract=595138>. One study establishes the relationship between corporate hedging and education of the board and audit committee members. Directors with financial education seek more hedging diminishing risk management level. Georges Dionne and Thouraya Triki, *Risk Management and Corporate Governance: The Importance of Independence and Financial Knowledge for the Board and the Audit Committee*. Available in ssrn. See also Adrian Buckley and Mattheus Van Der Nat, *Derivatives and the Non-Executive Director*. *European Management Journal*, vol. 21, n. 3, (2003) (reporting disturbing levels of ignorance among independent directors in matters of derivatives policy).

³⁰⁷ For literature reviews, see Sanjai Bhagat & Bernard Black, *The Uncertain Relationship Between Board Composition and Firm Performance*, 54 *Bus. Law.* 921 (1999); and Roberta Romano, *Corporate Law and Corporate Governance*, 5 *Indus. & Corp. Change* 277 (1996).

³⁰⁸ Dionne & Triki, *supra note* __, at 2.

³⁰⁹ Mark L. DeFond et al. *Does the Market Value Financial Expertise on Audit Committees of Boards of Directors?* Jan. 2002, available in ssrn. (“because it is controversial whether SOX should define financial experts narrowly to include primarily *accounting* financial experts (as initially proposed), or more broadly to include *non-accounting* financial experts (as ultimately passed), we separately examine appointments of each type of expert. We find significantly positive CARs around the appointment of *accounting* financial experts to the audit committee, but not around the appointment of *non-accounting* financial experts or directors without financial expertise.”) at 1.

³¹⁰ Note that Alchian and Demsetz’s theory information asymmetry between agent and principal was modeled on the shop-floor foreman/worker relation, where the foreman had all the relevant knowledge and the worker did not have any knowledge, tacit or otherwise, that the supervisor lacked. The board setting, and the director-manager relation, however, are knowledge intensive settings in which tacit and other sticky knowledge is of the essence, and where many additional considerations, such as for example, the fear of potentially revealing competitive information to outside directors, affect the competence of the board’s decisions.

V. CONCLUSION

Drawing on the new focus of knowledge resources in economics and management, the present paper seeks to provide a new approach to questions of corporate law and corporate governance. We show the intricate relationship between firm structure and the deployment and production of knowledge resources in the production of goods within firms, as well the importance of legal institutions in shaping knowledge transactions inside/outside the firm. This new focus opens up a whole host of interesting avenues of exploration, as our application of the knowledge based theory of the firm to intellectual property protections and to the financial, ownership and governance structure of high tech firms has shown. The present paper merely makes a beginning in this regard.

At the same time, we hope to contribute to the development of the knowledge based theory of the firm in the economics literature. We believe that the typology we have developed for distinguishing different types of knowledge in the production process provides an important new perspective on the development of different types of firms. Organizational economics has already recognized the importance of legal rules to the knowledge structure of firms in the case of patents. The impact of law on knowledge management, however, is much more extensive and will hopefully be of interest to economists.

What is clearly lacking in the monitoring-model of corporate governance, is proper attention to who is in possession of the relevant knowledge and correspondingly well-situated so as to govern or control *successfully* by whatever standard. The legal right to make decisions (including decisions to reign in management misbehavior) remains a formal property without the relevant knowledge to exercise the right skillfully. Therefore, the increased emphasis on outside directors and shareholders as those who ought to be accorded greater legal authority, threatens to lead to a separation of knowledge and control, even as it closes the gap between ownership and control.

Our paper opens a new debate concerning the importance of law and knowledge for firm governance. We have put forward some hypotheses that have to be empirically investigated and theoretically modeled. We hope scholars will be able to enrich our approach, confirming or criticizing the main ideas developed in this paper.