

**DEPARTMENT OF ECONOMICS  
COLLEGE OF BUSINESS AND ECONOMICS  
UNIVERSITY OF CANTERBURY  
CHRISTCHURCH, NEW ZEALAND**

**The (non)Theory of the Knowledge Firm**

by Paul Walker

***WORKING PAPER***

**No. 07/2008**

**Department of Economics  
College of Business and Economics  
University of Canterbury  
Private Bag 4800, Christchurch 8140  
New Zealand**

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## The (non)Theory of the Knowledge Firm

by Paul Walker<sup>†</sup>

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**Abstract:** This paper argues that the mainstream approaches to the theory of the firm do not provide a theory of the human capital based or knowledge based firm. We examine the textbook (neoclassical) theory of the firm, the transaction cost model, the incentive-system approach and the Grossman Hart Moore approach to the firm and argue that none of them are able to fully capture the changes to the firm that the movement towards a knowledge economy entails. We also consider the effects of knowledge on the location of production.

**Keywords:** theory of the firm, knowledge economy, human-capital based firm

**JEL Classification Codes:** L14, L23

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<sup>†</sup> The author is a PhD. student in the Department of Economics, University of Canterbury, College of Business and Economics, University of Canterbury, Private Bag 4800, Christchurch 8140, New Zealand. E-mail [paul.walker@canterbury.ac.nz](mailto:paul.walker@canterbury.ac.nz).

“... little research to date has generated deep understand of the relationship between organizations and the digital economy ...”.

Orlikowski and Iacono (2000: 365)

## 1 Introduction

John Kay makes the point that “[i]t is a cliché that we live today in a knowledge economy” (Kay 2005: 266).<sup>1</sup> In recent years it has become common for politicians and commentators to argue that changes in technology, in particular information and communication technology (ICT), have become the major driver of economic growth. The then Assistant to the President for Science and Technology, Neal Lane, said in April 1999 that

“[t]he digital economy—defined by the changing characteristics of information, computing, and communications—is now the preeminent driver of economic growth and social change.” (Quoted in Brynjolfsson and Kahin 2000: 1).

Many commentators argue that the effects of ICTs are so pervasive through out the economy that we are now in a “new economy”. Alcaly (2003: 4), for example, argues that

“... much is new about this new economy, particularly its signature information technology, the broad combination of technical equipment and know-now that enables us to process, store, and transmit information more efficiently. There have also been significant changes in the ways businesses operate, in the extent of trade and economic integration among nation—globalization—an in the influence and inventiveness of financial markets, including the stock and junk-bond markets.”

For Alcaly the new economy developed in response to pressures from the application of information technologies in conjunction with increased global competition, deregulation and financial innovation. These factors have altered the whole business environment. Coyle (2001: 230) notes that,

“[t]echnology means the boundaries between what used to be different markets are more fluid, so your new competitor might be from a business you used to think of as entirely different from yours.”

Change is affecting not just markets but also firms within those markets. Rajan and Zingales (2003: 80) argue,

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<sup>1</sup>Sometimes also called the information economy or the digital economy or the weightless economy

“[i]ncreased competition, changes in technology, and widespread access to finance have reduced the advantages of the large, vertically integrated firm. We should therefore expect the largest firms to have shrunk. This is indeed the case.”

They go on to point out that these same factors have also affected the relationship between physical and human capital in firms creation of value and this is changing the organisational structure of the firm.

“Human capital is replacing inanimate assets as the most important source of corporate capabilities and value. In both their organizational structure and their promotion and compensation policies, large firms are becoming more like professional partnerships.” (Rajan and Zingales 2003: 90)

Further, Rajan and Zingales (2003: 87) argue that we are in fact seeing a new “kinder, gentler firm”. This is in response to the changing balance of power within firms following on from the increasing importance of the worker. In Rajan and Zingales’s view

“[t]he single biggest challenge for the owners or top management today is to manage in an atmosphere of diminished authority. Authority has to be gained by persuading lower managers and workers that the workplace is an attractive one and one that they would hate to lose. To do this, top management has to ensure that work is enriching, that responsibilities are handed down, and rich bonds develop among workers and between themselves and workers” (Rajan and Zingales 2003: 87).

That firms are changing matters because firms are the institutional structure within which most economic activity takes place and so as they change much of our economic lives change. Herbert Simon (1991: 27) makes this point about the importance of firms by asking us to envision a mythical visitor from Mars. This visitor approaches Earth from space equipped with a telescope which reveals social structures. What our visitor’s telescope would display is, according to Simon, that firms are the “dominant feature of the landscape”. For Simon the view that our visitor would get of the developed world or parts of the old Soviet Union or areas of urban China or urban India is one where most of the economic activity takes place, not within markets or self-sufficient households, but within the framework of firms. Roberts (2004: 77-8) explains that

“[i]n fact, John McMillan (2002: 168-9) estimates that less than a third of all the transactions in the U.S. economy occur through markets, and instead over 70 percent are within firms.”

But despite the obvious empirical importance of the firm, when our visitor turns its attention to an overview of the theory that purports to explain this “dominant feature of the landscape”, its survey would reveal a somewhat peculiar looking theoretical terrain. As Oliver Hart has written

“An outsider to the field of economics would probably take it for granted that economists have a highly developed theory of the firm. After all, firms are the engines of growth of modern capitalistic economies, and so economists must surely have fairly sophisticated views of how they behave. In fact, little could be further from the truth. Most formal models of the firm are extremely rudimentary, capable only of portraying hypothetical firms that bear little relation to the complex organizations we see in the world. Furthermore, theories that attempt to incorporate real world features of corporations, partnerships and the like often lack precision and rigor, and have therefore failed, by and large, to be accepted by the theoretical mainstream.” (Hart 1989: 1757).

While Hart’s point is made with reference to the orthodox view of theory of the (physical capital based) firm it applies with even greater vengeance when we consider the (human capital based) firm relevant to the knowledge or information economy. None of the textbook (neoclassical) model or the transaction cost model or the incentive-system approach or the Grossman Hart Moore (GHM) approach to the firm are able to fully capture the changes to the firm that the movement towards a knowledge economy entails. As knowledge becomes more important in the economy so human capital becomes more important to the firm and physical capital relatively less so. The major asset of a knowledge firm is their workers’ human capital. Crucially this increases the worker’s importance and thus improves their outside options and therefore changes the power relationships within the firm. Firm’s organisational structures are changing to reflect this new reality. On the other hand the orthodox theories of the firm are, in the main, silent about the changes that this increase in the importance of human capital is bringing about. This essay will examine these theories in an attempt to delineate the reasons for this silence.

The rest of the essay proceeds as follows. The mainstream approaches to the firm, and their shortcomings with regard to the human capital based firm, are analysed in sections 2 to 5. Section 2 will discuss the neoclassical model, section 3 covers the transaction cost approach, section 4 looks at the incentive-system theory while section 5 considers the Grossman Hart Moore model along with two extensions to the GHM approach. Section 6 looks at the effects that the division of knowledge has on the location of production and section 7 is the conclusion.

## 2 The neoclassical theory of the firm

The model of the “firm” found in most microeconomic textbooks does not incorporate knowledge – individual or institutional – or the knowledge worker; it can’t since it isn’t a “theory of the firm” in any meaningful sense. The output side of the standard neoclassical model is a theory of supply rather than a true theory of the firm. Many would date the beginning of a serious theory of the firm as recently as Knight (1921) or Coase (1937), rather than to the earlier neoclassical revolution.<sup>2</sup> Before the contributions of Knight and Coase, we had discussions of pin factories, but the discussion was about the importance of the division of labour rather than being an ‘enquiry into the nature and causes of the firm’. As has been pointed out by Demsetz (1982, 1988 and 1995) before Knight and Coase – and it could be added for much of the period after them – the fundamental preoccupation of economists was with the (knowledgeless) price system and hence little, or no, attention was paid to either the firm or the consumer as separate, important, economic entities. Firms (and consumers) existed as handmaidens to the price system.

The interest in the price system, culminating in the “perfect competition” model, has its intellectual origins in the eighteenth-century debate between free traders and mercantilists. This debate was, to a large degree, about the proper scope of government in the economy and the model it gave rise to reflects this. The central question of the debate was, Is central planning necessary to avoid the problems of a chaotic economic system? Adam Smith famously answered “no”.<sup>3</sup> Smith

“... realised that social harmony would emerge naturally as human beings struggled to find ways to live and work with each other. Freedom and self-interest need not lead to chaos, but – as if guided by an ‘invisible hand’ – would produce order and concord.

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<sup>2</sup>O’Brien (1984: 25) takes a contrary position: “[s]erious discussion of the history of the theory of the firm has to start with Alfred Marshall.” O’Brien’s argument is based, in the main, on Marshall (1920). O’Brien also argues that developments subsequent to Marshall have resulted in many of Marshall’s insights being lost to succeeding generations of economists. We would therefore argue that Marshall has left little in the way of a legacy in terms of the mainstream theory of the firm. In addition to his views on Marshall’s work and later developments O’Brien also argues that any “attempt to construct a pre-Marshallian theory from the materials available is likely to be unsuccessful.” See, however, Williams (1978) for such an attempt. On the neglect of Marshall’s ‘Industry and Trade’ (Marshall 1920) see also Liebhafsky (1955). The development of the “theory of the firm” from Marshall to Robinson and Chamberlin is also dealt with in Moss (1984).

<sup>3</sup>According to Smith the government has three duties: “[t]he first duty of the sovereign, that of protecting the society from the violence and invasion of other independent societies . . .”. Smith (1776: Book V, Chapter 1, Part First, page 689). “The second duty of the sovereign, that of protecting, as far as possible, every member of the society from injustice or oppression of every other member of it, or the duty of establishing an exact administration of justice, . . .”. Smith (1776: Book V, Chapter 1, Part II, page 709). “The third and last duty of the sovereign or commonwealth is that of erecting and maintaining those publick institutions and those publick works, which, though they may be in the highest degree advantageous to a great society, are, however, of such a nature that the profit could never repay the expense to any individual or small number of individuals, and which it therefore cannot be expected that any individual or small number of individuals should erect or maintain” Smith (1776: Book V, Chapter 1, Part III, page 723). For a fuller discussion of Smith’s view on the role of government see Kennedy (2005).

They would also bring about the most efficient possible use of resources. As free people struck bargains with others – solely in order to better their own condition – the nation’s land, capital, skills, knowledge, time, enterprise and inventiveness would be drawn automatically and inevitably to the ends and purposes that people valued most highly. Thus the maintenance of a prospering social order did not require the continued supervision of kings and ministers. It would grow organically as a product of human nature” (Butler 2007: 27-8).

For Smith, markets are the most prominent mechanism for solving the problems of coordination and motivation that arise with interdependencies of specialisation and the division of labour. Market institutions leave individuals free to pursue self-interested behaviour, but guide their choices by the prices they pay and receive. The following 200 hundred years amounted to a closer examination of what conditions would be sufficient for the price system to avoid chaos.

The formal model that arose from this examination is one which abstracts completely from any form of centralised control in the economy. It is a model delineated by “perfect decentralisation”. Authority, be it in the form of a government or a firm or a household, plays no role in coordinating resources. The only parameters guiding decision making are those given within the model – tastes and technologies – and those determined impersonally on markets – prices. All parameters are outside the control of any of the economic agents and this effectively deprives all forms of authority a role in allocation. This includes, of course, the firm. It doesn’t matter whether it is general equilibrium, characterised by Walras’s auctioneer, or partial equilibrium, characterised by Marshall’s representative firm, there is no serious consideration given to the firm as a problem solving institution.

In neoclassical theory, the firm is a ‘black box’ there to explain how changes in inputs lead to changes in outputs. The firm is a conceptualisation that represents, formally, the actions of the owners of inputs who place their inputs in the highest value uses, and makes sure that production is separated from consumption. The firm produces only for outsiders, there is no on-the-job or internal consumption, no self-sufficiency. In fact there are no managers or employees to indulge in on the job consumption and as production is separated from consumption, no self-sufficiency. Production for outsiders is, according to Demsetz (1995), the definition of a firm in the neoclassical model:

“[w]hat is needed is a concept of the firm in which production is exclusively for sale to those formally outside the firm. This requirement defines the firm (for neoclassical

theory), but it has little to do with the management of some by others. The firm in neoclassical theory is no more or less than a specialized unit of production, but it can be a one-person unit” (Demsetz 1995: 9).

As inputs are combined in the optimal fashion by the actions of independent owners of inputs motivated solely by market prices, there is no need for ‘management of some by others’, there is no role for managers or employees. Also note that as competition assures the absence of profits and losses in equilibrium, there is no need to have a residual claimant. This means that, in one sense at least, there are no owners of the firm.<sup>4</sup> As there are no physical assets controlled by the firm, there are no (residual) control rights over these assets to allocate. This implies there are no owners of the firm in the Grossman Hart Moore sense (see section 5).

The neoclassical production function is a way of representing the (efficient) black box conversion of inputs into outputs but tells us little about the inner workings of the black box. The production function is independent of the institutional framework of output creation. It can be given two interpretations: it can represent the production method of a single firm, of which all known firms are just divisions or, equally, it could represent the outcome of a series of purely market based transactions which give rise to the observed outputs.<sup>5</sup> Thus it represents the ‘firm’ without explaining the ‘firm’. The boundaries of the firm is an issue described by Williamson (1993: 4) as one of

“...make-or-buy. What is it that determines which transactions are executed how? That posed a deep puzzle for which the firm-as-production function approach had little to contribute.”

Hart (1995: 17) criticises the neoclassical model based on three characteristics of the theory. First, he notes that the theory completely ignores incentive problems within the firm. The firm is a perfectly efficient ‘black box’. Second, the theory has nothing to say about the internal organisation of the firm. Nothing is said about the hierarchical structure, how decisions are made, who has authority within a firm. Third, the theory tells us nothing about how to pin down the boundaries of the firm. The theory is as much a theory of plant or division size as firm size. As Hart points out

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<sup>4</sup>Hansmann (1996), for example, states “[a] firm’s ‘owners,’ as the term is conventionally used and as it will be used here, are those persons who share two formal rights: the right to control the firm and the right to appropriate the firm’s profits, or residual earnings (that is, the net earnings that remain with the firm after it has made all payments to which it is contractually committed, such as wages, interest payments, and prices for supplies).” (page 11) He later adds “[n]ot all firms have owners. In nonprofit firms, in particular, the persons who have control are barred from receiving residual earnings.” (page 12)

<sup>5</sup>This second interpretation is more inline with the Demsetz argument.



“[t]o put it in stark terms . . . neoclassical theory is consistent with there being one huge firm in the world, with every existing firm . . . being a division of this firm. It is also consistent with every plant and division of an existing firm becoming a separate and independent firm” (Hart 1995: 17).

Cyert and Hedrick (1972) addressed similar points. They argue that in the neoclassical system the firm doesn't exist, that no real world problems of firms are considered, that there are no organisational problems or any internal decision-making process at all.

“In one sense the controversy over the theory of the firm has arisen over a non-existent entity. The crux of microeconomics is the competitive system. Within the competitive model there is a hypothetical construct called the firm. This construct consists of a single decision criterion and an ability to get information from an external world, called the “market” [8, Cyert and March, 1963, pp. 4-16]. The information received from the market enables the firm to apply its decision criterion, and the competitive system then proceeds to allocate resources and produce output. The market information determines the behavior of the so called firm. None of the problems of real firms can find a home within this special construct. There are no organizational problems nor is there any room for analysis of the internal decision-making process” (Cyert and Hedrick 1972: 398).

Thus within the neoclassical model of the price system, the firm's only role is to allow input owners to convert inputs into outputs in response to market prices. Firms have no internal organisation since they have no need of one, they have no owners since there is nothing to own. Questions about the existence, definition and boundaries of the firm are to a large degree meaningless within this framework since firms, by any meaningful definition of that term, don't really exist. As Foss, Lando and Thomsen (1998) summarise it:

“The pure analysis of the market institution leaves almost no room for the firm (Debreu 1959). Under the assumption of a perfect set of contingent markets, as well as certain other restrictive assumptions, the model describes how markets may produce efficient outcomes. The question how organizations should be structured does not arise, because market-contracting perfectly solves all incentive and coordination issues. By assumption, firm behaviour (profit maximization) is invariant to institutional form (e.g. ownership structure). The whole economy can operate efficiently as one great system of markets, in which autonomous agents enter into very elaborate

contracts with each other. However, by treating the firm itself as a black box, where internal structure, contracts, etc. disappear from the picture, there are many other issues that the theory cannot address. For example, the theory does not tell us why firms exist” (Foss, Lando and Thomsen 1998: 1-2).

Given there is no serious modelling of the firm, there is no way to deal with the knowledge firm within this framework. There are no organisational problems or any internal decision-making process, in fact, there is no organisational structure at all and thus the advent of the knowledge economy can not alter this nonexistent structure. As there is no role for managers or employees there can be no knowledge workers in the firm. But the growth in knowledge workers is one of the most important aspects in the development of the knowledge society. And their advent will change the way we think about firms.

### **3 The transaction cost approach**

The recognition that writing a contract is in and of itself costly lies at the heart of the large and growing literature on the transaction cost approach to the firm. This literature has been developed by, among others, Williamson (1975, 1985, 1996) and Klein, Crawford and Alchian (1978). Coase (1937) started the transaction cost approach by making a simple, but important point, there are costs to carrying out market transactions. Costs, which today, are called transaction costs,

“[w]hat the prices are have to be discovered. There are negotiations to be undertaken, contracts have to be drawn up, inspections have to be made, arrangements have to be made to settle disputes, and so on.” (Coase 1992: 715).

Roberts (2004: 90) defines transaction costs as

“... the costs of finding and qualifying trading partners, of establishing specifications and prices, of negotiating and drafting contracts, and of monitoring and enforcing agreements. They are also the opportunity costs of lost benefits that are occasioned by the difficulties of developing complete, enforceable agreements between separate parties.”

Transaction cost economics is based the ideas of bounded rationality – intendedly rational, but only limitedly so – and opportunism – self-interest with guile. Two consequences of these assumptions is that contracts will be incomplete and contracts may not be honoured. Hart (1995:

23) argues that in transaction cost economics contracts are incomplete for three reasons, all of which are, in his view, forms of bounded rationality.

“First, in a complex and highly unpredictable world, it is hard for people to think very far ahead and to plan for all the various contingencies that may arise. Second, even if individual plans can be made, it is hard for the contracting parties to negotiate about these plans, not least because they have to find a common language to describe states of the world and actions with respect to which prior experience may not provide much of a guide. Third, even if the parties can plan and negotiate about the future, it may be very difficult for them to write their plans down in such a way that, in the event of a dispute, an outside authority – a court, say – can figure out what these plans mean and enforce them. In other words, the parties must be able to communicate not only with each other, but also with outsiders who may have little knowledge about the environment in which the contracting parties operate.”

But why do incomplete contracts matter? If parties to a contract can renegotiate the contract, and thus fill in any gaps, why does contractual incompleteness matter? First, there may be costs to haggling over the terms and conditions of the new contract. Haggling over the division of surpluses is inefficient in that it is time-consuming and wastes resources while serving no productive purpose. Second, informational asymmetries may prevent the parties from reaching an efficient outcome. Assume the buyer of an input does not know the actual cost of the input but only knows the probability distribution from which the costs are drawn. The seller of the input knows the true cost. Supply of the input can be ensured by a high price offer from the buyer. If the buyer wants to cover the seller’s costs with probability one then this could be an expensive option as the buyer will be overpaying in the low cost states of the world. If a low price offer is made then the seller will not supply in the high cost states of the world and so profit maximising behaviour by the buyer may lead to profitable trades not taking place.<sup>6</sup> An important point here is that if switching to a new trading partner at the renegotiation stage was easy then neither of these two costs would be significant. Thus for these costs to be high there must be something preventing the switching to a new trading partner. That ‘something’ is normally taken to be ex ante relationship-specific investment. In other words, a prior investment whose value is greatest

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<sup>6</sup>Assume the buyer values the input at 1. The seller’s costs are  $\frac{1}{2}$  or 1, each with probability  $\frac{1}{2}$ . An offer by the buyer of 1 ensures supply in all states of the world but results in zero profits for the buyer. An offer of  $\frac{1}{2}$  results in non-supply in the high cost states of the world but profits of  $1 - \frac{1}{2} = \frac{1}{2}$  in the low cost states of the world. Thus the low price, trade only  $\frac{1}{2}$  the time offer is more profitable than the high price, trade at all times offer and therefore profitable trades don’t take place.

when the contracting parties relationship extends over time but for which little or no value is created if the parties relationship breaks down. Such investments are normally thought of as investment in physical capital but as Roberts (2004: 91) points out,

“[f]irm-specific human capital—knowledge that is only (or especially) valuable in the context of employment with a particular firm—is another example.”

Relationship-specific investments result in there being a third cost of incomplete contracts. It may be that because contracts are incomplete parties are deterred from making efficient relationship-specific investments. In a comprehensive contracts world, relationship-specific investments could be protected by enforceable contracts. In an incomplete contracts world this may not be possible. Parties will recognise that any long-term contract between them will be incomplete. This could be because of problems such as being unable to specify far in advance the quality and quantity of the goods traded. This incompleteness will mean the contract will be subject to renegotiation. Even in a situation where problems of haggling and asymmetric information don't arise the gains from trade will have to be divided and this division will depend on the ex post bargaining strengths of the parties rather than on what is written in the contract or on the grounds of economic efficiency. This raises the fear that one party could be exploited by another. For example, an input supplier, who has made (sunk) relationship specific investments, may worry that the buyer will take advantage of these investments to drive the price he pays for the input down to around variable cost, so there is little or no contribution to covering the investment costs. But it is still not worthwhile for the supplier to stop supplying the buyer. This is simply because the sunk investment costs have to be paid whether or not supply takes place, and the asset has no other profitable use. This exploitation of quasi-rent – returns greater than what is required to keep asset in its current use once it has been created – is the classic “hold-up” problem.

Realising that such exploitation could occur may result in the supplier being unwilling to undertake the investment in the first place. Thus the buyer, if he wants the input supplied at all, may have to produce it himself. The buyer could purchase the supplier, i.e. vertically integrate with the supplier, thereby making the supplier part of the buyers firm. This eliminates the hold-up problem since the quasi-rents now accrue to the buyer. Use of the investment asset is now directly under the control of the buyer and all costs of and benefits from investment have been internalised. The investment decision is now just part of the buyers profit maximisation problem.

This argument that vertical integration deals with the hold-up problem is strongest when the assets involved are physical. The argument is less applicable to relationship-specific investments in human capital. As human capital can not be owned, by anyone other the particular individual acquiring it, the potential for opportunistic behaviour still exists even after vertical integration. The buyer does not have control over the human capital in the way he does over the physical capital. The individual who invests in the relationship-specific human capital still controls that capital even after becoming part of the buyer’s firm and thus they can still hold-up the buyer. Thus the explanation for the existence of firms as the answer to hold-up problems, related to relationship-specific investments, doesn’t hold for the case of a human capital only firm.

## 4 The incentive-system theory

This approach to the theory of the firm was developed by Holmstrom and Milgrom (1991, 1994); Holmstrom and Tirole (1991) and Holmstrom (1999) and has been described by Gibbons (2005: 206) as an “accidental theory of the firm”. The reason for Gibbons description is that focus of these papers was not on the make-or-buy problem of the transaction cost or Grossman Hart Moore approaches but rather on a multi-task, multi-instrument principal-agent problem and its application to the firm was an “accidental” outcome of this endeavour.

To analyse the application of this theory to the knowledge firm we will take advantage of Gibbons (2005: 210-2) “stick-figure rendition” of the theory. In the simple Gibbons model there is a technology of production which is a linear combination of the Agent’s actions:  $y = f_1a_1 + f_2a_2 + \varepsilon$  where the  $a_i$ s are actions chosen by the Agent and  $\varepsilon$  is a noise term. Evaluation of performance by the Agent is based upon the indicator  $p$  which is a different linear combination of the Agent’s actions:  $p = g_1a_1 + g_2a_2 + \phi$ , where  $\phi$  is another noise term. Gibbons assumes that both parties are risk-neutral,  $\omega$  is the total compensation paid by the Principal to the Agent and  $c(a_1, a_2)$  represents the Agent’s cost function. Gibbons makes the assumption that,

$$c(a_1, a_2) = \frac{1}{2}a_1^2 + \frac{1}{2}a_2^2.$$

In addition Gibbons assumes that the Principal and the Agent sign a linear contract,  $\omega = s + bp$ , based upon the performance indicator  $p$ .

To provide a theory of the firm this model has to be extended to include physical capital, a machine, which is used by the Agent during the production of  $y$ . Post production this capital

has a value determined by a third linear combination of the Agent's actions:  $v = h_1 a_1 + h_2 a_2 + \xi$  where  $\xi$  is a third noise term. The choice variables in the model are therefore the Agent's actions  $a_i, i = 1, 2$  and  $b$  the slope of the optimal contract. As a point of comparison note that the first-best actions of the Agent are those which maximise the expected total surplus, that is, they will maximise the expected value of the sum of the Principal's payoff,  $y - \omega$ , the Agent's payoff,  $\omega - c(a_1, a_2)$  and the value of the physical asset,  $v$ .

$$\begin{aligned}
TS^{FB} &= E(y - \omega + \omega - c(a_1, a_2) + v) \\
&= E(y + v) - c(a_1, a_2) \\
&= E(f_1 a_1 + f_2 a_2 + \varepsilon + h_1 a_1 + h_2 a_2 + \xi) - c(a_1, a_2) \\
&= f_1 a_1 + f_2 a_2 + h_1 a_1 + h_2 a_2 - c(a_1, a_2) \text{ assuming } E(\varepsilon) = E(\xi) = 0 \\
&= f_1 a_1 + f_2 a_2 + h_1 a_1 + h_2 a_2 - \frac{1}{2} a_1^2 + \frac{1}{2} a_2^2
\end{aligned}$$

and therefore  $a_1^{FB} = f_1 + h_1$  and  $a_2^{FB} = f_2 + h_2$ .<sup>7</sup>  $TS^{FB}$  is independent of the value of  $b$ .

If the Principal owns the machine then the Agent is an employee of his firm and the Principal's payoff is  $y + v - \omega$ , while the Agent's payoff is  $\omega - c$ . In this case the Agent's optimal actions maximise

$$\begin{aligned}
E(\omega) - c(a_1, a_2) &= E(s + bp) - \frac{1}{2} a_1^2 + \frac{1}{2} a_2^2 \\
&= E(s + b(g_1 a_1 + g_2 a_2 + \phi)) - \frac{1}{2} a_1^2 + \frac{1}{2} a_2^2 \\
&= s + b g_1 a_1 + b g_2 a_2 - \frac{1}{2} a_1^2 + \frac{1}{2} a_2^2 \text{ assuming } E(\phi) = 0.
\end{aligned}$$

The optimal actions are therefore,  $a_{1E}^*(b) = b g_1$  and  $a_{2E}^*(b) = b g_2$ .<sup>8</sup> The efficient contract slope,  $b_E^*$ , maximises the expected total surplus,  $E(y + v) - C(a_1, a_2)$  or

$$TS_E(b) = (f_1 + h_1) a_{1E}^*(b) + (f_2 + h_2) a_{2E}^*(b) - \frac{1}{2} a_{1E}^*(b)^2 + \frac{1}{2} a_{2E}^*(b)^2.$$

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$$\begin{aligned}
\frac{\partial TS^{FB}}{\partial a_i} &= 0 \\
\Rightarrow f_i + h_i - a_i &= 0 \\
\Rightarrow a_i^{FB} &= f_i + h_i
\end{aligned}$$

8

$$\begin{aligned}
\frac{\partial E(\omega) - c(a_1, a_2)}{\partial a_i} &= 0 \\
\Rightarrow b g_i - a_i &= 0 \\
\Rightarrow a_i^*(b) &= b g_i
\end{aligned}$$

Alternatively the machine can be owned by the Agent. Gibbons interprets this case as the Agent being an independent contractor. In this situation the payoffs for the Principal will be  $y - w$  and for the Agent they are  $w + v - c$ . The optimal actions for the Agent will therefore be,  $a_{1C}^*(b) = g_1b + h_1$  and  $a_{2C}^*(b) = g_2b + h_2$ .<sup>9</sup> For this case the efficient slope,  $b_C^*$ , will maximise the expected total surplus of

$$TS_C(b) = (f_1 + h_1)a_{1C}^*(b) + (f_2 + h_2)a_{2C}^*(b) - \frac{1}{2}a_{1C}^*(b)^2 + \frac{1}{2}a_{2C}^*(b)^2.$$

Gibbons (2005: 211) summaries the analysis so far as

“...having the Agent own the asset causes the Agent to respond to a given contract slope ( $b$ ) differently than when the Agent does not own the asset [i.e.  $a_{iE}^*(b) \neq a_{iC}^*(b)$ ], so the make-or-buy problem amounts to determining which of the Agent’s best-response functions – that of the employee,  $(a_{1E}^*(b), a_{2E}^*(b))$ , or that of the independent contractor,  $(a_{1C}^*(b), a_{2C}^*(b))$  – allows the parties to achieve greater total surplus.”

The discussion so far has relied on an unspecified assumption. This being that the value of the asset is not contractible and therefore the owner of the asset receives its value. Since the asset’s value is not contractible putting ownership in the hands of the Agent provides him with incentives that cannot be replicated via a contract. But providing the Agent with the incentive to increase the value of the asset may or may not help the Principal control the Agent’s incentives via contract. That is, if the Agent owns the asset he has two sources of incentives, the asset’s post-production value and contracted for performance. Without ownership he concentrates solely on the contracted for performance. Integration would be efficient, that is, having the Principal own the asset is efficient, when having the Agent do so hurts the Principal’s efforts to create incentives via contract.

When we turn to consider the case where the additional capital in the model isn’t a machine but is human capital, as would be important in a knowledge firm, an important difference arises. Critically, ownership can no longer be transferred, as it can in the physical capital case. If the asset is a human capital asset then, without slavery, ownership can not be transferred, it must remain with the person who made the investment in the first place. Also, as above, the non contractible of the asset’s value means the Principal and the Agent can not transfer the value

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<sup>9</sup>  $E(\omega + v) - c(a_1, a_2) = E(s + b(g_1a_1 + g_2a_2 + \phi) + h_1a_1 + h_2a_2 + \xi) - \frac{1}{2}a_1^2 + \frac{1}{2}a_2^2$   
 $= s + bg_1a_1 + bg_2a_2 + h_1a_1 + h_2a_2 - \frac{1}{2}a_1^2 + \frac{1}{2}a_2^2$  assuming  $E(\phi) = E(\xi) = 0$ .

The first order conditions are therefore of the form,  $bg_i + h_i - a_i = 0$  which gives  $a_{iC}^*(b) = g_ib + h_i$ ,  $i = 1, 2$ .

of the asset as part of a contract. So in contrast to the physical asset case, with a human asset, neither ownership nor value can be transferred. Thus if the Agent (Principal) makes an investment the value of the investment stays with the Agent (Principal) not matter what the form of the relationship between the Principal and the Agent. Importantly asset ownership can no longer determine whether the Agent is an employee or a contractor. Therefore a human asset can not serve as an instrument in the incentive problem in the same way as a physical asset. This means that the incentive-system theory (in the telling above) can not act as a model of a human capital based firm.

## 5 The Grossman Hart Moore approach

A more recent theory of the firm is based on the work of Grossman and Hart, (1986, 1987) and Hart and Moore (1990).<sup>10</sup> Within the GHM approach ownership is defined in terms of residual control over non-human assets, things such as machinery, inventories, buildings, patents, client lists, firm's reputation etc. Owner—managers employ labour that cannot work without the physical capital these firms own. Dismissal\resignation of the labour requires them to find other physical capital owning organisations (firms) to employ them. On liquidation of the firm, physical capital can be sold and the proceeds disbursed to the owners (shareholders). The standard theory of the firm is based on the role of non-human capital in the firm. The definition of a firm, the determinants of the boundaries of a firm – that is, the determinants of vertical integration of firms, the meaning of ownership of the firm, the nature of authority within the firm are all functions of control rights over the firm's non-human assets. Making non-human assets the centre of the theory means that questions to do with the ownership and control of the physical information technology can be addressed but this concentration on non-human assets means that the theory doesn't deal with firms based on human assets. However it had noted from the beginning that the theory could be extended to include human capital. As Hart (1988: 151) argues:

“...one difference with previous work is the emphasis on how integration changes control over physical assets. This is in contrast to Coase's 1937 paper which focuses on the way integration changes an ordinary contractual relationship into one where an employee accepts the authority of an employer (within limits). Note that these

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<sup>10</sup>Introductions to this literature, of varying technical sophistication, can be found in Hart (1988, 1989, 1995) and Moore (1992).



approaches are not contradictory. Authority and residual rights of control are very close and there is no reason why our analysis of the costs and benefits of allocating residual rights of control could not be extended to cover human, as well as physical, assets.”

But this extension isn't entirely satisfactory.

Once we move to a situation where firms may own\need little physical capital, then the modern theory of the firm loses much of its main reason for being. Once human capital (labour) becomes the most important\sole creator of wealth\value added then modern economic theory is in need of modification. The theory does not, however, lose all relevance. As Hart (1995: 56-7) explains, at least some, nonhuman assets are essential to a theory of the firm. To see why this may be so consider a situation where 'firm' 1 acquires 'firm' 2, which consists entirely of human-capital. The question Hart raises is, What is to stop firm 2's workers from quitting? Without any physical assets—e.g. buildings—firms 2's workers would not even have to relocate themselves physically. If these workers were linked by telephones or computers, which they themselves own, they could simply announce one day that they had decided to become a new firm. For the acquisition of firm 2 by firm 1 to make economic sense there has to be a source of value in firm 2 over and above the human-capital of the workers. It makes little sense to buy a 'firm' if that 'firm' can just get up and walk away. Hart argues there must be some 'glue' holding firm 2's workers in place.

The value which acts as this glue may consist of as little as a place to meet; the firm's name, reputation, or distribution network; the firm's files, containing important information about its operations or its customers; or even a contract that prohibits firm 2's workers from working for competitors or from taking existing clients with them should they quit. The source of value may even just represent the difficulty firm 2's workers face in co-ordinating a move to another firm. But, Hart points out, without something binding the firm together, the firm becomes a phantom, and as such we should expect that such firms would be flimsy and unstable entities, constantly subject to the possibility of break-up or dissolution.

Thus even a human-capital based firm will involve some nonhuman-capital, but the human-capital will play the dominate role. The important characteristic of human-capital is that it embodies information and knowledge. A theory of the human-capital based firm has to model this co-existence of the human and nonhuman-capital. Brynjolfsson (1994) deals with the issue by extending the property rights approach to the firm to include information whether this information is embodied in humans, in the form of human-capital, or in artifacts. Rabin (1993)

also works within the property rights framework but extends it by assuming that an agent has information about how to make production more productive which they are willing to sell. The problem is if the information is not revealed before the agent is paid, a (potential) buyer may have little reason to believe the agent is truly well-informed, but if the agent reveals the information up front, the buyer could simply use the information without payment. Rabin's answer is that the informed agent gains control over productive assets and thus doesn't have to sell the information. We look at these two papers below.

If the firm comprises human capital resources (eg., a legal or accounting firm) whose accumulated knowledge is the source of wealth, creation the balance of power stemming from the "ownership of the means of production", has changed. Likewise predictions about what would happen at the dissolution of a knowledge-firm, is also unclear. Who has the rights to the sell-off of the assets, where these assets are embodied in human beings? How can these assets be sold-off? These issues, although important in the context of the economic theory of the firm may have less importance when trying to measure the size\scale of the knowledge economy. However they are likely to have profound effects on the idea of a Knowledge Society where the balance of (economic) power will change - owners of physical capital losing this to owners of human capital, which without slavery map one-to-one to each individual. An individual's own economic power would likely vary with their different stocks of human capital as would the price they charge to hire it to others in the form of employment. This in turn affects who wins and who loses from the knowledge society.

In Brynjolfsson's model he considers an entrepreneur who has some expertise needed to run a firm. No value can be created without both the knowledge asset of the entrepreneur and the physical assets of the firm. He assumes that no comprehensive contract can be written between the entrepreneur and the firm. If the entrepreneur doesn't own the firm, then if he makes an investment in effort and creates value he can be subject to hold-up by the other party since he needs the firm's physical assets. If the entrepreneur owns the firm then clearly the hold-up problem goes away. The most obvious interpretation of Brynjolfsson model is as a model of a labour-owned firm. Brynjolfsson argues that it is optimal to give the entrepreneur ownership of the physical assets of the firm since he has information that is essential to its productivity. This result is obviously just an application of Hart and Moore's proposition 6, that an agent who is "indispensable" to an asset should own it.<sup>11</sup> Here firms are owned by the indispensable human

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<sup>11</sup>See Hart and Moore (1990: 1133). For Hart and Moore an agent  $i$  is indispensable to an asset  $a_n$  if, without agent  $i$  in a coalition, asset  $a_n$  has no effect on the marginal product of investment for the members of that coalition.

capital, or more normally by a small section of the human capital eg a partnership. Labour-owned firms are one way to form a human capital intensive firm but the shortcomings of such organisations are all too obvious: lack of access to capital, inadequate risk pooling, investment problems – older workers want a shorter pay-back period than younger workers, are membership rights tradable and if so under what conditions, new members would have to purchase ‘equity’ in the business from retiring ones, borrowing to cover such a purchase could be a problem for younger would-be members etc.

Rabin starts from the idea that there can be problems for an economic agent who wishes to sell potentially useful private information to others. Any person who believes that they have some valuable insights into how to produce something is unlikely to be able to exploit that information by offering to sell it to an existing firm. If they do not reveal their information before being paid, a firm may have little reason to believe the seller is truly well-informed. If they reveal the information up front, the firm may simply use the information without compensating the would-be seller. When the current owner of the firm cannot observe how informed the seller is, Rabin argues that the information seller may have to buy the factory to make money from their private information. In fact, Rabin shows that the more bargaining power an informed party has, the more likely they are to obtain control of an asset. In the Rabin model knowledge determines the owner of the firm, that is the “indispensable” human capital owns the physical capital just as in the Brynjolfsson model.

While the Brynjolfsson model is distinct from the Rabin model, they are complementary. The relationship between information, ownership and authority is central to both papers. Rabin works within a framework of an adverse selection model and shows that the adverse selection problems can be such that, in some cases, an informed party has to take over the firm to show that their information is indeed useful. The Brynjolfsson model is a moral hazard type framework which deals with the issue of incentives for an informed party to maximise uncontractible effort.

What may be a problem here is that part of what may be driving the results of both the Brynjolfsson and Rabin models is the implicit restriction in the GHM framework that the owner is also the manager. Hart and Holmström (2002) note there are several ways to see this: (1) according to the GHM theory, the major impact of a change in ownership is on those who gain or lose ownership rights (the owners); however, in a merger between two large firms it is often the

That is, for all agents  $j$  in any coalition  $S$  and for all sets  $A$  of assets containing  $a_n$ ,

$$v^j(S, A) \equiv v^j(S, A \setminus \{a_n\}) \quad \text{if } i \notin S.$$

case that the key decision makers (the managers) do not have substantial ownership right before or after the merger. So a model in which the decision makers lose or gain ownership rights must be a model where the owners are the managers; (2) the relationship-specific investments analysed are made by individuals rather than the firm; and (3) the approach envisions a situation in which all the relevant parties meet and bargain ex post over the gains from trade and the only issue is who has the right to walk away with which assets; there are other decisions in the model. As it stands the model has no room for “organisational structure”, “hierarchy” or “delegation”; in a sense the model continues to describe a pure market economy, although one enriched by the idea that individuals can be empowered through the ownership of key nonhuman assets. Holmström (1999: 87) goes so far as to argue that the GHM framework is an owner-manager framework since the theory is a theory of asset ownership by individuals rather than by firms. “Assets are like bargaining chips in an entirely autocratic market.” There are neither firms nor workers! Ownership of assets by an individual only provides a theory of organisational identities if we associate the firms with those asset owning individuals. The problem is that if human capital is important to the production process and it makes sense to allocate control of production to the informed party, that is, make that party the manager, then because the manager must also be the owner we end up with the human capital owning the firm. Thus a labour-owned firm may be an artifact of the model.

## **6 Knowledge and production location**

As has been discussed Hart (1995: 17) noted that the neoclassical model tells us nothing about where a firm’s boundaries will lie or about the size or location of a plant or factory within a given firm. This approach is consistent with every existing firm being a plant or division of one huge firm which produces everything. It is also consistent with every plant or division of each existing firm being a separate and independent firm in their own right. Thus it is not clear in what organisational form production will occur. Will it be organised as a single large factory, several smaller factories or a household? The GHM approach does delineate the boundaries of the firm but still does not tell us anything about the location or size of a plant or factory which is part of the firm. Again the form of production organisation is indeterminate. What will be argued below is that the division of knowledge is one important influence on the form of organisation in which production takes place. The most obvious issue has to do with the determination of whether or not work occurs in a centralised factory or in separate households or some combination. This has

been an issue since at least the industrial revolution.

In his discussion of the development of the factory system during the industrial revolution Mokyr (2002: chapter 4) puts forward the argument that the location of production was dependant, in part, on the trade-off between “the relative costs and benefits of moving people as opposed to moving information.” Mokyr (2002: 120). That is, he develops a line of reasoning that suggests that one factor encouraging the organising of workers under a single roof, rather than in separate households, was the division of knowledge.<sup>12</sup> As long as there was little division of knowledge, so that the knowledge needed to carry out production could be summarised in a few basic rules, the household could know all that was needed to act as the “unit of production”. The cost of information moving was low since there was little of it needed and it could be contained within a household. Moving people between households, however, was slow and costly. But as technology developed, the competence required for production moved beyond the capability of a single household.

Mokyr points out that the importance of the division of knowledge to the firm was first recognised, albeit in a non-historical setting, by Demsetz (1988) and formalised by Becker and Murphy (1992). What these works suggested was a new interpretation of the role of the firm. Given that there are limitations to what a worker can know, the competence that a firm has to possess to produce must be divided into manageable portions and allocated between the workers. The actions of the different groups of workers are then coordinated by the firm’s management. Thus workers who produce on the basis of knowledge they themselves do not possess, have their activities directed by someone who does possess (at least more) of the necessary knowledge. Therefore the coordination needed due to asymmetries in information among workers provides a rationale for management. In this way direction is a substitute for education, that is, a substitute for the transfer of the knowledge itself. Specialisation in knowledge can, therefore, both exacerbate existing information asymmetries and create new ones. Any information asymmetry gives rise to an organisation problem for the firm; how can agents who possess knowledge be encouraged to reveal their knowledge fully and truthfully to other workers or management. Mokyr argues that

“[p]utting all workers under one roof ensured repeated interaction and personal contact provides maximal bandwidth to maximize the chances that the information will

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<sup>12</sup>Mokyr (2002: 131) outlines the three main explanations for the rise of the factory. “One relies on fixed costs and technical and physical economies of scale and scope, which might have caused the minimum efficient size of plants to become larger than the household. A second explanation is drawn from the modern micro-economics of the firm: because of asymmetric information and the division of labor, costs were higher in decentralized households, and the new technology changed the benefits and costs of monitoring and the incentives to self-monitor. A third argument is that by concentrating all workers under one roof and placing them under supervision, actual labor effort is enhanced.” To these three Mokyr adds a fourth, the division of knowledge, which we discuss here.

be transmitted fully and reliably. Inside a plant agents knew and could trust each other, and this familiarity turned out to be an efficient way of sharing knowledge.” Mokyr (2002: 141).

From this it can be seen that as long as the minimum competence needed by a firm is small, the plant size can also be small and can, therefore, coincide with the household. When the competence needed grows the unit of production has to change or an efficient network for knowledge distribution has to develop. At a time when the main technique for the distribution of knowledge was direct contract, as at the time of the industrial revolution, such networks in the form of professional associations of mechanics, machinists, engineers etc did develop. But the firm was also an answer to the problem of knowledge distribution. Costs of accessing knowledge were minimised in a single plant where workers could communicate face to face. Factories acted as repositories of technical knowledge and allowed workers to access this information at relatively low cost.

As pointed out by Mokyr, the Demsetz\Becker-Murphy framework also suggests that

“... when knowledge can be shared and trusted among people by means other than personal contact ... firms may survive, but large plants may become less necessary.” (Mokyr 2002: 141).

This point is becoming more important as the use of ICTs is expanding.

The development of ICTs has meant that the costs of moving people as opposed to moving information have risen sharply. The costs involved in sending and receiving information have fallen thanks to technologies such as email and the Internet along with falls in the costs of long-distance phone calls and the expanding use of cellular networks. The costs of people moving have not fallen however. Commuting to work via congested city and suburban streets, for example, is at least as difficult as it was two decades ago. The increasing interest in congestion pricing in many cities around the world suggests that traffic problems are not lessening. The ever increasing relative cost of moving people would suggest that the size of the “unit of production” should be moving away from the large factory, so dominant for the last two centuries, towards more home based production, as in the period before the industrial revolution. Mokyr does however add a cautionary note;

“... it seems clear that the movement away from factory settings will eventually run into diminishing returns and that the locus of work will remain a mixture of work at home and work away from home”. (Mokyr 2002: 155).

Brynjolfsson (1994) also sees advantages in firms being small when information is important in production. In his view

“...small firms are likely to have an advantage in providing incentives, not only because it is likely to be easier to separate out and contractually reward the individual contributions, but also because agents in smaller firms have stronger incentives to make uncontractible contributions as well. ... When it is important to provide incentives for the application of information in ways that cannot be easily foreseen and incorporated into a contract small firms have a relative advantage over large firms.”  
(Brynjolfsson 1994: 1654).

Both the Demsetz\Becker-Murphy and Brynjolfsson models indicate that when knowledge is an important factor of production, small firms have advantages. If Mokyr is right then this downsizing of firms should lead to a movement back towards home production and away from large factory production.

## 7 Conclusion

Current research offers an increased understanding of how markets operate in the knowledge economy and some understanding of the effect of this on corporate strategy and related management issues.<sup>13</sup> This, however, stops short of an actual theory of the knowledge firm. While it is, as Foss (1997: 309) notes,

“...generally recognized that knowledge problems are behind all interesting aspects of economic organization, and that the major function of, for example, firms is to cope with the economic problems introduced by changing, partial, tacit, complex, asymmetrical, etc., knowledge[.]”

it must also be recognised that none of the orthodoxy theories of the firm capture the full implications of knowledge for economic organisation. The previous sections made this point by briefly outlining the effects of the increasing importance of knowledge for the mainstream theories of the firm. It was argued that the neo-classical production function approach is not a true theory of the firm but rather the firm is portrayed as a uninvestigated perfectly efficient ‘black box’ which simply turns inputs into outputs without organisation structure. Output is produced

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<sup>13</sup>See, for example, Arora, Fosfuri and Gambardella (2001), Carley (2000), Kling and Lamb (2000), Leibold, Probst and Gibbert (2005), Shapiro and Varian (1999), and Smith, Bailey and Brynjolfsson (2000).

by the actions of multiply input owners interacting solely via the market. Relationship-specific investment induced hold-up arguments for vertical integration are at their weakest when dealing with human capital. Human capital can not be owned in the same way as physical capital and so the investor in human capital can act opportunistically whether an employee or not. The incentive-system theory assumes the use of a physical asset rather than a human capital asset in the production process. Neither the the ownership nor the value of a human asset can be transferred and so such an asset cannot determine where the boundaries of the firm lie within the model. The extensions of the GHM framework offered by Brynjolfsson (1994) and Rabin (1993) inherits the implicit owner-manager restriction of the original GHM framework and thus are of limited value when modelling the knowledge firm. When we turn to the location of production the models suggest that we should, in general terms, see a movement back towards home production but we are not given a specific relationship between knowledge and plant size or production location.

We are left with an unsatisfactory model of the (knowledge) firm and thus we are unable to give guidance on either empirical or policy questions that flow, via changes to the firm, from the development of the knowledge economy. Firm's organisational structures are changing in response to the increased prominence of information and knowledge in the production process. In the new economy, not only will we see changes in the location of production, but even if production still takes place within a traditional firm, a factory or an office, that firm may have a very different structure and organisation from that which we see today. As was noted in the Introduction Rajan and Zingales (2003: 87) argue that we are in fact seeing a new "kinder, gentler firm". This is in response to the increase in the importance of human capital, along with increased competition and access to finance, all of which have increased the worker's importance and improved the outside options for workers, thereby changing the balance of power within firms. The Introduction also pointed out that in Rajan and Zingales's view

“[t]he single biggest challenge for the owners or top management today is to manage in an atmosphere of diminished authority. Authority has to be gained by persuading lower managers and workers that the workplace is an attractive one and one that they would hate to lose. To do this, top management has to ensure that work is enriching, that responsibilities are handed down, and rich bonds develop among workers and between themselves and workers” (Rajan and Zingales 2003: 87).



Cowen and Parker (1997) make a similar point about changing organisational structures. For them,

“[i]nformation as a factor of production is making old functional structures and methods of organisation and planning redundant in many areas of business. The successful use of knowledge involves not only its generation, but also its mobilisation and integration, requiring a change in the way it is handled and processed.” (Cowen and Parker 1997: 12).

Organisational change, as far as Cowen and Parker are concerned, is the consequence of the increasing need to make use of market principles within the firm and the growing importance of human capital. They note that as far as a firm’s labour force is concerned,

“[t]he emphasis now is upon encouraging knowledge acquisition, skills and adaptability in the workforce as critical factors in competitive advantage.” (Cowen and Parker 1997: 32).

Firms are obliged to rely more on market based mechanisms as the most efficient way of processing and transmitting information and giving the firm the flexibility and yet also focus it requires. Companies are decentralising their management systems as a way of coping with the uncertainty and pace of change in their markets. The aim is to ensure that those with the require knowledge and right incentives are the ones making the decisions and taking responsibility for the outcomes. Cowen and Parker (1997: 25-8) emphasise how advances in ICTs underlie the ability to be able to combine the advantages of this organisational flexibility with mass production.<sup>14</sup>

As people become a increasingly important part of the production process two additional issues will become more pressing for the firm. The first is that (tacit) knowledge about how to produce will be more imperfect as it is necessarily distributed among an increasing number of different people. The second problem is that knowledge about how to integrate the know-how of the different workers is also imperfect. As Langlois and Foss (1999: 203) note,

“[t]he first possibility brings us to the issue of *capabilities*; the second to the issue of *qualitative coordination*.”

Capabilities are firm-specific knowledge which is often tacit and distributed among members of the firm.<sup>15</sup> Such know-how is only utilised via the implementation of a multi-worker production

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<sup>14</sup>In addition to Cowen and Parker (1997) see Gable and Ellig (1993) and Koch (2007) for more detail on market-based management.

<sup>15</sup>For more on capabilities and organisation see, for example, Loasby (1998a, 1998b) and Richardson (1972).

process where no one worker has complete knowledge of the process. This means that some kind of qualitative coordination is required to utilise efficiently the aggregate knowledge available.

With the growth in the importance of human capital, firms increasingly face the issue of how to align not just the cooperating parties incentives but also align their knowledge and expectations. Capabilities and routines have a greater role to play as coordinating devices within the knowledge firm.

But little of these types of changes and issues are captured or explained by the mainstream theory of the firm. Expanding the orthodox view of the firm to include the new reality of the knowledge economy should be an urgent issue on the economic research agenda. As was argued in the Introduction, changes to the firm matter simply because so much economic activity takes place within their boundaries. As a consequence, changes to the firm will help determine who the “winners and losers” from the knowledge economy are. As in all previous “economic revolutions”, this is the ultimate issue to do with the knowledge economy.

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