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THE COMPARATIVE ADVANTAGES OF FIRMS, MARKETS, AND CONTRACTS: A UNIFIED THEORY

by

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Abstract

The most efficient labor market mechanism depends on the advantages of specialization, workers' costs of switching between entrepreneurs, and the frequency with which needs change. Multilateral mechanisms are more efficient when specialization is more advantageous, when it is cheap for workers to switch between entrepreneurs, and when individual entrepreneurs cannot occupy a worker on a full-time basis. Given a bilateral mechanism, employment (a firm) is more efficient than contracts when in-process adjustments arise more frequently. There exists three regions in which firms, markets, and sequences of bilateral contracts are weakly more efficient than all other mechanisms in a big class.

Most economic research is conducted by taking a trading mechanism as given, imposing some subset of a standard set of assumptions, and then answering questions about the resulting behaviors and allocations. While this procedure has proven very fruitful, it raises some deeper questions: What determines the choice of mechanism in the first place? And why are firms, markets, and contracts so commonly used? On these, we are well short of a theory which is unified in the sense that it can explain all three mechanisms and do so without relying on assumptions different than those normally imposed in analyses taking each of the mechanisms as given.

Parts of the puzzle have been looked at individually: Coase (1937) pioneered the comparison between firms and markets, Adam Smith and Stigler (1951) contrasted markets and bilateral mechanisms, while Grossman and Hart (1986) analyzed bilateral contracts and firms. However, these theories are driven by different forces and are not easily reconciled into a unified framework. Williamson (1971, 1975) offers a broader theory, but relies on several non-standard assumptions.

The present paper proposes a unified answer driven by the interaction between four natural forces: The advantages of specialization, workers' costs of switching between entrepreneurs, the size of entrepreneurs, and the frequency with which their needs change. The main effects are intuitive: multilateral mechanisms are more efficient when specialization is more advantageous, when it is cheap for workers to switch between entrepreneurs, and when individual entrepreneurs are "small" and cannot occupy a specialist on a full-time basis. Between bilateral mechanisms, employment is more efficient than a sequence of bilateral contracts when the needs of entrepreneurs change more frequently. The interaction effects are more subtle: First, higher switching costs favor bilateral mechanisms more if new services are needed on a more frequent basis and if players are more patient. (Proposition 4i.) Second, the advantages of employment (over sequential contracting) when needs change frequently is amplified by certain bargaining costs, while the effect of patience is amplified by other bargaining costs. (Proposition 4ii.) Third, smaller entrepreneurs mean that larger switching costs favor the market less. (Proposition 5ii.) Fourth, when entrepreneurs are smaller, more frequent changes in their needs and certain bargaining costs favor employment less. (Proposition 5iii.)

We can illustrate the effects of specialization, switching costs, and adjustment frequency by the way in which a medium-sized apartment building is maintained. The owner will typically have an employee, the superintendent, perform minor repairs ("the toilet runs"). The building generates a steady flow of small problems, they tend to be urgent, and the superintendent can solve each of them pretty well. On the other hand, certain minor renovations, such as those having to do with electricity ("install LED light bulbs in public spaces"), are normally done through the market. The jobs are often larger, specialists can do them better, and the building does not need a full time electrician. Major renovations, for which advance planning reduces the need for in-process changes, are typically governed by a bilateral contract subject to occasional, though typically costly, renegotiations.

The same example can illustrate the effects of size. A landlord who owns just one or two units will typically go to the market even for minor repairs because these units do not generate enough work to support a superintendent. On the other hand, very large landlords, such as universities, typically use specialist employees (their "own" electricians) for both repairs and minor renovations.

We analyze a simple model of trades in which entrepreneurs may need any of a wide variety of services, but do not know their needs in advance. (The dual facts that there are a very large set of possible services and that future needs are unknown combine to rule out long-term contracts, whether contingent or not.[1]) Entrepreneurs and workers can trade a sequence of labor services and these differ both in duration and the values put on them by each player. A player's valuation is the sum of a prior mean, a personal type effect, and a variable measuring the fit between the player and the service. At any point in time, an entrepreneur only assigns positive value to a single service. The identity of the valued service and its duration are common knowledge, but the type and fit variables are private information, such that there is two-sided incomplete information in each trade. On the other hand, any specific service is fully contractible.

The first wedge in the model is between gains from specialization and utilization in the market and saved switching costs in bilateral trade. The second wedge is coming from two-sided incomplete information in bilateral relationships. In such cases, we allow the players to learn their opponents' valuations by incurring search costs. There is one cost for learning a single period valuation and another for learning the opponent's type.

The two least familiar components of the model are (a) that workers incur a switching cost when switching from one entrepreneur to another and (b) bargaining costs. We will briefly discuss the nature and modeling of both.

(a) Workers incur a variety of costs when they switch from one entrepreneur to another. A worker serving one entrepreneur exclusively will know how that entrepreneur does things, will understand what other workers do, and can be on-site and ready to work at a moment's notice. In contrast, before working for a new entrepreneur, a worker has to find her, travel to the work site, learn about how to do things there, and spend time fitting his schedule to whatever else is going on there. After completing the work, he then has to manage the billing process, which on a per service basis is more onerous than the simple receipt of wages. There is a lot of variance in these switching costs; for a plumber they are mostly travel costs, but before an executive can work as a country manager for a multinational firm, it may be necessary to spend a year or more at headquarters, learning the "culture" of the firm. We will use a single parameter for these "switching costs", but they include as of the above as well as the search costs of Grossman and Helpman (2002), the metering costs of Barzel (1982), and the specific human capital investments of Hart and Moore (1990).

(b) Bargaining costs also come many guises. It is costly to prepare in advance, bargaining takes time and may be inefficient, and ill-will may fester afterwards.[2] To stay with standard assumptions only, we represent all of these costs by a single example: agents' expenditures on searching for information about their opponents. The idea is that, in the context of two-sided incomplete information, a bargainer can expect to do better if he has more information about the opponent's reservation price.[3] We assume that players have complete information after search and focus on cases with large expected gains from trade such that all agents choose to invest in search for competitive information. By thus transforming the bargaining costs from inefficient non-trade to search costs, we obtain simpler formulas for the comparative efficiency of mechanisms. The transformation is not innocuous in the sense that the two types of costs behave differently. In particular, the losses from inefficient non-trade are proportional to gains from trade, while search costs are proportional to the number of bargains undertaken. This plays an important role in our analysis, since we portray the employment mechanism as an attempt to economize on bargaining costs by pooling several negotiations into one.[4]

Trades are governed by one of many possible mechanisms and we are interested in maximizing net efficiency for different types of trading problems. All mechanisms are built around the same sequence of informational events, and they only differ in two ways: For purposes of price determination, which subsets of players are in the same "bargaining bin"? And for purposes of trade, who is matched with whom?

We start by focusing at three specific mechanisms which we suggestively will label as the "Market", "Sequential Contracting", and "Employment" mechanisms. After obtaining formulas for their expected performance, we go on to justify this focus by showing the existence of regions in which each of them weakly dominate alternative mechanisms in a very big class.

(1) In the "Market" mechanism, a single price is found, and any entrepreneur who is willing to pay it trades with a worker who is willing to take it. To keep the argument simple, we assume that the Market functions without bargaining costs.[5] Market payoffs thus only differ from the highest possible by the workers' costs of switching between entrepreneurs. A good example of the advantages of markets could be refrigerator repair: Specialists can clearly perform the service much more efficiently than most laymen (such as a butler or a care-taker). Furthermore, the typical home-owner has the problem on a very infrequent basis, making it much cheaper to pay the switching costs instead of hiring an appliance repairman to stand by at the house.

(2) In the “Sequential Contracting” mechanism, entrepreneurs and workers pair up on a once-and-for-all basis, but negotiate new contracts whenever the entrepreneur’s needs change. While this economizes on switching costs, production costs will be higher since workers cannot specialize. Furthermore, the loss of market discipline forces the players to engage in bargaining over each potential trade. On those occasions, bargainers would like to know each other’s reservation values for the specific services needed by the entrepreneur. We focus on regions of the parameter space in which both players choose to search for this information and thus get complete information. Total payoffs from the mechanism therefore reflect occasional bargaining costs and average productivity (since all services are performed by a single player), but only one instance of switching costs. Surprises during home renovations are a good example. (“We tore up the floor and found rotten planks; they have to be replaced before we can continue.”) The expected number of bargains is small and the contractor on-site can do most such jobs without new switching costs and at production costs close to those incurred by the most efficient outsider.

(3) In the “Employment” mechanism, the two players agree once-and-for-all on a single per-period price (wage) which then is applied to all future trades with the proviso that either player may terminate the relationship at any time. In this mechanism bargainers would like information about their opponent’s average valuation (type) and we again focus on cases in which both choose to search for this information. Concerning post bargaining behavior, we assume that the parties play a super-game equilibrium in which threats of termination allow the players to avoid as many inefficient trades as possible, in the limit maximizing gains from trade. So there is only one round of bargaining, but

again just average productivity. The aforementioned superintendent illustrates the attractiveness of this mechanism: In the typical case, so many things come up that it would be absurd to bargain on each occasion and most of the services are sufficiently simple that an experienced layman can perform them with reasonable efficiency.

This theory of "employment as the at-will use of a specific trading mechanism" differs in important ways from many influential strands of the theory of the firm. First, unlike the property rights theory and variations thereof (Grossman and Hart, 1986; Hart and Moore, 1990; Board, 2011), the present argument does not depend on assets, and does not portray asset ownership and employment as two results of a single force. Second, the controversial distinction between observability and verifyability (Maskin and Tirole, 1999) does not play any role here. There is no hold-up, but contracts are expensive to negotiate in a bilateral context. Third, and related to the above, there are no "private benefits" in our model; everything is transferable, but it is in some contexts costly to agree on transfers. Finally, in contrast to many recent contributions, our argument relies on standard rationality assumptions only.

On the other hand the theory also has several similarities with the literature. As Williamson (1971, 1975), and Hart and Moore (2008), it is about ex post adaptation rather than ex ante investment, as Macleod and Malcomson (1988), Baker, Gibbons, and Murphy (2002), and Halac (2012) it is about an implicit contract, as Taylor and Wiggins (1997) and Gibbons, Holden, and Powell (2012) it compares bilateral and multilateral mechanisms, as Bajari and Tadelis (2001), Bolton and Rajan (2001), and Matouschek (2004) it is about contracting/bargaining costs, and as Board (2011) it is about the tradeoff between advantages of specialization and "transaction-costs".[6] Our arguments about the advantages of specialization associated with market solutions can be seen as analogues of points raised by Adam Smith (Ch. 1-3, 1965), Stigler (1951), Lucas (1978), and Rosen (1983).[7]

We analyze the three main mechanisms in Section I, holding the size of the entrepreneurs constant. Other mechanisms are shown to be weakly dominated in Section II, and we consider the consequences of varying the size of entrepreneurs in Section III. Implications and further research are discussed in Section IV.

I. ALTERNATIVE MECHANISMS FOR A SEQUENCE OF PURCHASES

Time t is infinite and discrete; there is a set E of entrepreneurs with generic element e, a set W of workers with generic element w, and a set of labor services S with generic element s. Each entrepreneur "needs" one service per period and each worker can perform any service, but only one per period. Services are in equal demand in the sense that each is needed by $|E|/|S|$ entrepreneurs in each period. In a more general analysis, $|E| = |W|$ would be a property of equilibrium, but we here simply assume it. The length of a period is defined by the time between changes in needs. So if $r \in (0, 1)$ is the one period discount rate, $1/r$ is a measure of the frequency with which adaptation is necessary.

If e needs s in a given period, her valuation is $v_s = v + v_e + v_{es}$, where v is a population mean, v_e is the entrepreneur's "type", and v_{es} describes the "fit" between entrepreneur e and service s. The types and fits are private information and are iid draws from non-degenerate uniform distributions with domains $[-\bar{v}_e, \bar{v}_e]$, and $[-\bar{v}_{es}, \bar{v}_{es}]$ respectively. The entrepreneur gets no value from any other services.

Each worker is an "expert" in one service and there are an equal mass of experts ($|W|/|S|$) in all services. An expert can perform this service at cost c^* while his costs for any other service are $c_s = c + c_w + c_{ws}$, where c is a population mean, c_w is the "type" of worker w, and c_{ws} describes the "fit" between the skills of worker w and service s. A worker's type and fits are private information and are iid draws from uniform distributions with domains $[-\bar{c}_w, \bar{c}_w]$ and $[-\bar{c}_{ws}, \bar{c}_{ws}]$, respectively, and $c^* < c - \bar{c}_w - \bar{c}_{ws}$. To avoid trivial sub-cases in some of the following, we focus on the case in which $\bar{v}_e \in (0, \bar{v}_{es})$, $\bar{c}_w \in (0, \bar{c}_{ws})$, and $\bar{c}_{ws} \in (\bar{v}_{es}/2, 2\bar{v}_{es})$. So the variance in types is lower than that in fits, but the variance in costs can be larger or smaller than that in values.

Players can write binding contracts, but S is so big that a complete contingent claims contract is infeasible. In this spirit, and to keep things simple, we make the extreme assumption that contracts can specify a single price only. Because of unmodeled differences between individual entrepreneurs and workers, we also assume that any agreement that ties two players together for more than one period has to be negotiated bilaterally.[8] Multilateral contracting is costless, but bilateral contracting is costly because the two-sided asymmetric information causes the parties to incur some bargaining costs. The entrepreneur can, however, reduce the information asymmetry by learning the worker's type c_w or his cost c_s of providing the specific service s by incurring search costs K or k, respectively. Similarly, the worker can learn the entrepreneur's type v_e or her valuation v_s of the specific service s by incurring search costs K or k, respectively.

Players explore the possibilities for trade and negotiate contracts in "bargaining bins". These can consist of any number of entrepreneurs and workers, but a player can only participate in one bin per period. This means that a player who cannot reach agreement will not be able to try another bin until the next period.[9] (Without this assumption the bins are somewhat meaningless.)

The bargaining protocol used for bilateral bargaining is that the entrepreneur gets to make a TIOLI offer with probability $\theta \in (0, 1)$, while the worker makes the offer with probability $1 - \theta$. If an offer is refused, the trade to which it applied does not take place, and both players have zero payoffs in that period. While the TIOLI protocol raises some unpleasant questions about renegotiation, we follow a lot of literature and use it for technical convenience.[10] We do not assume a specific protocol when bargaining is multilateral (it could be a version of TIOLI), but simply assume that the players agree on a single price at which equal numbers of workers and entrepreneurs are willing to trade.

Workers incur switching costs u each time they perform a service for a new entrepreneur. To keep the analysis uncluttered, we assume that $u < v - \bar{v}_e - \bar{v}_{es} - c^*$ such that all trades are efficient when workers perform the services at which they are experts.

The critical parameters are $c - c^*$ (the mean advantages of specialization), u (workers' costs of switching between entrepreneurs), $1/r$ (the frequency with which entrepreneurs' needs change/the inverse discount rate), and K, k (the search/bargaining costs).[11]

We will consider mechanisms that can be constructed by inserting matching and price determination stages into the *Common Sequence of Events* defined as follows:

Prior to the start of the first period:

0. 1. Players learn their types and fits and workers learn the services at which they are experts.

In the first and all subsequent periods *t = 1, 2, …*

t. 1. Needs of all entrepreneurs are revealed.

t. 2. If agreement is reached, workers perform services.

All mechanisms have to respect budget constraints and we look at the most efficient sub-game perfect equilibria of each mechanism.

I. 1. Market

Putting the unique stages (price determination and matching) in bold, we define the "Market" mechanism as follows:

Prior to the start of the first period:

0. 1. Players learn their types and fits and workers learn the services at which they are experts.

In the first and all subsequent periods *t = 1, 2, …*

t. 1. Needs of all entrepreneurs are revealed.

*t. 2***. Price determination: The players are put into $|S|$ bargaining bins each consisting of all experts on a particular service along with all entrepreneurs who need it. They agree on a price such that equal numbers of workers and entrepreneurs want to trade**.[12]

t. 3. **Matching: In each bargaining bin, players who are willing to trade are randomly matched. All matched workers incur switching costs *u*.**

t. 4. If agreement is reached, workers perform services.

PROPOSITION 1: *The total social surplus expected (per worker per period) in the Market mechanism is*

$$\Pi_m \equiv v - c^* - u \tag{1}$$

PROOF: See Appendix

Payoffs differ from the best possible by the switching costs only and these costs matter less for services of longer duration. This conforms to our intuitions about the efficiency of larger markets, the gains from specialization, and the difference between having a repair done by a housekeeper versus waiting for a professional to come out and having to pay for his travel and set-up.[13] We could also interpret u as a decrease in entrepreneur benefits due to delayed delivery or as a combination of increased costs and reduced benefits. In the next two mechanisms these costs are eliminated by having each worker dedicate himself to a single entrepreneur (such that he can avoid repeatedly paying u).

I. 2. Sequential Contracting

Entrepreneurs and workers can be matched in many different ways and the efficiency of the mechanism depends on exactly how this is done. However, we will state results that hold for both random and assortative matching - arguably the most natural procedures. (To keep things simple, we will use formulas for random matching in later sections.)

We define this mechanism as follows:

Prior to the start of the first period:

0.1. Players learn their types and fits and workers learn the services at which they are experts.

0.2. **Matching: The players are randomly (or assortatively) matched up in worker-entrepreneur pairs. The worker incurs switching costs**.

In the first and all subsequent periods *t = 1, 2, …*

t. 1. Needs of all entrepreneurs are revealed.

***t. 2*. Price determination: Each matched pair constitutes a bargaining bin. These players may pay to search for each other's valuations. Nature decides who makes the TIOLI offer and the chosen player makes the offer aiming to maximize his or her own payoffs in the current period.[14] The other player accepts or refuses. Refusal means that both players get zero payoffs in this period.**

t. 3. If agreement is reached, workers perform services.

The non-trivial decisions concern whether to search and how much to offer. We will look at the latter first. There are two different cases:

(a) If the player making the offer knows the opponent's valuation and trade is efficient, the offer will give all surplus to the player making it. If trade is inefficient, no trade is made and both get zero surplus.

(b) If the player making the offer does not know the opponent's valuation, the offer will maximize expected payoff taking into account the probability of rejection.

We want to focus on situations in which players always search and thus know their opponents' valuations. So payoffs in case (a) have to be higher than those in case (b). The latter will grow over time: In the first period, the risk of rejection will be evaluated based on the prior beliefs, but players will have better information about their opponent's type in later periods, eventually knowing what it is.[15] So after a while the uncertainty will be about fits only. Since better-informed players have weaker incentives to search, we look for conditions under which even they will do so (prefer case (a) to case (b)). Tedious, but trivial, calculations then give us the following intuitive result:

FINDING 1: *Players are more likely to incur search cost if they have more bargaining power, if needs change infrequently, if the variance in opponent fits is larger, and if the bargaining costs are lower. The probability increases in the components of value, while it decreases in the components of costs, and thus increases in expected gains from trade.*[16]

PROPOSITION 2: *Assuming that both players always search, the ex ante expectation of social surplus (per worker per period) in the Sequential Contracting mechanism is*

$$\Pi_{sc} \equiv \iiiint_{v_s > c_s} (v_s - c_s) - 2k - ru \qquad (2)$$

If matching is random, (2) equals

$$v - c + \iint (Max\ c_s - Min\ v_s)^3/(96\ \bar{v}_{es}\ \ \bar{c}_{ws}\ \ \bar{v}_e\ \ \bar{c}_w)dv_e dc_s - 2k - ru, \qquad (2a)$$

where the expectation is taken over v_b and c_s. If matching is assortative, (2) is

$$v - c + \int\{(c + \ \bar{c}_{ws} - v + \ \bar{v}_{es} - x)^3/(48\ \bar{v}_{es}\ \ \bar{c}_{ws}\ [\ \bar{v}_e + \ \bar{c}_w])\}dx - 2k - ru. \qquad (2b)$$

PROOF: See Appendix

The first term is the expected value that would be generated if the parties always traded, the second term is the expected benefit from avoiding inefficient trades, and the third term is the bargaining costs. So payoffs differ from the best possible by the workers not specializing and the ongoing bargaining costs. The Employment mechanism aims to reduce these bargaining costs.

<u>I. 3. Employment</u>

We define the "Employment" mechanism as follows:

Prior to the start of the first period:

0.1. Players learn their types and fits and workers learn the services at which they are experts.

0.2. **Matching: The players are randomly (or assortatively) matched up in worker-entrepreneur pairs. The workers pay switching costs.**

0. 3. **Price determination 1: Each matched pair constitutes a bargaining bin**. **The players may pay to search for each other's types. Nature decides who makes the TIOLI offer and the chosen player offers a price to apply to any one service per**

period until one of the players terminate the agreement. The other player accepts or refuses. Refusal means that the players get zero payoffs in this and all future periods, and acceptance means that the players proceed to *1.1*.

In the first and all subsequent periods $t = 1, 2, \ldots$

t. 1. Needs of all entrepreneurs are revealed.

t. 2. **Price determination 2: Each player may make a claim about his or her private value. The players may agree not to trade in *t*. If so, they proceed to *t +1. 1*. Either player can terminate the agreement. If one does, the players get zero payoffs for this and all future periods. If neither does, they proceed to *t. 3*.**

t. 3. If agreement is reached, workers perform services.

The idea behind stage *t. 2* is to allow a super-game equilibrium in which the players avoid inefficient trades to the largest extent possible, for example by not allowing claims of $c_{ws} > c_{ws'}$ and $v_{es} < v_{es'}$ in fractions much greater than $(\bar{c}_{ws} - c_{ws}')/2\ \bar{c}_{ws}$ and $(\bar{v}_{es} + v_{es'})/2\ \bar{v}_{es}$ of large numbers of periods. By Corollary 2 in Jackson and Sonnenschein (2007), such an equilibrium can be asymptotically efficient as the per period interest rate $r \rightarrow 0$. Away from this limit, the Employment mechanism will be burdened by occasional inefficient trades (in addition to the bargaining cum search costs). We will denote this loss by the positive $I(r)$ which vanishes as $r \rightarrow 0$. In much of the following we will focus on the limit and abstract from $I(r)$, but since employment is more likely to be used exactly when r is small, this is not particularly offensive.

It is important to note that the Employment mechanism depends on repeated trade: For at least one of the players, there will be trades with negative payoffs. These are only consummated based on the expectation that future payoffs will come and on the average will be positive. Not surprisingly, we can characterize the conditions under which players will search in much the same terms as those under Sequential Contracting reported in Finding 1.

FINDING 2: *Players are more likely to incur search cost if they have more bargaining power, if the variance in the opponent's types is larger, and if the bargaining costs are lower. The probability increases in the components of valuation, while it decreases in the components of costs, and thus increases in expected gains from trade.*

PROPOSITION 3: *Assuming that both players always search, the ex ante expectation of social surplus (per worker per period) in the Employment mechanism is*

$$\Pi_e \equiv \iiiint_{v_s > c_s} (v_s - c_s) - r2K - ru - I(r) \tag{3}$$

If matching is random, (3) equals

$$v - c + \iint (Max\ c_s - Min\ v_s)^3/(96\ \bar{v}_{es}\ \ \bar{c}_{ws}\ \ \bar{v}_e\ \ \bar{c}_w) dv_e dc_s - r2K - ru - I(r), \tag{3a}$$

where the expectation is taken over v_b and c_s. If matching is assortative, (3) is

$$v - c + \int \{(c + \bar{c}_{ws} - v + \bar{v}_{es} - x)^3/(48\ \bar{v}_{es}\ \ \bar{c}_{ws}\ [\ \bar{v}_e + \bar{c}_w])\} dx - r2K - ru - I(r). \tag{3b}$$

PROOF: See Appendix

So payoffs differ from the best possible by the workers not specializing, the one-time bargaining costs, and the inefficient trades.

<u>I.4. Comparison</u>

Recapitulating, if the expected gains from trade are large, the expected social surplus (per worker per period) from the Market, Sequential Contracting, and Employment are

$$\Pi_m \equiv v - c^* - u, \tag{4}$$

$$\Pi_{sc} \equiv v - c + E(Max\ c_s - Min\ v_s)^3/(96\ \bar{v}_{es}\ \ \bar{c}_{ws}) - 2k - ru, \text{ and} \tag{5}$$

$$\Pi_e \equiv v - c + E(Max\ c_s - Min\ v_s)^3/(96\ \bar{v}_{es}\ \ \bar{c}_{ws}) - r2K - ru - I(r). \tag{6}$$

We get the following effects:

PROPOSITION 4: *If the mean gains from trade are large, then:*

(i) Comparing the Market mechanism and the bilateral mechanisms, we see that the Market is more efficient if switching costs are lower, if gains from specialization are larger, if bargaining costs are larger, and if the variances in fits and types are larger. Furthermore, the effect of switching costs is amplified if new services are needed on a more frequent basis and reduced if players are less patient.

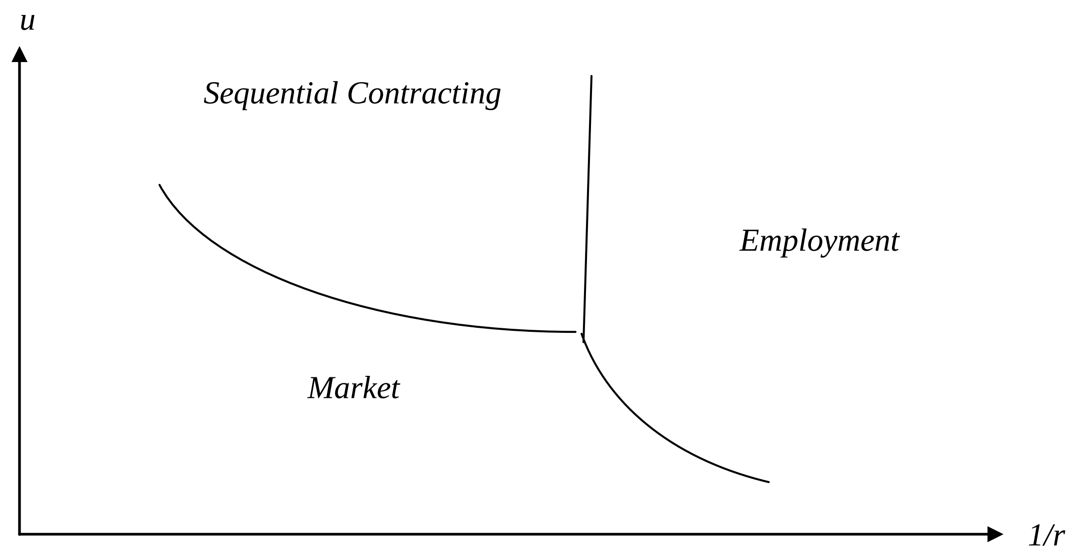
(ii) Comparing the Sequential Contracting mechanism and the Employment mechanism, we see that Employment is more efficient if new services are needed on a more frequent basis, if the fit bargaining costs are larger, if type bargaining costs are smaller, and if players are more patient. Furthermore, the effect of the frequency of new needs is amplified by larger fit bargaining costs, while the effect of patience is amplified by larger type bargaining cost.

The Proposition has several appealing empirical implications. For example, according to part (i) Markets should be more prevalent in more densely populated areas, in fields that require more education, where the performance of laymen varies more. The interaction effect further suggests that switching costs should matter more for services of shorter duration. According to Part (ii), Employment should be more prevalent for services that are subject to frequent change and services where opponent costs and values are harder to ascertain. The interaction effect predicts that these two effects are complements.

Figures 1 and 2 illustrate these results along the dimensions of frequency of change, switching costs, and gains from specialization.

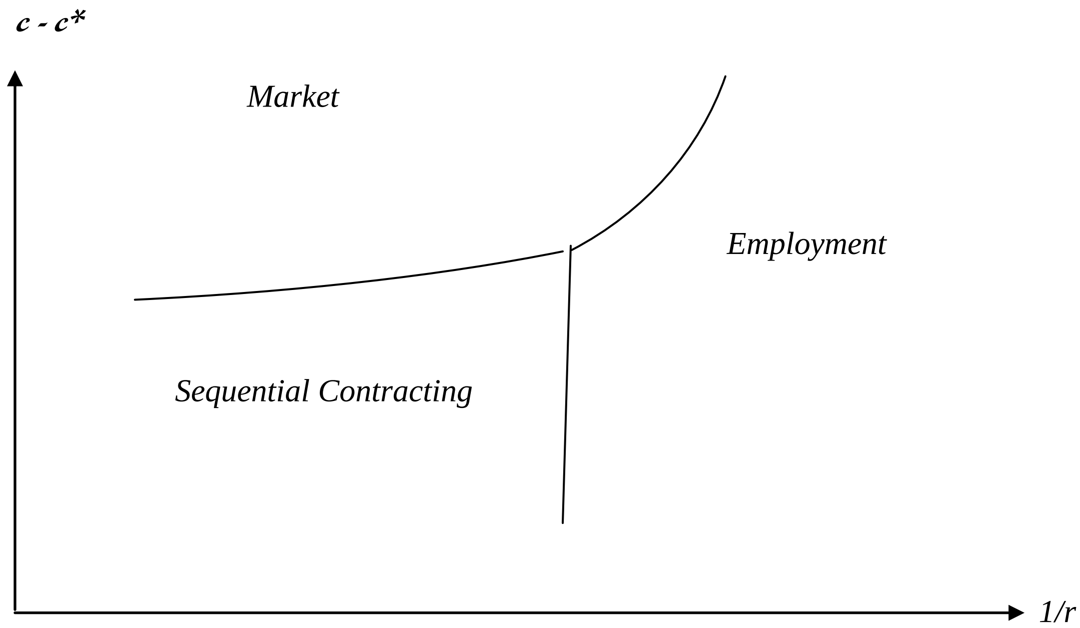
Figure 1

Most Efficient Mechanisms by Frequency of Change and Switching Costs



<u>Figure 2</u>

<u>Most Efficient Mechanisms by Frequency of Change and Gains from Specialization</u>



While the model thus makes intuitively appealing predictions about the use of Employment, Markets, and Sequential Contracts, the existence of even better alternatives have not yet been ruled out. We will therefore look at the attractiveness of other mechanisms in Section II.

II. OTHER MECHANISMS ARE WEAKLY DOMINATED

In this Section, we justify the focus on the Market, Sequential Contracting, and Employment, by showing the existence of regions in which each of the three mechanisms weakly dominate all other mechanisms in a very big class.

Specifically, we define the *class of mechanisms M* as all ex ante individually rational incentive compatible mechanisms whose extensive form contains the *Common Sequence of Events* and satisfy the technological and informational constraints on the model.

This implies that players may explore trades in bargaining bins with any numbers of entrepreneurs and workers, and that they may use any decision rules about the initiation, length, and termination of trading relationships. (In the focal mechanisms, trades are explored on a bilateral or global basis and trading relationships last one period or forever.)

Unlike most proofs involving a search of mechanism space, the following turns out to be comparatively simple. Each of our three mechanisms deviates from efficiency in one or two discrete ways: search costs are $r2K$, $2k$, or 0, average production costs are c or c^*, trading inefficiency is $I(r)$, and switching costs are u or 0.

THEOREM: *For each of our focal mechanisms, Market, Sequential Contracting, and Employment, there exists a region in which it weakly dominates any mechanisms in the class M.*[17]

PROOF: See Appendix

III. SMALLER AND LARGER ENTREPRENEURS

While the results so far have been derived under the assumption that each entrepreneur needs one worker per period, we now look at the effect of variation in the number of services each entrepreneur needs per period ("the size of the firm").[18]

<u>III.1. Small Entrepreneurs</u>

Consider first what happens if an entrepreneur sometimes has no needs at all, but the equilibrium still requires the worker to stick around and be idle. To model this, we assume that the "zero service" is needed with probability *z*. The entrepreneur values this at zero and the worker incurs no costs while being idle (delivering the zero service). We continue to assume that both players will search in both the Sequential Contracting and Employment mechanisms.

In this scenario, the ex ante expectation of total surplus (per period per worker) in the Sequential Contracting, Employment, and Market mechanisms are

$$\Pi_{sc} \equiv (1 - z)\,[v - c + E(Max\ c_s - Min\ v_s)^3/(96\ \bar{v}_{es}\ \bar{c}_{ws}) - 2k] - ru \qquad (7)$$

$$\Pi_e \equiv (1 - z)[v - c + E(Max\ c_s - Min\ v_s)^3/(96\ \bar{v}_{es}\ \bar{c}_{ws}) - I(r)] - r2K - ru \qquad (8)$$

$$\Pi_m \equiv (1 - z)(v - c^* - u) \qquad (9)$$

So in addition to the results derived in Section I, this gives the following effects:

PROPOSITION 5: *When entrepreneurs need help on a less regular basis:*

(i) The Market is more attractive and Employment is less attractive,

(ii) higher switching costs favor bilateral mechanisms less, and

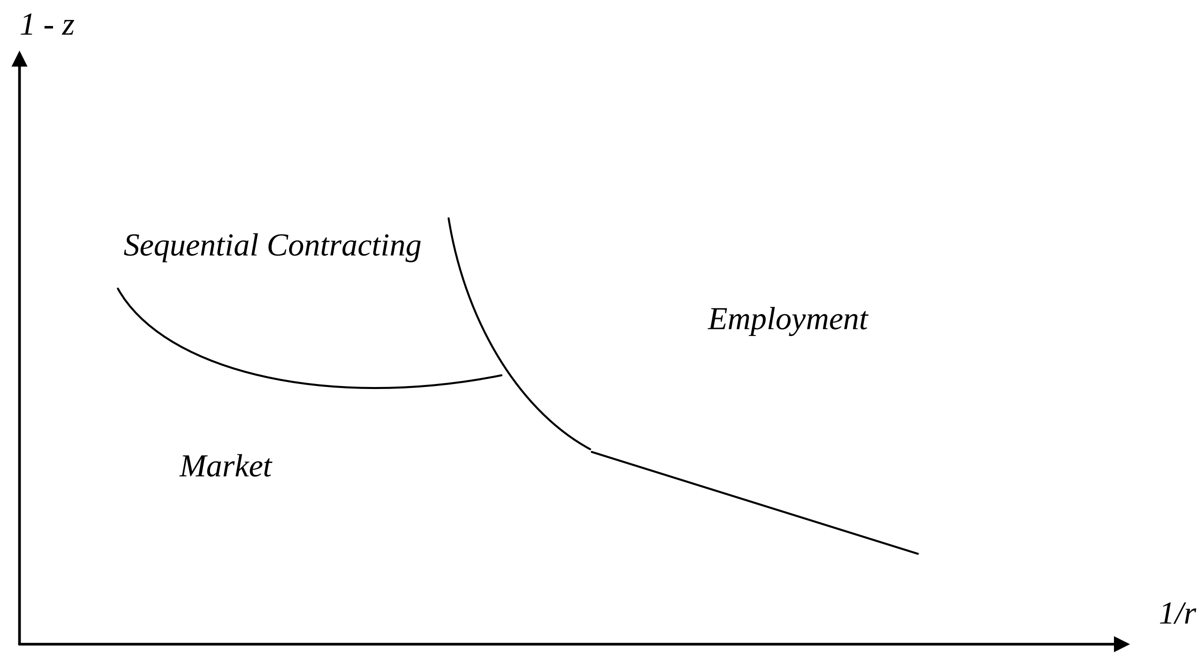
(iii) more frequently changing needs and larger fit bargaining costs favor Employment less.

Also this Proposition has intuitively appealing implications. Part (i) predicts that smaller entrepreneurs acquire more services in the Market, and the interaction effects in part (ii) suggests that Market use is less sensitive to switching costs when we look at smaller entrepreneurs. Finally, the interaction effect in part (iii) implies that the effect of service duration on the use of Employment is reduced for smaller entrepreneurs.

Figure 3 below illustrates this result.

Figure 3

Most Efficient Mechanisms by Frequency of Change and Number of Needs



III.2. Large Entrepreneurs

We next consider the case in which some entrepreneurs are "large" and need the services of several workers. Since this is very straightforward, we will proceed informally.

If an entrepreneur has regular needs in a narrow area, she can allow an employee to specialize, thereby closing part of the productivity gap between Employment and the Market. As suggested by the landlord example in the Introduction, such an entrepreneur could use Employment to acquire a relatively specialized service that normally would be traded in the Market. So *specialized workers will either work in large firms or as independents*.[19] This also implies that *larger entrepreneurs can benefit from lower average costs* through improved division of labor (Smith, 1965; Stigler, 1951). They can do this by hiring experts, but also more simply by allocating each period's services among the staff according to comparative advantages (though this is not modeled here). More generally, this is consistent with the stylized fact that larger firms internalize more functions. Effects of firm size are a natural part of the tradition starting with Adam Smith, but are unlikely to come out of a purely Coasian analysis of bilateral trading costs.[20] It is, however, worth noting that the theory implies that firms have stronger incentives to expand if this enables them to hire more efficient specialists. So larger gains from specialization can lead to more firm governance.

IV. DISCUSSION

The theory portrays Employment as more attractive if the entrepreneur has many, frequently changing needs, if it is costly for workers to switch from one entrepreneur to another, and if the advantages of specialization are small. This portrait shares many features with the similarly named real life trading institution. For example, one important stylized fact about the employment relationship is that no similar mechanism is used for trade in products made off-site. This is perfectly consistent with our characterization of the Employment mechanism. Its central advantage over the Market is that the worker avoids having to switch, and products made off-site would have to be transported no matter how they are traded, making it would be more efficient to use the Market mechanism. (For products made on-site we would have to discuss whether or not the operator should transition, putting us back in the Employment mechanism.) Another strong regularity is that employment is a *relationship* which never is used for one-shot trades. The same is true of our Employment mechanism for two reasons; it depends on an implicit contract and avoidance of switching costs is one of its main advantages.[21]

The theory has many testable implications in the areas of organizational, trade, and labor economics. A strong prediction of the bargaining cost component of the analysis is that smaller, more frequently changing services are more likely to be governed by Employment. Other testable hypotheses are driven by the gains from specialization and switching costs. One possibility is to see if there has been a recent increase in outsourcing in fields where remote work has become possible over the last twenty years (Brynjolfsson and Hitt, 2000). At an anecdotal level, this would seem to be consistent with the recent growth in western firms' business process outsourcing to countries like

India. Another is to test if larger firms internalize more functions and are more efficient. The results of Hortacsu and Syverson (2007) and Atalay, Hortacsu, and Syverson, (2013) are suggestive of this (although it should be noted that the quite different model of Helpman, Melitz, and Yeaple, 2004, makes very similar predictions). It should finally be possible to see if needs with greater gains from specialization are less likely to be met by employees.

In terms of future theoretical research it is tempting to develop a model of labor market equilibrium, or even general equilibrium, with endogenous trading mechanisms.[22] By allowing for appropriate heterogeneity, such a model would have an equilibrium in which the three mechanisms are used in different proportions depending on the types of services and players involved. Another possibility is to expand the domain of the model by considering larger organizations and asking questions about scope, delegation, mergers, etc.

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APPENDIX: PROOFS

PROOF OF PROPOSITION 1:

Since all trades are consummated, the expected gains per worker are

$E(v + v_e + v_{es}) - c^* - u = v - c^* - u.$

QED

PROOF OF PROPOSITION 2:

To get *(2a)*, we first integrate the first term of Π_{sc} with respect to v_{bs} and c_{ws}, using that their distributions are uniform. We then note that $c + c_w + \bar{c}_{ws}$ is the highest possible cost given c_w and that $v + v_e - \bar{v}_{es}$ is the lowest possible value given v_e. If matching is random, types v_b and c_w are independent, and we integrate over both of them.

If matching is assortative, types are matched sequentially along a single dimension such that the highest unmatched v_b is matched with the lowest unmatched c_w, and so on. To get *(2b)*, use that matching makes the $v_e - c_w$ variable uniform on $[-\bar{v}_e - \bar{c}_w, \bar{v}_e + \bar{c}_w]$.

QED

PROOF OF PROPOSITION 3:

By an argument parallel to that used to prove Proposition 2.

QED

PROOF OF THEOREM:

There are six components of efficiency in this model: Getting jobs done by the lowest cost workers (division of labor), avoiding switching costs, minimizing the two types of bargaining costs, maximizing gains from trade (efficient trade), and not leaving workers idle (unmatched or jointly matched another worker and a single entrepreneur).

Sequential Contracting implements all efficient trades if the players invest in search, while Employment implements all efficient trades if adaptation is frequent and players invest in search. Per Findings 1 and 2, players invest in search if *v-c* is large relative to *k* and *K*. Since the Market always implements all efficient trades, we thus have

LEMMA 0: *For fixed θ, c*, u, k, K, we can find small values of r and large values of v-c such that our three focal mechanisms perform as summarized in Table 1 below.*

Table 1

Components of Efficiency and Performance of Mechanisms

	Market	Sequential Contracting	Employment
Division of Labor	Full	1	1
Switching Costs	2	Full	Full
Type Bargaining Costs	Full	Full	3
Fit Bargaining Costs	Full	3	Full
Efficient Trade	Full	Full	Full
No Idle Workers	Full	Full	Full

1, 2, and 3 are defined in the text.

A mechanism can only be more efficient than these if it does better in a cell labeled 1, 2, or 3 without losing more in cells labeled “Full” in the same column.

The only way to do better in the cells labeled “1” is to permanently put more workers into an entrepreneur’s bargaining bin (in effect hiring several people to do one person’s job). Compared to the Market, this would avoid switching costs, but cause some workers to be idle and do less well on the division of labor. Compared to Sequential Contracting or Employment, it leaves some workers idle but improves on the division of labor. Since the cost of idling grows with *v-c*, we have

LEMMA 1: *For fixed* θ, c^*, u, k, K, *we can find small values of r and large values of v-c such that at most one worker should be based on site.*

The only way to do better in the cell labeled “2” is to sometimes let a worker continue contingent on his costs (asking the carpenter to hang around to see if he wants to do the plumbing as well). This mechanism, which we will refer to as Contingent Turnover, involves keeping last period’s worker until the next need is revealed. The incumbent worker can then stay and do the job iff his costs are less than $c^* + u$, those of an expert. There are two versions of this; in Contingent Employment a replaced incumbent returns after missing a job, and in Contingent Sequential Contracting the incumbent position shifts to the new worker. An example of the former would be the employee idling while an expert, such as a plumber, does a specific job. The latter would involve the plumber staying around to see if he could do the electrician’s job. Since this does not allow him to enter another bargaining bin in the same period, a replaced worker will be idle for one period. Compared to the Market, Contingent Turnover does better on switching costs and less well on idling of workers, the division of labor, and bargaining costs. Relative to Sequential Contracting, it improves the division of labor, but does less well on switching costs and the idling of workers. Since the cost of idling depends on v-c, we have

LEMMA 2: *For fixed θ, c^*, u, k, K, we can find small values of r and large values of v-c such that Contingent Turnover is weakly dominated by the Market, Sequential Contracting or Employment.*

We end by looking at the cells labeled “3”. Since all agreements tying two parties together for more than one period has to be negotiated bilaterally, the question is whether we can find a more efficient bilateral mechanism. Suppose that the players consider a mechanism *m*. Because trade is repeated, the randomness in “fits” v_{ew} and c_{ws} may average out over time. However, this argument does not apply to the “types” which are constant over time. The expected payoffs, $\Pi_{me}(v_e, c_w)$, $\Pi_{ms}(v_e, c_w)$ will depend on v_e and c_w. The simplest way to negotiate a price will be in the form of a one-time pre-play transfer, negotiation about which will not affect *m*. But by Myerson-Satterthwaite (1983), no incentive compatible individually rational mechanism can govern such a negotiation in a fully efficient way. So we have

LEMMA 3: *For fixed θ, c^*, u, k, we can find small values of r, large values of v-c, and small values of K such that any incentive compatible individually rational bilateral mechanism is weakly dominated by Employment.*

Given Lemmas 0 -3, we can find regions in which the Market, Sequential Contracting, or Employment weakly dominates by letting c^*, k, or K, respectively, become small, while holding the other parameters fixed. This then implies the Theorem. QED

REFERENCES

Antras, P., and Helpman, E. (2004), “Global Sourcing”, *Journal of Political Economy,* **112**, no. 3, 552 – 80.

Atalay, E., Hortacsu, A., and Syverson, C. (2013), “Vertical Integration and Input Flows”, *American Economic Review*, (forthcoming).

Bajari, P., and Tadelis, S. (2001),“Incentives versus Transaction Costs: A theory of Procurement Contracts”, *RAND Journal of Economics,* **32**, 387-407.

Baker, G. P., Gibbons, R., and Murphy, K. M., (2002), “Relational Contracts and the Theory of the Firm”, *Quarterly Journal of Economics,* **117**, 39-83.

Barzel, Y. (1982), “Measurement Costs and the Organization of Markets”, *Journal of Law and Economics,* **25**, 27 – 48.

Board, S. (2011), “Relational Contracts and the Value of Loyalty”, *American Economic Review,* **101**, 3349 - 67.

Bolton, P., and Rajan, A. (2001), “The Employment Relation and the Theory of the Firm: Arm’s Length Contracting versus Authority”, Working Paper, Princeton University.

Brynjolfsson, E., and Hitt, L. M. (2000), “Beyond Computation: Information Technology, Organizational Transformation, and Business Performance”, *Journal of Economic Perspectives*, **14**, 23-48.

Busse, M., Silva-Risso, J.,and Zettelmeyer, F., (2006), “$1000 Cash Back: The Pass-Through of Auto Manufacturer Promotions”, *American Economic Review*, **96**, 1253-70.

Calzolari, G., and Spagnolo, G. (2009), “Relational Contracting and Competitive Screening”, Working Paper, University of Bologna.

Coase, R. H. (1937), “The Nature of the Firm”, *Economica*, **n. s. 4**, 386-405.

Cremer, J., Spiegel, Y., and Zheng, C. Z. (2009), “Auctions with Costly Information Acquisition”, *Economic Theory*, **38**, 41-72.

Dessein, W., and Santos, T. (2006), “Adaptive Organizations”, *Journal of Political Economy,* **114**, 956-95.

Fehr, E., Hart, O. D. , and Zehnder, C. (2009), “Contracts, Reference Points, and Competition: Behavioral Consequences of the Fundamental Transformation”, *Journal of the European Economic Association*, **7**, 561-72.

Gibbons, R., Holden, R., and Powell, M. (2012), “Organization and Information: Firms’ Governance Choices in Rational-Expectations Equilibrium, *Quarterly Journal of Economics*, **127**, 1813-41.

Grossman, G. M., and Helpman, E. (2002), “Integration versus Outsourcing in Industry Equilibrium”, *Quarterly Journal of Economics*, **11**7, 85 – 120.

Grossman, S., and Hart, O. D. (1986), “The Costs and Benefits of Ownership”, *Journal of Political Economy,* **94**, 691-719.

Guasch, J. L. (2004), Granting and Renegotiating Infrastructure Concessions: Doing it Right, Washington DC: World Bank Publications.

Halac, M. (2012), “Relational Contracts and the Value of Relationships”, *American Economic Review,* **102**, 750-79.

Hart, O. D. and Moore, J. (1990),”Property Rights and the Nature of the Firm”, *Journal of Political Economy,* **98**, 1119-58.

Hart, O. D., and Moore, J. (2008), “Contracts as Reference Points”, *Quarterly Journal of Economics,* **123**, 1-48.

Helpman, E., Melitz, M. J., and Yeaple, S. R. (2002), “Export versus FDI with Heterogeneous Firms”, *American Economic Review,* **94**, 300 -16.

Hortacsu, A., and Syverson, C. (2007), “Cementing Relationships: Vertical Integration, Foreclosure, Productivity, and Prices”, *Journal of Political Economy,* **115**, 250-300.

Jackson, M. O., and Sonnenschein, H. F. (2007), “Overcoming Incentive Constraints by Linking Decisions”, *Econometrica,* **75**, 241-57.

Lucas, R. (1978), “On the Size Distribution of Business Firms”, *Bell Journal of Economics,* **9**, 508-23.

Maciejovsky, B., and Wernerfelt, B. (2011),"Costs of Implementation: Bargaining Costs versus Allocative Efficiency", *Journal of Economic Behavior and Organization,* **77**, 318-25.

Macleod, W. B., and Malcomson, J. M. (1988), "Reputation and Hierarchy in Dynamic Models of Employment", *Journal of Political Economy*, **96**, 832-54.

Maskin, E., and Tirole, J. (1999), "Unforeseen Contingencies and Incomplete Contracts", *Review of Economic Studies,* **66**, 83-114.

Matouschek, N. (2004), "Ex Post Inefficiencies in a Property Rights Theory of the Firm", *Journal of Law, Economics, and Organization,* **20**, 125-47.

Myerson, R. B., and Satterthwaite, M. A. (1983), "Efficient Mechanisms for Bilateral Trading", *Journal of Economic Theory,* **29**, 265-81.

Rosen, S. (1983), "Specialization and Human Capital", *Journal of Labor Economics,* **1**, 43-49.

Simester, D. I., and Knez, M. (2002), "Direct and Indirect Bargaining Costs and the Scope of the Firm", *Journal of Business,* **72**, 283-304.

Social Security Administration, US Government, Online Social Security Handbook (2009): http://socialsecurity.gov/OP_Home/handbook/handbook.08/handbook-0802.html.

Smith, A. (1965), *The Wealth of Nations*, New York, NY: Modern Library.

Stigler, G. J. (1951), "The Division of Labor is Limited by the Extent of the Market", *Journal of Political Economy*, **59**, 185-93.

Taylor, C. R., and Wiggins, S. N. (1997), "Competition of Compensation: Supplier Incentives Under the American and Japanese Subcontracting Systems," *American Economic Review,* **87**, 598-618.

Wernerfelt, B. (2012), "Inefficient Pre-Bargaining Search", *Journal of Institutional and Theoretical Economics,* **168**, 211-23.

Williamson, O. E. (1971), "The Vertical Integration of Production: Market Failure Considerations", *American Economic Review,* **61**, 112-23.

Williamson, O. E. (1975), *Markets and Hierarchies: Analysis and Antitrust Implications,* New York, NY: The Free Press.

ENDNOTES

[1] In the working paper version of this paper, we justify this by looking at a "Price List" mechanism that is efficient only if a small number of services recur. Unlike the Employment mechanism, the Price List mechanism does not require repeated trade.

[2] For example, Fehr, Hart, and Zehnder (2009) experimentally show that post-bargaining ill-will can cause significant inefficiencies.

[3] Pre-play information gathering has been studied in the context of several other mechanisms, including auctions (Cremer, Spiegel, and Zheng, 2009). Busse, Silvia-Russo, and Zettelmeyer (2006) show that car entrepreneurs negotiate lower prices if they search for information about worker costs, and Simester and Knez (2002) report that firms take steps to make it harder for trading partners to acquire such information.

[4] Maciejovsky and Wernerfelt (2011) experimentally show that the functional form of full-information bargaining costs lead to this behavior.

[5] As highlighted by the works of Guasch (2004) and Calzolari and Spagnolo (2009), this is clearly an approximation. However, all that matters is that the bargaining costs are lower than in the bilateral mechanisms.

[6] In Board (2011), the transaction costs come from the possibility of hold-up.

[7] We focus on differences in innate abilities rather than scale or learning advantages, but could reformulate the model with few changes.

[8] There are services for which this is not a reasonable assumption, but it simplifies the exposition by ruling out a mechanism that in an earlier version was called "Employment with market wages."

[9] This constraint makes it costly to let the continuation of a trading relationship depend on period by period cost realizations.

[10] We just need the protocol to have the property that a player's expected payoff with complete information is larger than that with incomplete information regardless of what his opponent knows. A suitable class of protocols is characterized in Wernerfelt (2012).

[11] In the working paper version of this paper, we consider a case in which these parameters differ between classes of tasks, such that different mechanisms can co-exist in the economy.

[12]This means that the equilibrium price is between $c^* + u$ and $v - \bar{v}_e - \bar{v}_{es}$.

[13] Many suppliers of home repairs, such as plumbers, appliance repairmen, and locksmiths, explicitly charge for travel plus time spent on site.

[14] Since a sequence of offers will be made, the players could possibly gain by making offers depend on their history. However, unless full efficiency could be achieved, the directional effects will stay the same. Furthermore, it will turn out that Sequential Contracting is relatively most efficient in circumstances under which such repeated game strategies are harder to sustain (when the variances in fits are large and the periods are long.) To keep things simple, we make the extreme assumption in *t.2*.

[15] This information could come from revealing offers, acceptances or rejections, as well as from search.

[16] This is thus consistent with the often voiced intuition that players are willing to spend more when bargaining over higher rents.

[17] It should be noted that the Theorem does not rule out the existence of regions in which other mechanisms dominate these three.

[18] Further generalizations are considered in the working paper version of the paper.

[19] In addition to size-differences, mixed mode governance could also come about if too few workers have costs that are low enough to justify using the market.

[20] While efficiency advantages from internalizing gains from specialization will lead to larger firms, one could imagine that the opportunities to do so eventually will dry out or become less good. This could form the basis for a theory of the scope of the firm.

[21] A third often cited property is the so-called common law test under which “the person you work for has the right to tell you what to do, how, when, and where to do your job” (Online Social Security Handbook, 802.1, 2009). However, I do not believe that the definition coincides perfectly with everyday use.

[22] General equilibrium models with endogenous institutions have been developed by Grossman and Helpman (2002), and Antras and Helpman (2004).