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EFFICIENT ADAPTATION VERSUS GAINS FROM SPECIALIZATION: PROCURING LABOR SERVICES

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Abstract

We combine the traditions of Coase and Adam Smith to look for the most efficient mechanisms in situations where buyers need sequences of human asset services, but only know their sequence one step ahead. The environment has two critical features: (a) multilateral matching allows gains from specialization, but sellers incur specific set-up costs for each new buyer they serve. (b) Bilateral relationships economize on set-up costs, but are burdened by two-sided incomplete information and thus bargaining costs. In suitable regions, three mechanisms weakly dominate others. A bilateral mechanism (a market) is best when specific set-up costs are larger (smaller), when sellers? costs differ less (more), and when the buyer has more ongoing (intermittent) needs. The bilateral mechanism looks like employment (a sequence of bilateral contracts) when each service takes less (more) time.

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by

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Abstract

We combine the traditions of Coase and Adam Smith to look for the most efficient mechanisms in situations where buyers need sequences of human asset services, but only know their sequence one step ahead. The environment has two critical features: (a) multilateral matching allows gains from specialization, but sellers incur specific set-up costs for each new buyer they serve. (b) Bilateral relationships economize on set-up costs, but are burdened by two-sided incomplete information and thus bargaining costs. In suitable regions, three mechanisms weakly dominate others. A bilateral mechanism (a market) is best when specific set-up costs are larger (smaller), when sellers' costs differ less (more), and when the buyer has more ongoing (intermittent) needs. The bilateral mechanism looks like employment (a sequence of bilateral contracts) when each service takes less (more) time.

I. INTRODUCTION

Research in the tradition of Coase (1937) compares firms and contracts as alternative bilateral mechanisms, while the tradition originating from Adam Smith and Stigler (1951) is focused on the contrast between markets and bilateral mechanisms. We combine elements from both traditions to show how advantages of specialization, haggling costs, and specific set-up costs influence the relative efficiency of large markets, bilateral contracts (aka small markets), and employment relationships. Compared to complex interactive effects favored by much recent literature, many of the arguments offered here rely on simpler and more direct forces.

The essential intuition is that multilateral mechanisms are more efficient when specialization is more advantageous, when it is cheap for sellers to switch between buyers, and when individual buyers can not occupy a seller on a full-time basis. Given a bilateral mechanism, employment is more efficient when in-process adjustments, and thus the potential for haggling, arise more frequently.

We can illustrate the effects of size, specialization and adjustment frequency by the typical employment versus market choices made by owners of differently sized apartment complexes. A landlord who owns just one or two units will typically go to the market for everything from minor repairs (“toilet does not work”) to smaller renovations (“install LED light bulbs in public spaces”). The units do not generate enough work to support an employee. On the other hand, the owner of a medium-sized building will typically have an employee, the superintendent, perform minor repairs. 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, renovations such as electrical jobs are normally done through the market. The jobs are larger, specialists can do them better, and the building does not need a full time electrician. Finally, very large landlords, such as universities, typically use employees for both repairs and minor renovations. Major renovations or building projects, 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.

To understand all the moving parts of the model, consider a slightly more abstract example in which you are buying a sequence of labor services in a well-functioning market. Each service is bought from whoever can supply it at the lowest cost and the presence of alternative suppliers pushes price down to marginal costs while eliminating the need for bargaining. However, in addition to the marginal labor costs you have to pay for any specific investments the seller has to make in order to serve you. These investments may be as trivial as the time it takes an electrician to get to you or as large as the time a manager needs to learn how you do things. There is no hold-up in the argument, but it is simply inefficient to incur set-up costs on a very frequent basis. If you need a very small service, these costs can be absurdly large relative to the gains from specialization. A possible alternative is therefore to strike up a relationship with a single seller who could work exclusively for you. This might be efficient under two conditions: First, that the services in question are of types for which different sellers have more or less identical costs, and second, that you need enough services to occupy him. A problem is, however, that the loss of market discipline opens the door for bargaining and burdens each purchase with some bargaining costs. To minimize this problem, you might consider pooling the bargains into a single agreement under which you can have any service in a particular set for the same hourly price. The advantage of this arrangement, which we will think of as employment, is that adaptation is cheap: Relative to other bilateral mechanisms you can switch between services without incurring any bargaining costs, and relative to the market, you avoid incurring set-up costs at each turn.

The central components of our theory are (a) the advantages of specialization, (b) the notion that sellers of labor have to incur some buyer-specific set-up costs and (c) bargaining costs. We will briefly discuss the latter two.

(b) There is a large literature on, and controversy about, "frictions" in markets for goods and services. While it is hard to judge the general importance of the arguments made, it is not difficult to understand the nature of costs and delays associated with changing buyers of labor (human asset services). A supplier working exclusively for one buyer will know how the buyer does things, will understand what other suppliers do, and can be on-site and ready to work at a moment's notice. In contrast, before working for a new buyer, a supplier has to find her, travel to the work site, learn about how to do things there, and spend time meshing schedules with whatever else is going on there. After completing the work, he then has to manage the billing process, which on a per task basis is more onerous than the simple receipt of wages. There is a lot of variance in these costs; for a plumber they are mostly travel costs, but before working as a country manager for a multinational firm, it may be necessary to spend a year or more at headquarters. We will use a single parameter for these "specific set-up costs", but they include the search costs of Grossman and Helpman (2002), the metering costs of Barzel (1982), large specific human capital investments of Hart and Moore (1990), and simple transportation costs.

(c) Recent literature on non-Coasian bargaining has documented the existence and importance of several types of bargaining costs, incurred after, during, and prior to bargaining.[1] We here represent all of these costs by agents' pre-bargaining expenditures on intelligence gathering 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.[2] Speaking to this, Busse, Silvia-Russo, and Zettelmeyer (2006) show that car buyers negotiate lower prices if they search for information about seller costs, and Simester and Knez (2002) report that firms take steps to make it harder for trading partners to acquire such information.

We assume that search results in complete information and focus on the region of the parameter space in which all agents choose to invest in it. By thus transforming the bargaining costs from inefficient non-trade to pre-bargaining search costs, we avoid many of the complexities associated with two-sided incomplete information and 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 pre-bargaining 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.[3]

[1] For example, Fehr, Hart, and Zehnder (2009) experimentally show that post-bargaining ill-will can cause significant inefficiencies, and Myerson and Satterthwaite (1983) show that bargaining with two-sided incomplete information often cannot be efficient.
[2] Pre-play information gathering has been studied in the context of several other mechanisms, such as auctions (Cremer, Spiegel, and Zheng, 2009) and Vickrey-Clarke-Groves schemes (Bergemann and Valimaki, 2002).
[3] We briefly look at a model with inefficient non-trade in the Appendix.

The analytical part of the paper looks a simple market model and a dynamic model of bilateral trades. In the latter, a buyer and a seller can trade a sequence of labor services and these differ both in duration and the values put on them by each of the two players. 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, only a single service gives the buyer positive value. 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.

The first wedge in the model is between market and relational trade. The former offers gains from specialization and the latter saves on seller set-up costs. 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 long-run average of these (the personal type). The model is driven by these bargaining costs, the advantages of market specialization, and the sellers' specific set-up costs.

We start by focusing at three specific mechanisms which we suggestively will label as the "Market", "Sequential Contracting", and "Employment" mechanisms.[4] We will later justify this focus by finding conditions under which they weakly dominate alternative mechanisms in a very large class.

(1) In the "Market" mechanism, the buyers take advantage of gains from specialization and trade with whichever seller can meet their needs at the lowest costs in any given period. For buyers with intermittent needs, the mechanism has the additional

[4] In a later Section, we also look at a "Price List" mechanism that is efficient if a small number of services recur. Unlike the Employment mechanism, the Price List mechanism does not require repeated trade.

advantage of introducing a no-trade option (since the sellers will match with other buyers with higher valuations). To keep the argument simple, we assume that the Market functions without bargaining costs and no inefficiencies beyond the specific set-up costs associated with the process of switching trading partners. Market payoffs thus differ from the highest possible by these specific set-up costs only. A good example could be refrigerator repair: Specialists can clearly perform the service much more efficiently than most amateurs (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 transportation costs instead of hiring an appliance repairman to stand by at the house.

(2) In the "Sequential Contracting" mechanism, the seller incurs specific set-up costs only once. On the other hand, production costs will be higher since the buyer is likely to have a variety of needs, making it impossible for the seller to specialize in just the tasks he can perform most efficiently. Furthermore, the loss of market discipline forces the players to engage in bargaining over each potential trade. We focus on parameter values for which the players choose to invest in information about each others' reservation values and thus incur bargaining costs. To keep things simple, we assume that bargaining is efficient such that only efficient trades are made and none are missed. Total payoffs from the mechanism thus reflect occasional bargaining costs and average productivity, but only one instance of specific set-up 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 set-up 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 and this is then applied to all trades in the infinite sequence with the proviso that either player may terminate the relationship at any time. In this case bargainers need information about their opponent's average valuation and we focus on parameter values for which both choose to collect this information. To avoid non-essential inefficiencies, we assume that ex post behavior is efficient - the parties play a super-game equilibrium in which threats of termination allow the players to avoid all inefficient trades. So there is only one round of bargaining, but just average productivity (since all tasks are performed by a single player). 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 many of the tasks are sufficiently simple that an experienced "amateur" can perform them with reasonable efficiency.

In sum then, we portray the Employment mechanism as an arrangement that economizes on bargaining costs while keeping a not-necessarily-efficient seller ready to perform a variety of tasks as soon as asked. Trade in the Market allows gains from specialization and avoidance of bargaining, but imposes specific set-up costs during the process of switching between trading partners.

This theory of "employment as a 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; Holmstrom and Milgrom, 1994; 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 assumptions about non-contractibility (Hart and Moore, 1999; Maskin and Tirole, 1999) do not play any role here. There is no hold-up: Everything is in principle ex ante and ex post contractible, but contracts are expensive to negotiate in a bilateral context. Third, and related to the above, there are no "private benefits" in our model (Hart and Holmstrom, 2010); everything is transferable, but it is in some contexts costly to agree on transfers. Fourth, in some bilateral mechanisms, the parties are tied together by forces that may be quite weak, such as co-location or implicit contracts, rather than the large specific investments featured in other work (though some buyer-specific human capital investments may be very large). Since most employees perform tasks that many others could do just as well or better, it seems important to go beyond the two-person models that are ubiquitous in literature following the Coasian tradition. Finally, in contrast to many recent contributions (e. g. Hart, 2008; Akerlof, 2009; Van den Steen, 2010), 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) and Baker, Gibbons, and Murphy (2002) it is about an implicit contract, as Taylor and Wiggins (1997) it compares multilateral and bilateral mechanisms, as Grossman and Helpman (2002), Legros and Newman (2009), and Gibbons, Holden, and Powell (2009) it features a vertically integrated dyad embedded in a market context, as Jehiel (2003), Bajari and Tadelis (2001), Bolton and Rajan (2001), and Matouschek (2004) it is about contracting/bargaining costs, broadly construed, like Antras (2005) it is about the frequency of changes, and as Board (2011) it is about the tradeoff between advantages of specialization and "transaction-costs".[5] 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).[6]

We analyze the three main mechanisms in Section II, starting with the Market and ending with the two-person mechanisms. Other mechanisms are shown to be dominated in Section III, some extensions of interest to labor economists are considered in Section IV, and we discuss implications and further research in Section V.

II. ALTERNATIVE MECHANISMS FOR A SEQUENCE OF PURCHASES

There is a unit mass of buyers with generic element *b*, a unit mass of sellers with generic element *s*, and an uncountable set of labor services *T* with generic element *t*. Each buyer needs an infinite sequence of different labor services, each of which can be supplied by any of the sellers. Until Section IV, we will assume that the needs of each buyer are such that they can be met by exactly one seller in every period. For a given buyer and a given period, only one service is "right" in the sense that it creates non-negative value for the buyer.[7] For each buyer, the identity of the right service is determined by an independent, equiprobable draw in each period. To keep the notation simple, we will often use *t* to denote the time-period in which the service *t* is right for the focal buyer *b*. The buyer

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

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

[7] While this is done for reasons of simplicity, it has the side-effect of making the buyer's private information more important. In larger organizations, it will often be the case that the boss gets information from several employees (Dessein and Santos, 2006), but none of them will individually have better information than the boss.

values the right service t at $v_t = h(v + v_b + v_{bt})$, where h is its "duration"[8], v is a population mean, v_b is the buyer "type", and v_{bt} describes the "fit" between buyer b and service t. The variables v_b and v_{bt} are random. In particular, v_b is drawn from a uniform distribution F_b with domain $[-\beta, \beta]$, and v_{bt} is drawn from a uniform distribution G_b whose domain we normalize to $[-½, ½]$. So β measures the extent to which the two buyer-types differ. The identity of the right task is iid across buyers and periods, the duration is iid across tasks, the types are iid across buyers, and the fits are iid across buyers and tasks. Since each service takes h periods, new services are needed in each of the "trading periods" $t = 1, 1 + h, 1 + 2h, \ldots$

The seller s can perform service t by incurring the cost $c_t = h(c + c_s + c_{st})$, where c is a population mean, c_s is the "type" of seller s, and c_{st} describes the "fit" between the skills of seller s and service t.[9] Both c_s and c_{st} are random variables. In particular, c_s is drawn from a uniform distribution F_s with domain $[-\gamma, \gamma]$ and c_{st} is drawn from a uniform distribution G_s on $[-\alpha, \alpha]$. So γ measures the extent to which the seller-types are different and α is the variance in costs relative to that in valuations. Paralleling the assumptions made about buyers, we assume that the types are iid across sellers, and the fits are iid across sellers and tasks. To avoid trivial sub-cases in some of the following, we assume that $\beta \in (0, ½)$, $\gamma \in (0, \alpha)$, and $\alpha \in (1/4, 1)$. So the variance in costs can be larger or smaller than that in values.

Before starting to service a buyer, the seller has incur some strictly positive buyer-specific costs u; referred to as "set-up" costs in the following.[10] A seller can go

[8] Alternatively, we can think of h as the expected time until the next arrival of new information.
[9] We here ignore the scale advantages of specialization emphasized by Adam Smith (1965) and Stigler (1951), as well as the countervailing coordination costs stressed by Becker and Murphy (1992).
[10] The buyer clearly incurs some loss from waiting, but to keep things simple, we ignore that.

from “home” to a buyer and back home again in one period, but if he serves one buyer, he has to wait until the next period before he can work for another buyer.[11]

The duration of any service, plus the parameters *c, v, u, h* and the probability distributions of v_b, v_{bt}, c_s, and c_{st} are common knowledge, but the types v_b and c_s, as well as the fits v_{bt} and c_{st} are private information. The players will be able to infer each other’s types if they trade over a sufficiently long period. Prior to that, but after the seller has incurred the specific set-up costs, the buyer can learn his type c_s or his cost c_t of providing the service *t* by incurring costs of K_b or k_b, respectively. Similarly, at this time the seller can learn the buyer’s type v_b or her valuation v_t of the service *t* by incurring costs of K_s or k_s, respectively. We could interpret the *k*s and *K*s as out-of-pocket cost or opportunity costs of time. The game is played in perpetuity and the discount rate for is *r* per period, or $(1 + r)^h – 1$ for every trading period.

The players’ option to “spy” on their opponent’s type prior to bargaining causes some technical complications. Specifically, if a player is uncertain about the opponent’s beliefs, the Common Knowledge of Common Prior (CKCP) condition no longer holds and it is difficult to analyze most bargaining games. Some protocols, like TIOLI or second price auctions, avoid this because a player’s strategy is independent of the opponent’s information. Other alternatives are to look for Ex Post Perfect Public Equilibria or to assume that spying and its results are common knowledge. While the TIOLI protocol raises some unpleasant questions about renegotiation, we use it for technical convenience. So the players bargain by having the buyer make a TIOLI offer with probability θ, and having the seller make the offer with probability $1 - \theta$. If an offer

[11] The assumption is used in two places and we will flag them both.

is refused, the trade to which it applied does not take place, and both players have zero payoffs.[12]

As noted in the Introduction, we will focus the bulk of the analysis on three mechanisms. In the "Market" mechanism, the buyer faces a sequence of sellers, trading with whoever is most efficient in each period. Compared to bilateral mechanisms, this has two advantages; it allows trade from a more attractive cost-distribution, and it subjects the players to "market discipline", eliminating incentives to bargain and thus the need to collect information about each other.[13] However, since the seller will trade with a sequence of buyers, he will incur specific set-up costs at each turn. The "Sequential Contracting" mechanism is one in which the two parties stay with each other in perpetuity and bargain anew over each trade. This allows them to incur the specific set-up costs u only once, because the seller is continuing to serve the same buyer. On the other hand, they lose the market discipline and thus face some bargaining costs. While they eventually learn each others' types v_b and c_s, they will have to pay to learn the fits, v_{bt} and c_{st}, between their opponents and each task. The "Employment" mechanism is similar in the sense that the two parties never trade with anyone else. However, in this mechanism they only bargain once – at the very start – and then make any subsequent trades at the price agreed upon. This may involve fewer bargaining costs than the Sequential Contracting mechanism. We will now look at each mechanism in turn.

[12] We need rejection payoffs to be zero in order to maintain the credibility of a TIOLI offer. It is not unreasonable in the Sequential Contracting mechanism because one could expect some delays in any re-matching process. While it is not appealing in the Employment mechanism, it should be kept in mind that the TIOLI bargaining process is not essential for the results. It merely allows us to model one type of bargaining costs in a consistent way. The key is that no mechanism can govern bargaining in a fully efficient way (Myerson and Satterthwaite, 1983).

[13] In Section IV, we will add a third advantage, that the Market allows the buyer to be idle.

II. 1. Market

To avoid burdening the Market with any non-essential inefficiencies, we look for equilibria in which sellers provide the services with which they have the best fit. Recalling that the fit c_{st} between a given service t and a specific seller s is constant over time, we will say that s is an "expert" in the service t' with which he has the best fit. So t' is defined by $c_{st'} = Min_t\{c_{st} \mid t \in T\}$. We assume that sellers exit all markets in which they are not experts.

Let $\underline{c}_{t'} \equiv Max_s\{c + c_s + c_{st'}\}$ and $\underline{v}_{bt'} \equiv Min_b\{v + v_b + v_{bt'}\}$ be the per period cost and value of the worst type seller and buyer, respectively, in submarket t'. We imagine that the players run a θ-double auction (Rustichini, Satterthwaite, and Williams, 1994) and assume that $\theta\underline{c}_{t'} + u/h < \theta\underline{v}_{bt'}$, such that all participants will be willing to trade at $p_{t'} = h\theta\underline{c}_{t'} + h(1 - \theta)\underline{v}_{bt'} + u$. Using E as the expectations operator and recalling that $|T| = \infty$, we note that $E\underline{c}_{st'} = -\alpha$, $\underline{c}_{t'} = c + \gamma - \alpha$, and the value created per trade is $h(v - c + \alpha) - u$.[14]

Our formulation implies that we abstract from the service delays experienced by buyers and portray the sellers' specific set-up costs as the only downside of the market. While this is quite arbitrary, it 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.[15] The following sequence of events then defines the "Market" mechanism from the perspective of the buyer b:

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[14] Since $E\underline{v}_{bt'} = -1/2$ if $|T| = \infty$, all trades are made if $c + \gamma - \alpha + u/h < v - \beta - 1/2$.

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

Prior to the start of the first period:

0.1. The players observe their types. Each seller *s* observes the service t' for which he is an expert. The players run a θ-double auction resulting in an equilibrium per period price of $p_{t'} = \theta \underline{c}_{t'} + (1 - \theta)\underline{v}_{bt'} + u/h$.

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

t.1. The buyer learns which service *t* is right as well as her valuation of it.

t.2. The buyer is matched with an expert seller of *t* and the parties trade.

t.3. The seller delivers after incurring the specific set-up costs *u*.

This gives:

PROPOSITION 1: *The total expected per buyer per period payoffs in the Market mechanism approximates*

$$\Pi_m \equiv v - c + \alpha - u/h \qquad (1)$$

So payoffs differ from the best possible by the specific set-up costs only and these costs matter less for services of longer duration. Note that we also could interpret *u* as a decrease in buyer 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 seller dedicate himself to a single seller (such that he can avoid repeatedly paying *u*). The downside of this is that gains from specialization are lost and bargaining costs appear.

II. 2. Sequential Contracting

We define this mechanism as follows:

Prior to the start of the first trading period:

0.1. The players observe their types and are matched up in seller-buyer pairs.

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

t.1. The buyer learns which service *t* is right and informs the seller.

t.2. The buyer observes v_t and the seller observes c_t.

t.3. The players may pay to observe each other's valuations.

t.4. Nature decides who makes the TIOLI offer and the chosen player makes the offer.

t.5. The other player accepts or refuses. Refusal means that both players get zero payoffs in this trading period.[16] Acceptance means that the service is performed and that payoffs are distributed. In either case the players proceed to the next trading period.

The non-trivial decisions are at stages *t.3* and *t.4* and we will look at the latter first. There are three different cases.

(a) If the player making the offer knows the opponent's valuation and $v_t > c_t$, the offer will give all surplus to the player making it.

(b) If the player making the offer knows the opponent's valuation and $v_t < c_t$, no trade is made and both get zero surplus.

[16] The TIOLI protocol is given credibility by the assumption that no seller can service two buyers in the same period.

(c) 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.

Only the last case is complicated. In the first trading 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. This information could come from revealing offers, acceptances or rejections, as well as from search. Since better-informed players have weaker incentives to search, we look for conditions under which even they will do so.

Consider a seller who knows the buyer's type v_b, but not the realization v_{bt}. This seller's TIOLI offer would be

$$p^*_{st}(c_t, v_b)/h = argmax(p_{st} - c_t)Prob(v_t > p_{st})/h$$

$$= v + v_b + ½, \qquad if\ -1/2 \geq v + v_b - c - c_s - c_{st}$$

$$= 1/4 + (v + v_b)/2 + (c + c_s + c_{st})/2, \qquad if\ -1/2 < v + v_b - c - c_s - c_{st} < 3/2,$$

$$= v + v_b - ½, \qquad if\ v + v_b - c - c_s - c_{st} \geq 3/2 \qquad (2)$$

Sellers in the first region will not pay to learn v_{bt} since there is no trade anyway. A seller in the second region only benefits from knowing his opponent's valuation if he get to make the offer. If such a seller has costs above the minimum possible valuation, he will pay k_s to learn v_{bt} if

$$(1- \theta)\{\int c_t\ [v_t - c_t]dv_t - (p^*_{st} - c_t)[1- G_b(p^*_{st}/h - v - v_b)]\} > k_s$$

or

$$(1- \theta)(v + v_b + 1/2 - c_t/h)^2/4 > k_s/h \qquad (3)$$

If his cost are below the minimum possible valuation, *(3)* becomes

$$(1-\theta)[v + v_b - c_t/h - (v + v_b + 1/2 - c_t/h)^2/4] > k_s/h \qquad (4)$$

Finally, a seller in the third region will pay k_s to learn v_{bt} if $k_s < ½$. So we have

FINDING 1: *Sellers are more likely to incur search cost if they have more bargaining power (1- θ), if the tasks are big (h), if the buyer's valuation is high (v_b), and if the search costs are lower (k_s). The probability increases in v and v_b, while it decreases in c, c_s, and c_{st}, and thus increases in expected surplus ($v - c - c_s - c_{st}$).*[17]

We next look at a buyer who knows the seller's type c_s, but not the realization c_{st}. This buyer will make a TIOLI offer of

$$p^*_{bt}(v_t, c_s)/h = \operatorname{argmax}(v_t - p_{bt})Prob(p_{bt} > c_t)/h$$

$$= c + c_s - \alpha, \qquad \text{if } -\alpha \geq v + v_b + v_{bt} - c - c_s.$$

$$= (c + c_s)/2 + (v + v_b + v_{bt})/2 - a/2, \qquad \text{if } -\alpha < v + v_b + v_{bt} - c - c_s < 3\alpha.$$

$$= c + c_s + \alpha, \qquad \text{if } v + v_b + v_{bt} - c - c_s \geq 3\alpha. \qquad (5)$$

As was the case for the sellers, buyers in the first region will not pay to learn c_{st} since there is no trade anyway. A buyer in the second region with valuation below the maximum possible cost will pay k_b to learn c_{st} if

$$\theta\{\int^{vt} [v_t - c_t]/(2\alpha)dc_t - (v_t - p^*_{bt})\, G_s(p^*_{bt}/h - c - c_s)\} > k_b$$

or

$$\theta[v_t/h - c - c_s + \alpha]^2/(8\alpha) > k_b/h \qquad (6)$$

If the buyer's valuation is above the maximum possible costs, *(6)* becomes

$$v_t/h - c - c_s - (v_t/h - c - c_s + \alpha)^2 > 8\alpha k_b/(h\,\theta) \qquad (7)$$

---

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

Finally, buyers in the third region will pay k_b to learn c_{st} if $\alpha > k_b$. So we get:

FINDING 2: *Buyers are more likely to incur search cost if they have more bargaining power (θ), if the services are big (h), if the seller's costs are likely to be low (c_s), if the variance in seller fits is larger (α), and if the search costs are lower (k_b). The probability increases in v, v_b, and v_{bt}, while it decreases in c, c_s and thus increases in expected surplus ($v + v_b + v_{bt} - c - c_s$).*

In the region in which all players search, bargaining costs take the form of search costs rather than missed trades.

PROPOSITION 2: *Assuming that both players always search, the ex ante expectation of total payoffs per buyer per period in the Sequential Contracting mechanism is*

$$\Pi_{sc} \equiv \iiiint_{v_t > c_t} (v_t - c_t)/h\, dG_b dG_s dF_b dF_s - (k_b + k_s)/h - ru$$

$$= v - c + E(c + c_s + \alpha - v - v_b + 1/2)^3/(12\alpha) - (k_b + k_s)/h - ru$$

$$= \quad v - c + E(\max c_t - \mathrm{Min}\, v_t)^3/(12\alpha) - (k_b + k_s)/h - ru, \qquad (8)$$

where the expectation is taken over v_b and c_s.

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 search costs. So payoffs differ from the best possible by the inefficiency of the seller and the ongoing bargaining costs. The Employment mechanism aims to reduce these bargaining costs.

Remark 1: While the extensive form does not allow a player to break up and search for another partner in case he or she gets bad news about the initial partner, it is logical to ask about this possibility. While the benefits of re-matching depend on the way one specifies the matching market as well as the relative numbers of sellers and buyers, it is clear that some the available players will be strong ”types” while the others will be “weak” (perhaps having been rejected by stronger partners). So a player may need to break up and rematch more than once before finding a compatible partner and the expected cost per pair is a multiple of $k_s + k_b + u$. The simplest way to think about the foregoing extensive form is that the Mechanism is credible because $k_s + k_b + u$ is large relative to the variances in types and fits (representing the possible gains from re-matching).

II. 3. Employment

We define the “Employment” mechanism as follows:

Prior to the start of the first trading period:

0.1. The players observe their types and are matched up in seller-buyer pairs.

0.2. The players may pay to observe each other’s types.

03. Nature decides who makes the TIOLI offer and the chosen player makes an offer for all periods until one of the players terminate the agreement.

0.4. 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 game continues to stage 1 below.

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

t.1. The buyer learns which service t is right and informs the seller.

t.2. The buyer observes v_t and the seller observes c_t.

t.3. The players may communicate about v_t and c_t.

t.4. The players may agree to abstain from trade in trading period t. If so, they proceed to the next trading period.

t.5. Either player can terminate the agreement. If one does, the players get zero payoffs for this and all future periods. If neither does, the service is performed, payoffs are distributed, and the players proceed to the next trading period.

The idea behind stages 3 and 4 is to allow a super-game equilibrium in which the players avoid inefficient trades, for example by not allowing claims of $c_{st} > c'$ and $v_{bt} < v'$ in fractions greater than $1 – G_s(c')$ and $G_b(v')$ of large numbers of trading periods. By Corollary 2 in Jackson and Sonnenschein (2007), such an equilibrium can be asymptotically efficient if the per trading period interest rate $(1 + r)^h – 1$ is sufficiently small. But since employment is more likely to be used exactly when h is small, this is not a particularly offensive assumption. Without this super-game equilibrium, the Employment mechanism would be burdened by occasional inefficient trades as well as pre-bargaining search costs. Assuming efficient ex post trade helps keep the analysis clean.

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.

To investigate the players' incentives to incur search costs, we proceed as in subsection II.2 and consider a seller who does not know the buyer's type v_b. This seller's TIOLI offer would be

$$
\begin{aligned}
p^*_{es}(c_s) &= argmax(p_{et} - c - c_s)Prob(v + v_b > p_{et}) \\
&= v + \beta, && \text{if } c_s - \beta \geq v - c \\
&= (\beta + v + c + c_s)/2, && \text{if } c_s - \beta < v - c < 3\beta + c_s \\
&= v - \beta, && \text{if } v - c \geq 3\beta + c_s \qquad (9)
\end{aligned}
$$

As in sequential contracting, sellers in the first region will not pay to learn v_b since there is no trade anyway. A seller in the second region only benefit from knowing his opponent's type if he get to make the offer. Such a seller with $c_s > v - \beta - c$ will pay K_s to learn v_b if

$$(1-\theta)\{\int_{c + cs - v} [v + v_b - c - c_s]dG_b - (p^*_{es} - c - c_s)[1 - G_b(p^*_{es} - v)]\} > rK_s, \qquad (10)$$

while a seller with $c_s \leq v - \beta - c$ will pay K_s to learn v_b

$$(1-\theta)\{\int[v + v_b - c - c_s]dG_b - (p^*_{es} - c - c_s)[1 - G_b(p^*_{es} - v)]\} > rK_s, \qquad (11)$$

Finally, sellers in the third region will pay K_s to learn v_b if $K_s < \beta$. So we have:

FINDING 3: *Sellers are more likely to incur search cost if they have more bargaining power* $(1-\theta)$, *if the variance in buyer types is larger* (β), *and if the search costs are lower* (rK_s). *The probability increases in* v *and* v_b, *while it decreases in* c *and* c_s, *and thus increases in expected surplus* $(v - c - c_s)$.

Similarly, a buyer who does not know the seller's type c_s will make a TIOLI offer of

$$p^*_{eb}(v_t, c_s) = argmax(v + v_b - p_{eb})Prob(p_{eb} > c + c_s)$$

$$= c - \gamma, \qquad if -\gamma - v_b \geq v - c.$$

$$= (v + v_b + c - \gamma)/2, \qquad if -\gamma - v_b < v - c < 3\gamma - v_b.$$

$$= c + \gamma, \qquad if\ v - c \geq 3\gamma - v_b. \qquad (12)$$

As above, buyers in the first region will not pay to learn c_s. A buyer in the second region with valuation below the maximum possible costs will pay K_b to learn c_s if

$$\theta\{\int^{v+vb-c}[v + v_b - c - c_s]dG_s - (v + v_b - p^*_{eb})\, G_s(p^*_{eb} - c)\} > rK_b, \qquad (13)$$

while if the buyer's valuation is above the maximum possible costs, *(13)* becomes

$$\theta\{\int[v + v_b - c - c_s]dG_s - (v + v_b - p^*_{eb})\, G_s(p^*_{eb} - c)\} > rK_b \qquad (14)$$

Finally, buyers in the third region will pay K_b to learn c_s if $K_b < \gamma$. So we have:

FINDING 4: *Buyers are more likely to incur search cost if they have more bargaining power (θ), if the variance in seller types is larger (γ), and if the search costs are lower (rK_b). The probability increases in v and v_b, while it decreases in c and thus increases in expected surplus ($v + v_b - c$).*

PROPOSITION 3: *Assuming that both players always search, the ex ante expectation of total payoffs per buyer per period in the Employment mechanism is*

$$\Pi_e \equiv \iiiint_{v_t > c_t} (v_t - c_t)/h dG_b dG_s dF_b dF_s - r(K_b + K_s) - ru =$$

$$v - c + E(max\ c_t - Min\ v_t)^3/(12\alpha) - r(K_b + K_s) - ru, \qquad (15)$$

where the expectation is taken over v_b and c_s.

So payoffs differ from the best possible by the one-time bargaining costs and the inefficiency of the seller.

Remark 2: Also here, the extensive form does not allow a player to break up and search for another partner in case he or she gets bad news about the initial partner and it is again logical to ask about this possibility. Analogously to what was argued in *Remark 1*, the simplest way to think about the foregoing extensive form is that TIOLI protocol is credible because $K_s + K_b + u$ is large relative to the variances in types.

Remark 3: If it is anticipated that the types will change over time, one could imagine agreements with increasing wage-profiles. Similarly, while the commitment against renegotiation is supported by the bargaining costs K_s and K_b, one could imagine unanticipated shocks setting off occasional renegotiation and changes in wages. Nevertheless, the difference to Sequential Contracting should be clear, since all changes result in renewed negotiations in the latter mechanism.

II.4. Comparison

As we have built the argument in a piecemeal way, it might be helpful to summarize the relative strengths and weaknesses of the different mechanisms here. Recapitulating, the expected per buyer per period payoffs from the Market mechanism, the Sequential Contracting mechanism, and the Employment mechanism are, from **PROPOSITIONS 1, 2,** and **3:**

$$\Pi_m \equiv v - c + \alpha - u/h \qquad (16)$$

$$\Pi_{sc} \equiv v - c + E(max\ c_t - Min\ v_t)^3/(12\alpha) - (k_b + k_s)/h - ru. \qquad (17)$$

$$\Pi_e \equiv v - c + E(max\ c_t - Min\ v_t)^3/(12\alpha) - r(K_b + K_s) - ru \qquad (18)$$

We immediately get:

PROPOSITION 4: *(i) Comparing the Market mechanism and the bilateral mechanisms, we see that the Market is more efficient if gains from specialization are larger (α), if set-up is cheaper (u), and if bargaining costs are larger (k, K).*

(ii) Comparing the Sequential Contracting mechanism and the Employment mechanism, we see that Employment is more efficient if services are smaller (1/h), if the spot bargaining costs are larger ($k_b + k_s$), and if players are more patient (r).

Figures 1 and 2 illustrate these results along the dimensions of frequency of change (*1/h*), specific set-up costs (*u*), and gains from specialization (α).

Figure 1

Most Efficient Mechanisms by Frequency of Change and Specific Set-up Costs

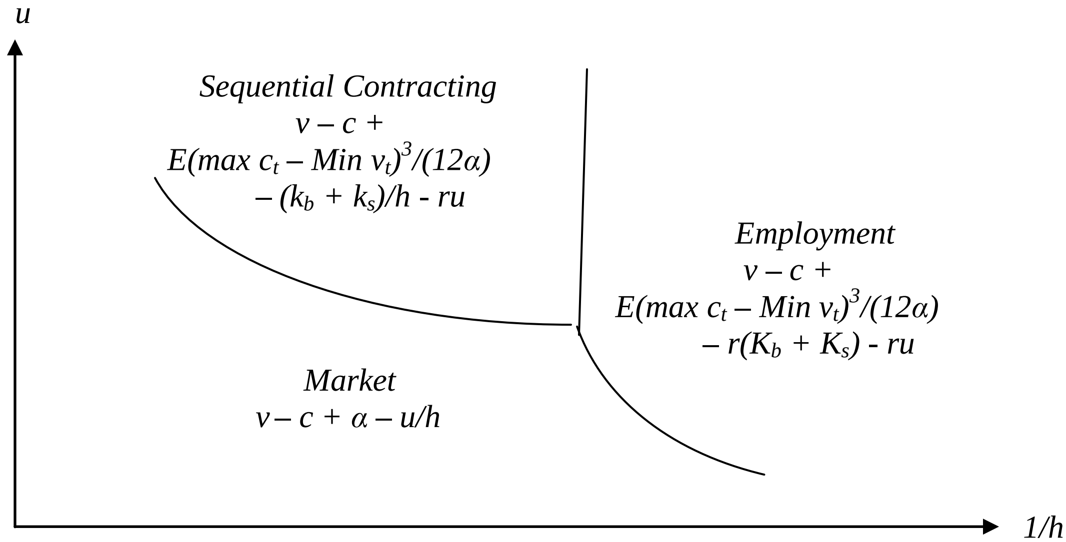
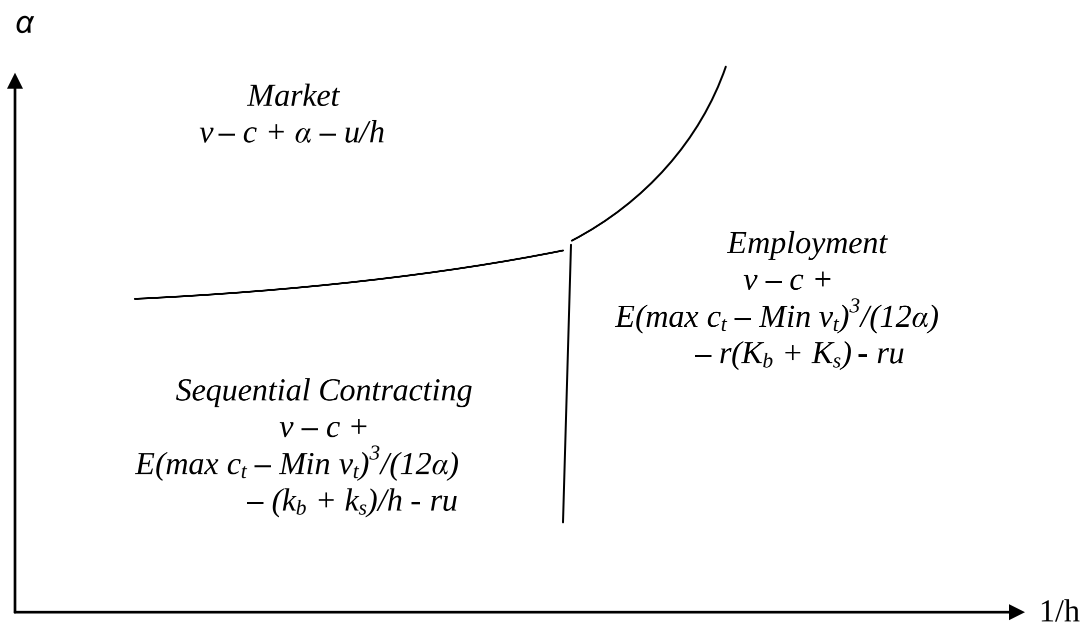


Figure 2

Most Efficient Mechanisms by Frequency of Change and Gains from Specialization



While the model makes intuitively appealing predictions about the use of employment versus markets, the existence of even better alternatives have not yet been ruled out. We will therefore look at the attractiveness of other mechanisms in Section III.

III. OTHER MECHANISMS ARE WEAKLY DOMINATED

In this Section, we justify the focus on the Market, Sequential Contracting, and Employment, by showing that, for the model laid out in Section II, there exists three regions in which any incentive compatible individually rational mechanism is weakly dominated by one the three. The result is admittedly quite weak. It asserts the existence of three regions, but says nothing about their size. It is entirely feasible that the reader's favorite mechanism dominates in a larger region.

Before embarking on the proof, it is useful to make clarify exactly what the result is. The alternative mechanisms have to respect the technological and informational constraints on the model; we do not allow remote production, coalitions, or budget breaking. So what alternatives do we allow? First, our three focal mechanisms have all sellers simultaneously exploring trade with all buyers (Market) or one seller exploring trade with one buyer (Employment and Sequential Contracting). We allow any number of sellers to simultaneously explore trade with any, possibly different, number of buyers. Second, in our focal mechanisms, equilibrium trade between two players is either not repeated (Market), or repeated ad infinitum (Employment and Sequential Contracting). Subject to the informational constraints, we allow any decision rules about the initiation, length, and termination of trading relationships. Third, in Employment and Sequential Contracting, all bilateral bargaining follows a TIOLI protocol. We allow any other incentive compatible individually rational protocol whether two or more players are exploring trade.

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 k, K, or 0, production costs are c or c-α, and specific set-up costs are u or 0. Mechanisms involving different numbers and lengths of interactions tend to score on the same discrete scales, making efficiency comparisons relatively straightforward. Furthermore, we can to some extent piggyback on Myerson and Satterthwaite (1983) when evaluating alternatives to the TIOLI bargaining protocol.

THEOREM: *There exists three regions in which any incentive compatible individually rational mechanism is weakly dominated by the Market, Sequential Contracting, or Employment, respectively.*

PROOF: The Market always implements efficient trade and the two bilateral mechanisms do so if players invest in pre-bargaining search. Since we just want to establish existence of a region, we focus on subsets of the parameter space in which this happens. There are six components of efficiency in this model: Getting jobs done by the lowest cost sellers (division of labor), maximizing gains from trade (efficient trade), avoiding specific set-up costs, minimizing the two types of bargaining costs (call k costs and K costs), and not leaving sellers idle. Each of the three mechanisms considered excels at some of these and does less well on others. The performances of our three focal mechanisms are summarized in Table 1 below.

Table 1

Components of Efficiency and Performance of Mechanisms

	Market	Sequential Contracting	Employment
Division of Labor	x	1	1
Efficient Trade	x	x	x
Specific Set-up Costs	2	x	x
K Bargaining Costs	x	x	3
k Bargaining Costs	x	3	x
No Idle Sellers	x	x	x

x denotes that the mechanism is maximally efficient on the component in question.
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 "x" in the same column.

The only way to do better in the cells labeled "1" is to permanently station more than one seller on site (in effect hiring several people to do one person's job). Compared to the Market, stationing more sellers on site would avoid specific set-up costs, but cause some sellers to be idle and do less well on the division of labor. Compared to Sequential Contracting or Employment, it leaves some sellers idle but improves on the division of labor. Having more sellers on site might also avoid *k* or *K* bargaining costs but would in that case lose some efficiency. Note, however, that the players would incur search costs as long as these are sufficiently small. We thus assume that search costs are incurred and that trade is fully efficient and find a condition under which at most one seller should be based on site. Recall that each buyer's needs require one full time equivalent seller and suppose that $\varphi > 1$ sellers are based on site and share the assignment such that any service is performed by whoever can do it at the lowest cost. Let G_φ be the distribution of the lowest of φ draws from the cost distribution G_s. Disregarding the cost of reaching agreement and the cost of being idle, we can write an upper bound on the expected sum of buyer and seller payoffs, per service, per seller, as

$$E \iint_{v_t > c_t} (v_t - c_t)/h dG_b dG_\varphi / \varphi, \tag{19}$$

where the expectation is taken over v_b and c_s. For the uniform G_s used here, this is decreasing in φ, and its value for $\varphi = 2$ is less than the payoff from Employment unless v-c is very small. Specifically, we have

LEMMA 1: *At most one seller should be based on site if*

$$v - c > 2r(K_b + K_s) - E \iint_{c_t > v_t} (c_t - v_t)(c_{st} + \alpha)/(2\alpha^2 h) dv_{bt} dc_{st} \tag{20}$$

The only way to do better in the cell labeled "2" is to sometimes let a seller 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 seller on site until the next need is revealed.[18] The incumbent seller can then stay and do the job iff his costs are less than $h(c - \alpha) + u$[19], those of the average 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 seller. An example of the former would be the

[18] This shares features with the mechanisms studied by Stole and Zweibel (1996a, b)
[19] As in Section II, we assume that $c + \gamma - \alpha + u < v - \beta - 1/2$, such that there is trade in every period.

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. As the former generally is more efficient, we will look at that.

Since no seller can visit two buyers in the same period, a replaced seller will be idle for one period. Compared to the Market, Contingent Turnover does better on specific set-up costs and less well on idling of sellers, the division of labor, and bargaining costs. Relative to Sequential Contracting, it improves the division of labor, but does less well on specific set-up costs and the idling of sellers. To rule this out, we will find a set of conditions under which either the Market, Sequential Contracting, or Employment does better. To keep things simple, we make the argument for the case $h = 1$. (So all services take exactly one period to perform.)

Consider a mechanism in which the price charged by a continuing seller is determined by bargaining and confine attention to the region in which both parties will incur the search costs k_s and k_b, as in Sequential Negotiation. Since all active sellers will have low costs, an incumbent can continue if $c_{st} < - \alpha + u$. The chance of this is $u/(2\alpha)$ and in those cases the average cost is $c – \alpha + u/2$, while the search costs are $r(K_s + K_b)$. There are no bargaining costs when the seller is replaced, but the production costs are $c – \alpha + u$, and the incumbent seller will be idle for the period. The average per period, per seller, surplus is then $\{v – c + \alpha – u + (u/[2\alpha])(u/2- rK_s - rK_b)\}/(2 - u/[2\alpha])$. This mechanism is non-degenerate if $r(K_s + K_b) < u/2 < \alpha$, and the payoffs go to Π_{sc} and Π_m, respectively, as $u \rightarrow 2\alpha$ and $u \rightarrow 2r(K_s + K_b)$. Noting that $\Pi_{sc} = v – c - k_s - k_b$ and $\Pi_p = v – c – r(K_s - K_b)$, when the seller is known to have low costs and all trades are efficient, this gives us

LEMMA 2: *Contingent Turnover is dominated by the Market if*

$$(u/[2\alpha])(u/2- rK_s - rK_b)/(1 - u/[2\alpha]) < v - c + \alpha - u \qquad (21)$$

It is dominated by Sequential Contracting or Employment if

$$v - c + \alpha - u <$$

$$(v - c - Min\{k_s+k_b, rK_s+rK_b\})(2 - u/[2\alpha]) - (u/[2\alpha])(u/2- rK_s-rK_b).\text{[20]} \qquad (22)$$

In other words, when experts' cost advantage *(α)* is large, specific set-up costs *(u)* are small, and bargaining costs $rK_s + rK_b$ are large, Contingent Turnover is dominated by the Market. When experts' cost advantage is small, specific set-up costs are large, and bargaining costs are small, it is dominated by Sequential Contracting or Employment.

We end by looking at the cells labeled "3", which pertain to bilateral mechanisms only. Suppose that the players consider a mechanism *M*. Because trade is repeated, the randomness in "fits" v_{bt} and c_{st} may average out over time. However, this argument does not apply to the "types" which are constant over time. The expected payoffs, $\Pi_{Mb}(v_b, c_s)$, $\Pi_{Ms}(v_b, c_s)$ will depend on v_b and c_s. 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 for sufficiently low values of K_b and K_s, both players will have incentives to invest in search about the opponent's type

[20] Neither inequality holds in a sliver of the parameter space in which *α* is close to *u/2*, such that Contingent Employment (Contingent Sequential Contracting) almost degenerates to, behaves like, and performs as, regular Employment (Sequential Contracting).

prior to negotiation. There will thus be a region in which the players would incur the *K* bargaining costs and therefore do weakly worse than Employment. So we have

LEMMA 3: *There exists a region in which any incentive compatible individually rational bilateral mechanism is weakly dominated by Employment.*

Proposition 4 and Lemmas 1, 2, and 3 imply the Theorem.

Q.E.D.

Since the model analyzed so far is extremely stylized, we now generalize it in several directions. Doing so will introduce more forces to the Sequential Negotiation vs. Employment vs. Market comparison.

IV. EXTENSIONS

IV.1. Buyers with Needs of Different Magnitude

We can get some interesting labor economics implications by looking at a case in which some buyers need the services of more than one seller while other need less.

Consider first what happens if the buyer sometimes has no needs at all, but the equilibrium still requires the seller to stick around and be idle? To model this, we assume that the "zero service" is right with probability *z*. The buyer values this at $v_z = 0$ and the seller 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 payoffs per period per seller in the Sequential Contracting, Employment, and Market mechanisms are

$$\Pi_{sc} \equiv (1 - z)\ [v - c + E(\max c_t - \mathrm{Min}\ v_t)^3/(12\alpha) - (k_b + k_s)/h] - ru \tag{23}$$

$$\Pi_e \equiv (1 - z)[v - c + E(\max c_t - \mathrm{Min}\ v_t)^3/(12\alpha)] - r(K_b + K_s) - ru \tag{24}$$

$$\Pi_m \equiv v - c + \alpha - u/h \tag{25}$$

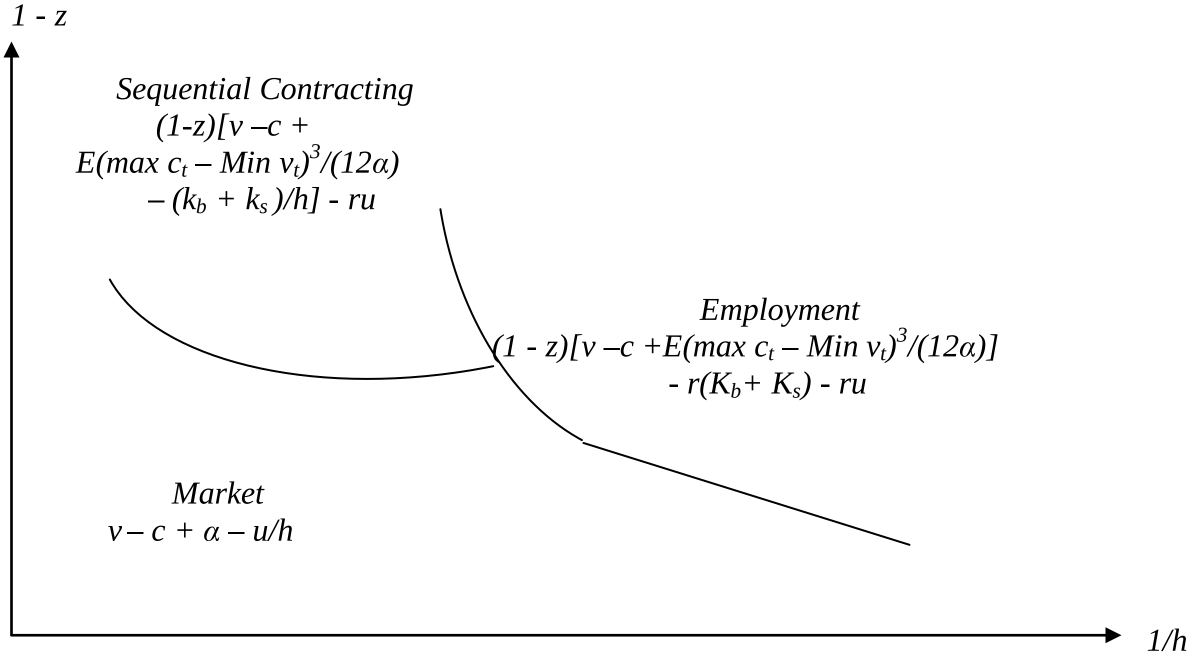
So in addition to the results derived in Section II, this gives:

FINDING 5: *Employment will be more attractive if the right trade is less likely to be inefficient. An important special case of this is when the buyer has more constant needs (1- z). Conversely, a major advantage of the Market mechanism is that sellers are not waiting around for buyers to need them, but are used more efficiently.*

Figure 3 below illustrates this result by giving the surplus along the dimensions of frequency of change ($1/h$) and constancy of needs ($1 - z$).

Figure 3

Most Efficient Mechanisms by Frequency of Change and Constancy of Needs



An interesting implication of the result is that buyers with many needs in a narrow area can allow employees to specialize quite a bit, thereby closing part of the productivity gap between Employment and the Market. Consider a buyer with very large needs. As suggested by the landlord example in the Introduction, such a buyer could use Employment to acquire a relatively specialized service that normally would be traded in the Market. So *specialists will either work in large firms or as independents*.[21] This also implies that *larger buyers 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. More generally, this is consistent with the stylized fact that

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

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.

IV.2. Many Classes of Services

In the models considered so far, there is no heterogeneity in equilibrium; all sellers use the same mechanism. One way to study heterogeneity is to look at the (realistic) case in which the set of services T is partitioned into τ uncountable subsets $(T_1, T_2, \ldots T_\tau)$ each of which is characterized by its own vector of parameters $(\alpha_i, \beta_i, \gamma_i, h_i, u_i, z_i \ldots)$. We assume that this is a τ-fold replication of the original model except that each seller has cost realizations in all subsets, but can participate in one only. So a seller can become a semi-specialized employee with responsibility for all services in T_i, but not for others, or he can become an independent seller of one service in one subset of T, while not participating in the other subsets at all.

Compared to the analysis in Section II, this tells us little new about the mechanisms used to trade different types of services as functions of their location in the parameter space. However, it does allow us to characterize the types of sellers who will supply different classes of services. A seller's surplus as a Market specialist will depend on the difference, $\underline{c}_t - (c + c_s + c_{st})$, between his costs and those of the weakest Market participant, while his surplus as an Employee will depend on his bargaining power, his average cost $c + c_s$, and the buyer's mean valuation v. Recognizing that the bargaining power is endogenous, we can nevertheless predict that *sellers with strong talents* (c_{st}) *in* *narrow Market traded services will become independents, while those with strengths (c_s) in broader Employment traded services will become employees* (Rosen, 1983).

IV. 3. Few Tasks: Price Lists

We have so far thought of the number of possible services as being uncountable. Suppose however, that the number of different services, $|T|$, is a small finite number. In this case, services will recur and the players have the option of using the same prices as those negotiated the last time the service was right. By thus creating a "price list", the players can do weakly better. A market is made "thicker", and thus weakly more efficient, by the price list. In a bilateral setting, the ex ante expectation of total payoffs per period in the Price List mechanism are

$$\Pi_{pl} \equiv \iint_{v_t > c_t} [v_t - c_t]/h\,dG_b dG_s - r|T|(k_b + k_s)/h - ru =$$

$$v - c + E(\max c_t - \mathrm{Min}\, v_t)^3/(12\alpha) - r|T|(k_b + k_s)/h - ru \qquad (26)$$

Comparing to *(8)* and *(15)*, the Price List mechanism is better than the Sequential Contracting mechanism if $r|T| < 1$, and better than the Employment mechanism if $|T|(k_b + k_s) < h(K_b + K_s)$. *So the attractiveness of the Employment mechanism depends on the tasks being sufficiently diverse.*

Beauty shops are good examples of price lists. They offer a small set of services but some, such as haircuts, can be delivered in many variations ("as you like it"). It is important to note that all prices are higher than the corresponding costs, implying that the Price List mechanism, unlike Employment, does not depend on an ongoing relationship between buyer and seller. (So hairdressers are not employees of their customers.)

V. DISCUSSION

Our theory portrays Employment as more attractive if the buyer has many, small needs, if it is costly for sellers to switch from one buyer to another, and if the advantages of specialization are small. The Market is used if needs are less constant, for larger services, and better met by specialists.

While we thus can build a model in which the Employment mechanism plays the role of what we normally call employment in *this* model against *these* alternatives, one could ask whether the Employment mechanism could be used in (un-modeled) cases where employment is not? We will give partial answer: 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 seller avoids having to set-up, 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 (as in Board, 2011).[22]

[22] 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). Two important circumstances in which the buyer will want to prescribe a particular method of production are when she knows more about the production technology or when it is hard to ask an individual to "make" a particular final good (as in team production). Insisting on a method could potentially be difficult if the seller feels that an alternative would have been easier. However, since the seller's compensation is scaled by the "duration" h, he should be happy to oblige as long as $c_t = h(c + c_s + c_{st})$ falls within the anticipated distribution. To be sure, such accommodations could in principle also be made in the Sequential Contracting or Market mechanisms. For example, one could imagine, in order of decreasing

The theory has many testable implications in the areas of organizational, trade, and labor economics. One strong prediction of the bargaining cost component of the analysis is that smaller, more frequently changing tasks are more likely to be governed by Employment. Other testable hypotheses are driven by the gains from specialization and specific set-up 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, 2009) 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 contrast to almost all empirical work in the economics of organization, this test would be driven by differences in the "cost of hierarchy", as opposed to the "cost of the market" (Gibbons, 2010).

In terms of future theoretical research it is tempting to develop a general equilibrium model with endogenous trading mechanisms, along the lines of Grossman and Helpman (2002), Antras and Helpman (2004), and Acemoglu, Gancia, and Zilibotti (2010). By allowing for appropriate heterogeneity, such a model would have an

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absurdity, getting a left-handed haircut, having one's lawn cut with a push mower, or buying "organically grown" fruit. To the extent that these requests are unusual it will, however, be hard to enforce quality standards in one-shot deals. So the Employment mechanism should be more attractive if the buyer wants to specify the methods by which work is done. However, as seen by the above examples, I do not believe that the definition coincides perfectly with everyday use.

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. Size would eventually be limited by increased transportation costs on the output side, but as the model currently stands, it does not have any organizational dis-economies of scale. However, it would seem logical to assume the buyer faces increasing cost of attending to the implicit contracts of employees, thus opening the door for a theory of organizational structure.

However, to properly model larger organizations, we should look at the needs as endogenous; firms decide how many, and which, markets they want to serve. This has very appealing implications. Consider a firm that has hired a manager who has gone through the corporate socialization process (u), but whose expertise the firm does not use at all times (or a firm whose needs for an expert are large, but not quite large enough to justify hiring a full time employee.) Such a firm will have incentives to enter an additional line of business in order to fully utilize the expert. This argument is very similar to those made by Penrose (1959) and is consistent with management scholars' views about the determinants of the scope of the firm.[23]

[23] Interestingly, The Economist Magazine (2010) recently called for economic theories of the firm to incorporate elements of the "Resource-Based View" of the firm that has been so influential in the management literature.

APPENDIX: BARGAINING COSTS AS MISSED TRADES

Instead of using pre-bargaining search costs to represent the inefficiencies of the Sequential Contracting and Employment mechanisms, we could build a simpler model by focusing on the inevitably missed trades.

In such a model, the Sequential Contracting mechanism is defined as follows:

Prior to the start of the first trading period:

0.2. The seller incurs u, the buyer observes v_b, and the seller observes c_s.

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

t.1. The buyer learns which service t is right and informs the seller.

t.2. The buyer observes v_t and the seller observes c_t,.

t.3. The players use the most efficient bargaining protocol as identified by Myerson and Satterthwaite (1983).

t.4. Disagreement means that both players get zero payoffs in this trading period. Agreement means that the service is performed and that payoffs are distributed. In either case the players proceed to the next trading period.

Using L_{sc} to denote the difference between the maximal and actual gains from trade, we get:

PROPOSITION 2a: *The ex ante expectation of total payoffs per period in the Sequential Contracting mechanism is*

$$\Pi_{sc} \equiv \iiiint_{v_t > c_t} (v_t - c_t)/h dG_b dG_s dF_b dF_s - ru - L_{sc}$$

$$= \quad v - c + E(\max c_t - \min v_t)^3/(12\alpha) - ru - L_{sc} \qquad (A1)$$

where the expectation is taken over v_b and c_s.

Similarly, we can define the Employment mechanism as follows:

Prior to the start of the first trading period:

0.1. The seller incurs u, the buyer observes v_b, and the seller observes c_s.

0.2. The players may pay to observe each other's types.

03. The players use the most efficient bargaining protocol as identified by Myerson and Satterthwaite (1983)

0.4. Disagreement means that the players get zero payoffs in this and all future periods and agreement means that the game continues to stage 1 below.

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

t.1. The buyer learns which service t is right and informs the seller.

t.2. The buyer observes v_t and the seller observes c_t.

t.3. The players may communicate about v_t and c_t.

t.4. The players may agree to abstain from trade in trading period t. If so, they proceed to the next trading period.

t.5. Either player can terminate the agreement. If one does, the players get zero payoffs for this and all future periods. If neither does, the service is performed, payoffs are distributed, and the players proceed to the next trading period.

Using L_e to denote the difference between the maximal and actual gains from trade, we get:

PROPOSITION 3a: *The ex ante expectation of total payoffs per period in the Employment mechanism is*

$$\Pi_e \equiv \iiiint_{v_t > c_t} (v_t - c_t)/h dG_b dG_s dF_b dF_s - ru - L_e =$$

$$v - c + E(\max c_t - \operatorname{Min} v_t)^3/(12\alpha) - ru - L_e, \qquad (A2)$$

where the expectation is taken over v_b *and* c_s.

The comparisons between the Market, Sequential Contracting, and Employment are very similar to those in the main text. One difference is that the search costs are replaced by missed trades; another is that the former are proportional to the number of negotiations while the latter are proportional to the gains from trade. We thus loose the prediction that more frequent trade favors Employment over Sequential Contracting.

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