

THE EQUILIBRIUM ORGANIZATION OF LABOR

by

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Abstract

We look for the equilibrium organization of labor. The environment has two critical features: (a) Multilateral matching allows gains from specialization, but players incur specific set-up costs each time they are matched with a new trading partner. (b) Bilateral relationships economize on set-up costs, but are burdened by bargaining costs. Under weak conditions, four mechanisms weakly dominate all others: Markets, employment with negotiated wages, employment with market wages, and bilateral sequential contracting. For each mechanism, we characterize the tasks traded in it and the players participating. The model does not rest on non-standard assumptions and its predictions depend on several factors that do not play a role in other contemporary theories of organization.

I. INTRODUCTION

The advantages of specialization and the role of markets in supporting it have played a central role in economic reasoning at least since Adam Smith. A more recent, but still old stream of work has compared employment and contracts in agreements of their adaptive properties (Coase, 1937; Simon, 1951). We here draw on both of these traditions to develop a unified theory of governance in the context of labor market equilibrium. Specifically, we first analyze a simple workhorse model with homogeneous tasks, manufacturers, and laborers, showing that four mechanisms; markets, employment with negotiated agreements, employment with wages set in a market, and sequential contracting, weakly dominate all others. Secondly, we introduce different kinds of heterogeneity and characterize the equilibrium mix of mechanisms and the types of products, manufacturers, and laborers for which each is most efficient. We end by taking up the question of optimal firm size. Unlike many modern theories of economic organization the argument does not depend on non-standard assumptions such as behavioral biases, bounded rationality, heterogeneous beliefs, or incomplete contracting.¹

The predictions of the model turn on a different set of factors than those highlighted in much of the literature. Markets are preferred over bilateral mechanisms for services that take longer time to perform, are in less demand, require fewer partner-specific investments, and have larger cost differences between experts and others. Employment is more efficient than sequential contracting when needs change more frequently, and market wages are used for jobs with more standardized agreements. The equilibrium prevalence of each mechanism reflects the relative incidence of services with these properties.

Larger firms hire specialist-employees, firms of intermediate size hire generalist-employees or go to the markets for specialists, and very small firms use the market exclusively. In order of decreasing efficiency, experts work as specialist-employees, then as market specialists, and finally as employees. Firms grow to take advantage of gains from specialization, but these gains vanish if the specialists have to work in too many different areas. Finally, markets

¹ The model does use a reduced form representation of subadditive bargaining costs, but these can be micro-founded on standard assumptions. One possible such micro-foundation starts with two-sided incomplete information. While this often leads to strategic bargaining costs (Myerson and Satterthwaite, 1983), these are typically not subadditive. However, if we allow bargainers to engage in costly attempts to learn the private information of their opponents, the resulting search costs may well be subadditive. So in the region in which bargainers chooses to search, we can have complete information bargaining with subadditive bargaining costs, just as assumed here (Wernerfelt, 2012).

become more prevalent with tariff agreements and the emergence of more efficient modes of transportation and communication.

To fix ideas, we will briefly discuss three examples:

Example 1. We can illustrate several of the results by the use of repair labor in differently sized apartment complexes. A landlord who owns just one or two units will typically go to the market and hire specialists 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 a generalist-employee, the superintendent, perform minor repairs. The building generates a steady flow of small problems and the superintendent can solve each of them pretty well. Market specialists could do the jobs more easily, but is costly to pay for a new person to come in every time there is a problem. On the other hand, renovations such as electrical jobs are normally done by market specialists through the market. The jobs are larger, experts can do them better, and the building does not need a full time electrician. Finally, very large landlords, such as universities, normally use specialist-employees for both repairs and minor renovations.

Major renovations or building projects, in which several services are bundled together, are typically governed by a bilateral contract regardless of the size of the landlord. The projects run for a finite time, each change may have significant implications for costs, and a lot of duplicate costs would be required to switch generalist-contractors midstream. As a result, changes are typically managed through renegotiations with incumbent generalist-contractors.

Example 2. Another set of results can be illustrated by supermarkets. Many tasks, such as bagging, stocking and check out, are performed by employees because it is important for the firm to be able to re-assign them on short notice. For example, baggers may be asked to help with stocking and others may be diverted from cash registers to help bag. These jobs are fairly standardized across supermarkets and while local conditions may vary, workers will generally prefer whichever local supermarket offers the best wage. This leads to a non-negotiable “market” wage for employees performing relatively standardized tasks. In contrast, executive jobs are more unique and often require a significant amount of learning about the company. These are invariably staffed by employees at negotiated wages. Even if management tasks could be performed by a sequence of specialists, it would simply be too

expensive to pay the necessary learning costs at every turn. Consider finally the design of a system for deciding how many checkout stations to man as a function of demand. This is an area in which specialists do a lot better than generalists and also one in which needs are unlikely to change too often. (The ideal system can be described once and for all.) These tasks are generally performed by consultants.

Example 3. Think finally of the 57 men who came from the Mayflower to Plymouth Plantation in the 1600s. Many of them used to work as independent bakers, roofers, or black smiths in the cities from which they came. But upon landing in Plymouth, they found that local demand was so small that they had to give up their professions. As a result, individual households baked their own bread etc. until a sufficiently large local economy had emerged.

Overview. 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 and buyers eliminates the scope for bargaining. However, in addition to the labor costs you have to pay for any co-specific investments you and the seller have to make in order for him to serve you. For a plumber these investments are mostly travel costs, but if an executive is due to work as a country manager for a multinational firm, it may be necessary to use a lot of resources teaching the new hire about the company's way of doing business. 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. If you have to bargain very frequently, it may be cheaper to pool 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 additional bargaining costs, and relative to the market, the employee avoids incurring set-up costs at

each turn. All employment relationships require some bilateral negotiation of agreements, but if the job is relatively standard, wages could be set by market forces.

If a manufacturer has large and regular needs for a specific task, she can take advantage of the gains from specialization without having to pay a lot of set-up costs by hiring a specialist employee to perform just the task in question. Since specialist-employees create more value than anybody else, these positions are taken by sellers who are even more efficient than those who become market specialists. Manufacturers thus have an incentive to expand their scope in order to grow large enough to hire specialist-employees. A possible downside of this expansion is that the specialists in low demand have to work in a lot of different areas and thus may be less efficient.

Frictions. The results are driven by two frictions; one affecting markets and one affecting bilateral mechanisms. The frictions are (i) set-up costs that are specific to each seller-buyer match and (ii) subadditive bargaining costs. We will briefly discuss both.

(i) There are many costs and delays associated with changing trading partners of labor (human asset services). The parties have to find each other, physically get together, learn how their new partners do things, mesh schedules, and coordinate with other sellers. For most of the analysis we will use a single parameter for these "specific set-up" costs, but they must be expected to vary all the way from transportation costs to absorption of corporate "culture". In our model, reductions in specific set-up costs have the same effect as increases in the cost advantage of experts.

(ii) We assume the existence of bargaining costs that are subadditive in the number of tasks covered by the agreement. While this clearly is a controversial component of the model, increasing bargaining costs are consistent with the rent-seeking literature (Tullock, 1967). More directly, Maciejovsky and Wernerfelt (2011) report on a laboratory experiment in which bargaining costs are found to be positive and subadditive.

Focal mechanisms. We first look at a model in which tasks, sellers, and manufacturers are statistically identical and all trades thus are governed in the same way. We show that four specific mechanisms, suggestively labeled as the "Market", "Employment", "Sequential Contracting", and "Employment with Market Wages", weakly dominate a large class of alternatives.

(1) In the “Market” mechanism, buyers take advantage of gains from specialization and trade with expert sellers who can meet their needs at the low costs. 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: Experts 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 transportation costs instead of hiring an appliance repairman to stand by at the house.

(2) In the “Employment” mechanism, the two players agree once-and-for-all on all components of a trading relationship. So there is only one round of bargaining, but often just average productivity (since all tasks are performed by a single player). However, sufficiently large manufacturers may be able to use individuals as specialist-employees, performing only tasks within their expertise. The aforementioned superintendent illustrates the attractiveness of employment: 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 simple, such that an experienced “layman” can perform them with reasonable efficiency. Consistent with common terminology, Employment is a relationship in this model (Bartling, Fehr, and Schmidt, 2012). Linking to the famous example of Alchian and Demsetz (1972), the relationship between a boss and an employee is one in which a single wage has been agreed upon on a once-and-for-all basis, while a buyer in a grocery store is confronted with new market prices in every period. The latter pair could in principle negotiate a complete long term contract, but bargaining costs will make this massively inefficient.

(3) In the “Sequential Contracting” mechanism, the two players agree to maintain a relationship for a while, but renegotiate each time the manufacturer needs a new service. Used instead of Employment when bargaining is rare, it shares the same advantages.

(4) In the “Employment with Market Wages” mechanism, players first participate in a multilateral job market in which wages are determined without bargaining costs. Sellers and manufacturers are then matched such the first tasks performed by sellers are those at which they are experts. Because later tasks are unknown, the parties still have to negotiate over the non-wage components of the employment relationship, but overall bargaining costs are

smaller. While these markets may not exist for many types of work, this mechanism allows some specialization, requires some bargaining costs, and sacrifices some gains from trade.

After identifying these four weakly dominant mechanisms in an economy with homogeneous trades, we proceed to introduce several types of heterogeneity and characterize the equilibrium mix between the market and employment sectors of an economy. If tasks differ, those with greater variance in costs, lower specific set-up costs, and longer duration are traded in markets as opposed to from employees. If sellers differ, those working as specialist contractors will generally be more efficient than those working as employees. Furthermore, tasks in less demand are performed by the most efficient sellers working as market specialists or by a mixture of market specialists and employees. Manufacturers have incentives to grow larger by hiring specialist employees though the increased scope will force some specialists to work in a very large number of areas.

Literature. The paper links the classical literature on the division of labor with some strands of the modern literature on the theory of the firm. The former literature (Smith, 1965; Stigler, 1951; Rosen, 1978) has considered the effects of specialization and indivisibilities (Rosen, 1983), but the present paper is, to the best of our knowledge, the first to combine these and other frictions with an explicit consideration of alternative mechanisms. The main payoff is a new set of predictions about the interaction between mechanisms and specialization. In particular, we compare market specialists in markets with specialist-employees in bilateral relationships and distinguish between different kinds of employment and sequential contracting.

By looking at governance in the context of labor market equilibrium, the results contribute to the theory of integration at the industry level and bring in several new forces (advantages of specialization, aggregate demand for a task, size of manufacturer needs, the frequency with which needs change, the size of individual tasks, and the extent of job standardization). We are not aware of any other paper using this exact lens, but some come close. One recent stream (Grosman and Helpman, 2002; Legros and Newman, 2012; Ruzzier, 2011a, b; and Gibbons, Holden, and Powell, 2012) looks at governance in the context of output market equilibrium, while Garicano and Rossi-Hansberg (2006) look at organizational structure in the context of labor market equilibrium.

Unlike many recent theories of the firm, the argument made here does not depend on non-contractibility (Maskin and Tirole, 1999). Everything is in principle contractible, but bilateral contracting is costly thus causing complete long term contracts to be inefficient. Of course, the use of such contracting/bargaining costs have recent precedents in the literature (Bajari and Tadelis, 2001; Matouschek, 2004).

Simplicity. While the basic model in Sections II and III deliberately is kept as simple as possible, this does not mean that it is unnecessary. The primary benefits of the model are to make the underlying assumptions precise, to give us a language for thinking about the forces driving the results, to suggest several testable propositions, and to prepare us for the more complicated analyses later in the paper. Even so, some of the comparative performance conditions in the Theorem would be difficult to derive without a formal model, as would the characteristics of dominant mechanisms.

Vertical Integration. As the title suggests, the paper is about the ways in which labor is traded, including the employment relationship. However, this has direct implications for vertical integration. The model defines the firm by the employment relationship and one firm is part of another if and only if one top-manager is an employee of the other. The prediction is then that the attractiveness of integration depends on the forces highlighted in the Theorem, notably the frequency with which needs change, the advantages of specialization, and the specific set-up costs. The former is tested by Novak and Wernerfelt (2012) and the latter plays a big role in the empirical literature on transaction-cost economics, but the effect of advantages of specialization awaits more empirical scrutiny.

Horizontal Integration. The theory suggests that different forces drive horizontal integration. As explained in Section V, firms may want to pursue horizontal integration in order to become large enough to be able to hire full time specialist-employees in more areas of work. On the other hand, this will ultimately force some specialists to work in a lot of different areas and it seems reasonable to conjecture that this will erode the gains from specialization.

Asset Ownership. The analysis does not depend on assets, but the nature of the employment relationship has direct implications for asset ownership. For example, one could argue that

the boss should own most productive assets since his decisions typically are the main determinant of the rate at which an asset is run down.²

Plan of the Paper. We formulate a very simple workhorse model in Section II and use it to justify the focus on Markets, Employment, Sequential Contracting, and Employment with Market Wages in Section III. Specifically, if tasks, manufacturers, and laborers are ex ante identical, Proposition 1 states that one of the four mechanisms listed above can govern all labor transactions in the economy as efficiently as any other mechanism in a large class. In Section IV, we look at different kinds of heterogeneity and characterize the market and employment sectors of an economy. Two extensions, including the optimal scope of the firm, are sketched in Section V, and further research is discussed in Section VI. All proofs are relegated to the Appendix.

II. WORKHORSE MODEL

II.1 Basic elements of the economy.

We look at an economy in which a single output is produced with labor as the only input. The environment changes over time and in each state there are several different ways to use labor productively. Agents can work in two ways: They can sell their labor or they can monitor *areas* of the environment to identify appropriate uses for labor.

The model covers two time periods, $\tau = 1, 2$ and a unit payment in period 2 is worth $\delta \in (0, 1)$ in period 1. Larger values of δ imply that periods are shorter, or equivalently, that changes are more frequent. There is a mass S of *sellers* with generic element s and a mass M of *manufacturers* with generic element m . (Though we will abstract from integer problems throughout, it will, in some of the following, be natural to think of S/M as a natural number.)

The environment can be divided into more than M *areas*. In each area there is, in each period, a productive *task* that, if performed, will create one unit of output. The tasks are random draws from a large finite set \mathcal{T} , where $|\mathcal{T}| = T$ and t is a generic task. Sellers can perform one task per period and any seller can perform any task in \mathcal{T} . Each manufacturer m monitors her own set of areas and at the start of each period identifies S/M tasks that are productive in the period.

² The theory is in Wernerfelt (2002), and a test is in Simester and Wernerfelt (2005).

We will say that manufacturer m *needs* the productive tasks she identifies. These needs are not known in advance and change at the start of each period. All tasks are equally likely to be needed in every area and production cannot be expanded by performing a needed task more than once, or by performing an unneeded task.

Seller s bears positive effort costs every time he performs a task. Each s is an *expert* at performing one task, $t^*(s)$, and there is an equal mass of experts S/T at each task, such that all needs in principle could be met by experts. The cost of performing $t^*(s)$ is c^* . In Subsection V.I we will consider the possibility that c^* increases with the number of areas in which the expert works. However, for most of the paper, c^* is just a constant. For $t \neq t^*(s)$, s is a layman and all these tasks cost $c > c^*$. The value of output is $v > c$.

Players are risk neutral and total surplus is the sum of gains from trade less the costs of the two trading frictions discussed in Section I.³

(1) If a seller is re-matched (switches) from one manufacturer to another, the new manufacturer incurs some strictly positive seller-specific costs u ; referred to as “*specific set-up*” costs in the following. These costs are incurred prior to the task being performed. In Section IV, we will briefly allow them to vary between tasks, but for now we aim to keep things as simple as possible. To initialize the model and provide a starting point for the possible re-matches, sellers and manufacturers are randomly matched prior to period I .

(2a) Each time a seller engages in negotiations with a single manufacturer, the latter incurs *bargaining costs*. In this formulation, an agreement is a pair consisting of one price covering any element in a set of tasks plus a set of *conditions* under which this price will be paid. Conditions customize the trade to the idiosyncrasies of the parties and could be location, hours worked, completion times per task, allocation of risk for various adverse circumstances, etc. Bargaining costs are proportional to the number of agreements struck, but sub-additive in the number of tasks covered by each agreement. If the parties make a single agreement covering T' tasks, the manufacturer incurs total bargaining costs $K(T')$ per seller, where $K(T')$ is positive, subadditive, and reaches its maximum \bar{K} at $T_K < T$.

³ Since the model does not depend on hold-up, we eliminate the possibility by assuming that the costs of frictions are borne by the manufacturers who, as the short side of the market, have bargaining power. We could interpret this literally or as a result of ex ante re-imburements.

The subadditivity means that it is cheaper to negotiate a single price for several tasks than to agree on prices for each of them one-by-one. Since the players are risk-neutral and in general do not know which tasks will be needed in the next period, it never makes sense to negotiate more than one agreement per period, though possibly one covering many tasks.⁴

(2b) If more than one manufacturer is involved in negotiations, competition means that prices are determined costlessly. However, each manufacturer-seller pair still has to agree on the conditions of the trade. The idea is that the parties need to fill in details of the contract in light of local circumstances. These are thus by necessity bilateral negotiations. For a single task this may be a very small effect. However, no executive, salesperson, or staffer will take an open ended job without knowing a lot about its content. We use $H(\cdot)$ to denote the costs of negotiating conditions and assume that $H(T')$ is less than $K(T')$, positive, subadditive and reaches its maximum \bar{H} at $T_H < T$.

II.2 Simple Mechanisms.

Agents explore and consummate trades by participating in a *mechanism*, which governs the processes used for matching and reaching agreements prior to trades. A mechanism is *simple* if all trades are governed in the same way and g denotes a generic simple mechanism. Since our workhorse model is based on ex ante identical players and tasks, one simple mechanism will be optimal for the entire economy.

Three types of costs are incurred in mechanisms: Production costs, specific set-up costs, and bargaining costs. Production costs reflect the mechanism's ability to match manufacturer needs and seller expertise, and thus depend on the sizes of the pools of sellers and manufacturers $(M_{g\tau}, S_{g\tau})$, $\tau = 1, 2$, within which matching takes place and agreements are reached before each period. For example, there can be no matching ($M_{g\tau} = 1, S_{g\tau} \leq S/M$), maximal matching ($M_{g\tau} = M, S_{g\tau} = S$), or anything in between. Specific set-up costs are incurred when and if players are re-matched between periods. Their incidence thus follows low production costs, reducing the net benefit to $c - c^* - u$. Bargaining costs are incurred in connection with the making of agreements on prices and conditions when these involve a single manufacturer.

⁴ One could, of course, also justify this by a complexity argument, as is done by Segal (1999) and Hart and Moore (1999).

We will now characterize the set of simple mechanisms capable of implementing all trades at the lowest possible total costs.

PROPOSITION 1: *Consider*

$$(1) \quad \bar{K} < (1 + \delta)K(1), \text{ and}$$

$$(2) \quad \bar{H} > \delta(c^* - c + u) + (1 + \delta)H(1)$$

If (1) holds (does not hold), any mechanism with $M_{g1} = 1$ is dominated by one in the class $\{M_{g1} = M_{g2} = 1, S_{g1} = S_{g2} = S/M, T_{g1} = T, T_{g1} = 0\}$ ($\{M_{g1} = M_{g2} = 1, S_{g1} = S_{g2} = S/M, T_{g1} = T_{g2} = 1\}$).

If (2) holds (does not hold), any mechanism with $M_g > 1$ is dominated by one in the class $\{M_{g1} = M_{g2} = M, S_{g1} = S_{g2} = S, T_{g1} = T_{g2} = 1\}$ ($\{M_{g1} = M, M_{g2} = 1, S_{g1} = S, S_{g2} = S/M, T_{g1} = T, T_{g2} = 0\}$).

The condition (1) says that one large bargain now is more efficient than many small bargains in the future and (2) says that it is expensive to customize contracts negotiated in the market to local conditions.

III.2. Market, Employment, Sequential Contracting, and Employment with Market Wages as examples of the four dominant classes.

To illustrate the nature of the four classes, we now define a mechanism representing each.

Definition. The *Market mechanism* is an element of the class $\{M_{g1} = M_{g2} = M, S_{g1} = S_{g2} = S, T_{g1} = T_{g2} = 1\}$ and prescribes the following extensive form game between M manufacturers and S sellers:

Prior to period 1:

Sellers' areas of expertise are realized and S/M sellers are randomly matched with each manufacturer.

In each period $\tau = 1, 2$:

$\tau.1$. All manufacturers' needs are realized.

$\tau.2$. All manufacturers make TIOLI offers to find the *fees* ($f_{1\tau}, f_{2\tau}, \dots, f_{T\tau}$).

$\tau.3.$ For all t , manufacturers needing t pay u and are matched with sellers willing to work for f_{τ} .

$\tau.4.$ Manufacturers and sellers negotiate over conditions.

$\tau.5.$ If conditions are agreed upon, sellers perform their tasks and payments are made. ■

The fees will equal c^* since sellers are the long side of the market.

Definition. The *Employment mechanism* is an element of the class $\{M_{g1} = M_{g2} = I, S_{g1} = S_{g2} = S/M, T_{g1} = T, T_{g2} = O\}$ and prescribes the following extensive form game.

Prior to period 1:

Sellers' areas of expertise are realized and S/M sellers are randomly matched with each manufacturer.

0. 1. Manufacturers make TIOLI wage offers to the sellers with whom she is matched and negotiates conditions while incurring total bargaining costs \bar{K} per seller.⁵

In each period $\tau = 1, 2$:

$\tau.1.$ Manufacturer's needs are realized.

$\tau.2.$ Each manufacturer distributes her needs across the S/M employees and asks each employee to meet one need. The employee can agree or not. Either party can dissolve the match at any time. If so, the employee has zero payoffs and the manufacturer has one unmet need in all future periods.

$\tau.3.$ If trade is agreed, employees perform their tasks and payments are made.■

Wages will equal c .

Definition. The *Sequential Contracting mechanism* is an element of the class $\{M_{g1} = M_{g2} = I, S_{g1} = S_{g2} = S/M, T_{g1} = T_{g2} = I\}$ and prescribes the following extensive form game.

Prior to period 1:

⁵ Many employees are paid under non-linear incentive contracts. The present model is so simple that there is no need for anything other than flat contracts.

Sellers' areas of expertise are realized and S/M sellers are randomly matched with each manufacturer.

In each period $\tau = 1, 2$:

$\tau.1$. Manufacturer needs are realized.

$\tau.2$. Manufacturer distributes her needs across sellers with whom she is matched, makes TIOLI price offers to each of them, and negotiates conditions, thus incurring total bargaining costs $K(I)$.

$\tau.3$. If trade is agreed, generalist-contractors perform their tasks, and payments are made. ■

Definition. The *Employment with Market Wages mechanism* is an element of the class $\{M_{g1} = M, M_{g2} = I, S_{g1} = S, S_{g2} = S/M, T_{g1} = T, T_{g2} = 0\}$ and prescribes the following extensive form game:

Prior to period 1:

Sellers' areas of expertise are realized and S/M sellers are randomly matched with each manufacturer.

1.1. All manufacturers' needs are realized.

1.2. All manufacturers make TIOLI offers to find the wages w .

1.3. Sellers are matched with manufacturers according to needs and expertise. The contracts are customized to the match and manufacturers incur \bar{H} . For all t , each matched seller-manufacturer pair trades at w iff both agree. Either party can dissolve the match at any time. If so, the employee has zero payoffs and the manufacturer has one unmet need in periods 1 and 2.

1.4. If trade is agreed, sellers perform their tasks, payments are made, and output is traded.

2.1. All manufacturers' needs are realized.

2.2. For all t , each matched seller-manufacturer pair trades at w .

2.3. If trade is agreed, sellers perform their tasks and payments are made. ■

The costs of Markets, Employment, Sequential Contracting, and Employment with Market Wages are $[c^* + u + H(1)][1+\delta]$, $c[1+\delta] + \bar{K}$, $[c + K(1)][1+\delta]$, and $[c^* + u + \bar{H}] + c\delta$, respectively. So the most efficient simple mechanism depends on the six parameters: $[c^* - c + u, \bar{K}, \bar{H}, K(1), H(1), \delta]$ and we can identify the most efficient mechanism from the following conditions:

THEOREM: *Consider*

$$(3) \quad c^* - c + u + H(1) < \bar{K}/(1 + \delta),$$

$$(4) \quad c^* - c + u + H(1) < K(1),$$

$$(5) \quad c^* - c + u < \bar{K} - \bar{H}, \text{ and}$$

$$(6) \quad c^* - c + u < (1 + \delta)K(1) - \bar{H}.$$

If (1), (2), and (3) hold, any mechanism is weakly dominated by the Market. If (1) and (2) hold, but (3) does not, any mechanism is weakly dominated by Employment.

If (2) and (4) hold, but (1) does not, any mechanism is weakly dominated by the Market. If (2) holds, but (1) and (4) do not, any mechanism is weakly dominated by Sequential Contracting.

If (1) and (5) holds, but (2) does not, any mechanism is weakly dominated by Employment with Market Wages. If (1) holds but (2) and (5) do not any mechanism is weakly dominated by Employment.

If (6) holds, but (1) and (2) do not, any mechanism is weakly dominated by Employment with Market Wages. If neither (1), (2), or (6), holds, any mechanism is weakly dominated by Sequential Contracting.

Consistent with intuition and casual observation, the Market is better when the efficiency gap between experts and laymen is wider ($c^* - c$), when the costs of re-matching are smaller (u)⁶, when trade is less frequent/tasks take less time to complete (δ), and when bargaining costs are

⁶ *Fun fact.* A widely used definition of “civilization” holds that three properties are necessary: Urbanization, division of labor, and surplus from production (International Society for the Comparative Study of Civilizations, 2011). If we interpret u narrowly as transportation costs, the Theorem portrays urbanization (u) and division of labor (Markets) as complements, and is thus consistent with the emergence of civilization.

larger. Employment is better than Sequential Contracting when trade is frequent, and Employment with Market Wages is better when jobs are standardized (\bar{H}).

Some possible empirical implications of this are that tasks requiring more education are more likely to be performed by market specialists, that these account for more work in areas with greater population density, that needs subject to frequent change are more likely to be met by employees, and that employees in more standardized jobs are paid wages determined by the market as opposed to negotiation.

IV. CHARACTERIZING THE MARKET AND EMPLOYMENT SECTORS

We now introduce various kinds of heterogeneity such that the economy divides into sectors governed by different simple mechanisms. To this end, we assume that (1) and (2) hold and thus focus on the Market versus Employment choice. So some sellers elect to be *employees*, while others opt to sell their services as *market specialists*. To keep the derivations uncluttered, we look at heterogeneity on a dimension-by-dimension basis.

IV. 1. Two-sector model.

We use \mathcal{E} for the set of tasks governed by Employment, such that the set $\mathcal{A}\mathcal{E}$ is sourced in the Market. For any \mathcal{E} , equilibrium requires that a corresponding measure of sellers work as employees, while the rest are market specialists.

We define the (non-simple) mechanism and the equilibrium concept in the natural way.

Definition. The *mechanism with both Markets and Employment*, prescribes the following extensive form game between M manufacturers and S sellers.

Prior to period 1:

Sellers' areas of expertise are realized and S/M sellers are randomly matched with each manufacturer.

0. 1. Each seller chooses whether to be a market specialists or an employee.

0. 2. Manufacturers decide which tasks to source from employees and which to get in the Market.

0. 3. Each manufacturer makes TIOLI offers to each of her employees, incurring bargaining costs $K(|\mathcal{E}|)$ for each.

In each period $\tau = 1, 2$:

$\tau.1$. Manufacturer needs are realized.

$\tau.2$. Each manufacturer distributes her needs $t \in \mathcal{E}$ across her employees and asks each to meet zero, one, or more of these needs. The employee can agree or not. Either party can dissolve the match at any time. If so, the employee has zero payoffs and the manufacturer has one unmet need in all future periods.

$\tau.3$. For each $t \in \mathcal{A}\mathcal{E}$, all manufacturers needing t make TIOLI offers to find a $|\mathcal{A}\mathcal{E}|$ vector of fees $f_{t\tau}$

$\tau.4$. For all $t \in \mathcal{A}\mathcal{E}$, market specialists bidding less than (or equal to) $f_{t\tau}$ are matched with manufacturers needing t . The manufacturers incur u per market specialist.

$\tau.5$. For all $t \in \mathcal{A}\mathcal{E}$, each matched market specialist-manufacturer pair negotiate over conditions and can agree to trade at $f_{t\tau}$. If one or both disagree, they have a new opportunity to trade in the next period.

$\tau.6$ If trade is agreed, sellers perform their tasks, and payments are made. ■

Definition. An *equilibrium* is an allocation of sellers to simple mechanisms, market specialists to tasks, and employees to manufacturers such that

- (i) All manufacturers have all needed tasks performed.
- (ii) All sellers weakly prefer the simple mechanism to which they are allocated.
- (iii) All manufacturers weakly prefer the mechanisms in which they get all tasks.
- (iv) All employees weakly prefer the manufacturer to which they are allocated.
- (v) All market specialists weakly prefer the task to which they are allocated. ■

We will now look at several different types of heterogeneity.

IV.2. Heterogeneous tasks.

If the cost parameters differ between tasks, we can characterize those traded in the market and employment sectors of the economy as follows.

PROPOSITION 2: *If c^* , u , and δ differ between tasks:*

- Market specialists perform tasks in which experts' cost advantage over laymen is higher than that given by (3), while all other tasks are performed by employees.

-Tasks with lower specific set-up costs (less frequent change) are performed by market specialists, while those with higher specific set-up costs (more frequent change) are performed by employees.

To the extent that the specific set-up costs simply are due to transportation, the intuition is that a market for market specialists will deliver tasks more efficiently in a city with smaller distances, and be less attractive in a rural area. So we should see more markets in cities and more relationships in rural areas (Chinitz, 1961). More generally, we would expect to see more employees when the set-up costs are more substantial, such as those incurred in the process of learning how to serve a specific manufacturer. If δ is small, meaning that tasks take a long time, it is more attractive to use the market. On the other hand, if tasks are quick, the specific set-up costs play a comparatively larger role. So we would expect to see employees meet quickly changing needs where the efficiency of adaptation matters more than the advantages of specialization.

The prediction about specific set-up costs is shared with several other theories of organization, but the effects of the frequency of change and advantages of specialization are not. Novak and Wernerfelt (2012) find strong support for the effect of frequency in a large study of the automobile industry, but we are not aware of any studies looking at advantages of specialization and employment.

IV.3. Sellers differ.

While Proposition 2 is about heterogeneous tasks, we can prove parallel results if we instead allow sellers to differ.

PROPOSITION 3: *Suppose that expert costs are drawn IID from a uniform distribution with support $[\underline{c}^*, \underline{c}^* + 1]$. Assuming that (1) and (2) hold for all experts, but that (3) holds*

for $c^* = \underline{c}^*$, but not for $c^* = \underline{c}^* + 1$, then the more efficient sellers will work as market specialists and less efficient sellers will become employees.

Similar results obtain elsewhere in the parameter space. For example, if neither (1) or (2) holds, either Sequential Contracting or Employment with Market Wages is weakly dominant and the critical condition is (6). In this case, the most efficient sellers will become Employees with Market Wages (because this allows them to work as experts in period 1).

We can also look at a case with heterogeneity in both tasks and sellers.

PROPOSITION 4: *Suppose that demand D_t differs between tasks and that expert costs are drawn IID from a uniform distribution with support $[\underline{c}^*, \underline{c}^* + 1]$.*

-Among the tasks for which demand is less than or equal to S/T ; if

$$(7) \quad \underline{c}^* + D_t T/S + u + H(1) \leq c + \bar{K}/(1 + \delta),$$

all needs are met by market specialists. If (7) does not hold, but

$$(8) \quad \underline{c}^* + u + H(1) \leq c + \bar{K}/(1 + \delta),$$

needs are met by a mixture of market specialists and employees. If (8) does not hold, all needs are met by employees.

-Among the tasks for which demand is larger than S/T ; if (8) holds, needs are met by a mixture of market specialists and employees, and if (8) does not hold, all needs are met by employees.

Intuitively, low demand tasks can be performed by market specialists because the market price, reflecting the costs of the least efficient market specialists, is low.

IV.4. Manufacturers differ.

We finally generalize the model to ask how mechanisms differ between manufacturers with different patterns of needs. Specifically, we allow manufacturers to have some *stable needs* in the sense that they are sure to need one or more sellers to meet these specific needs in every period, though possibly in different areas. This framework allows us to analyze the use of

specialist-employees, who perform tasks for a single manufacturer in return for a once-and-for-all negotiated wage, but concentrates all of their work on one task.

The extensive form is the same as before, except that sellers now decide between careers as market specialists, specialist-employees, or employees, while manufacturers decide which tasks to acquire from each of these three types of sellers. The equilibrium concept is similarly extended:

Definition. An equilibrium with some stable needs is an allocation of sellers to simple mechanisms, market specialists to tasks, and employees to manufacturers, such that

- (i) All manufacturers have all needed tasks performed.
- (ii) All sellers weakly prefer the simple mechanism to which they are allocated.
- (iii) All manufacturers weakly prefer the mechanisms in which they get all tasks.
- (iv) All employees and specialist-employees weakly prefer the manufacturer to which they are allocated.
- (v) All market specialists and specialist-employees weakly prefer the task to which they are allocated. ■

We will describe an efficient outcome and show in the Appendix that it is an equilibrium. As before, we assume that all tasks have a uniform distribution of costs with support $[\underline{c}^*, \underline{c}^* + I]$ and that total needs for each task are the same.⁷ Consider the task t and the seller s . The total two-period costs if s is a specialist-employee, a generalist-employee, and a market specialist are $(1 + \delta)c_{st}^* + \bar{K}$, $(1 + \delta)c + \bar{K}$, and $(1 + \delta)[c_{st}^* + u + H(I)]$, respectively. The social return to lower c_{st}^* is the same for specialist-employees and market specialists, but if $(1 + \delta)[u + H(I)] > \bar{K}$, the former create more surplus. Define S_{mt} as the number of sellers m needs to perform t in every period. Since the stronger seller types can offer manufacturers more, the $\int_m S_{mt} = (S - M)/T$ most efficient sellers will work as specialist-employees on t . The next most efficient group will then be market specialists, while generalist-employees come last.

Out of the S/T sellers who are experts at a task t , the $(S - M)/T$ most efficient will thus work as specialist-employees and the least efficient among them will have costs $c_{st}^* = \underline{c}^* + I -$

⁷ This assumption means that we forego analysis of the effects of demand differences in this Section. A simple extension would, for example, suggest that tasks with very low demand are supplied by market specialists only. (Since no manufacturer will have large enough needs to justify hiring a specialist.)

*(d) in order of decreasing efficiency, sellers become specialist-employees, market specialists, and generalist-employee.*⁸

This prediction appears to contrast with that of Garicano (2000). In his model, legal skills are ordered along a single dimension and the best lawyers perform the most difficult tasks. If we make the additional assumption that the most difficult problems these come up infrequently, the best lawyers will work in law firms rather than in firms. In the present model, legal skills are multi-dimensional and for each skill there are manufacturers with full-time needs.

Because the best lawyers produce most surplus when working as specialist-employees, they do not work in law firms. So a test of Proposition 5 should focus on skills for which some firms have full-time needs.

The Proposition explains why more focused firms employ specialized labor, such as lawyers and plumbers, which more diverse firms hire market specialists on a case-by-case basis.

V. SKETCH OF FURTHER EXTENSIONS

The workhorse model can be extended in a many other ways and we here sketch two.

V.1 The scope of manufacturers

While manufacturers' sizes so far have been assumed to be fixed, we now look at their incentives to grow and in the process sketch a theory about the optimal scope of the firm. The starting point is that Proposition 5 implies that firms have incentives to expand in order to be able to hire specialist employees.

In this context, it is reasonable to assume that the costs of an expert, c^* , increases as he works in more areas. This could be due to some costs of switching between areas or because differences between the areas mean that a given task has to be performed in slightly different ways in each of them. To explore the implications of this, we define q_t as the number of areas in which a specialist employee has to work in order to be fully utilized. Such an expert will have costs $c^*(q_t)$ that are increasing in q_t .

So we immediately have

⁸ The proof consists of a fee, wage and payment schedule that implements the equilibrium. Since the wages and payments result from decentralized negotiations, it is hard to argue that these particular values will be agreed on. However, it will be clear that many different wage and payment schedules implement the same equilibrium.

FINDING 1: *The scope of the firm will be bounded if there exists a $\bar{q} \in \{q_t \mid t \in \mathcal{T}\}$ such that $c^*(q_t) > c^* + u + H(1)$ for $q_t > \bar{q}$.*

This is reminiscent of prescriptions from the managerial literature on corporate strategy according to which firms should change their scope to leverage excess capacity of productive resources - thereby eliminating this excess and focusing on “what they are good at.” In Edith Penrose’s (1959) original formulation of this idea, the excess capacity is tied to the time of individual managers; much like the above argument is driven by the efficiency gains from fully utilizing specialist-employees. While we will not pursue it here, the argument could easily be extended to cover groups of employees with complementary skills.

If we think of areas as industries and assume that similar industries need similar tasks performed, the Finding suggests that firms will expand to similar industries and stop expanding before their scope becomes too unfocused. This would suggest that costs decrease with volume within an industry, but increase with the extent of inter-industry diversification, in line with empirical results (Hortacsu and Syverson, 2007; Atalay, Hortacsu, and Syverson, 20129; Montgomery and Wernerfelt, 1988; Wernerfelt and Montgomery, 1988).

V.2 Trade and Distance

We can model tariffs and geographical distances in the workhorse model by letting the specific set-up costs depend on the identities of each (seller, manufacturer) pair. As a simple example, suppose that the economy is divided into two clusters, one with all sellers who are experts in tasks $t \in \mathcal{T}'$ together with $M \mid \mathcal{T}' \mid / T$ manufacturers and another with all the other agents (and thus all sellers who are experts in tasks $t \in \mathcal{T} \setminus \mathcal{T}'$). Suppose further that the specific set-up costs between s and m , $u_{sm} \in [\bar{K}/(1 + \delta), c - c^* - H(1) + \bar{K}/(1 + \delta)]$ if s and m are in the same cluster and infinitely large otherwise. In this case only some sellers can work as market specialists while the rest will be employees. However, if the clusters are merged, all sellers will become market specialists.

FINDING 2: *If barriers between initially unbalanced clusters are reduced, more sellers become market specialists and fewer remain employees.*

So beyond increasing specialization, trade also affects the mechanisms through which agents sell their labor. Specifically, the making of tariff agreements and the emergence of trains, cars, and electronic communication should cause a shift towards market governance.

VI. CONCLUSION

We have characterized the equilibrium use of markets, employment, sequential contracting, and employment with market wages, as well as the tasks, sellers, and manufacturers for which each is most efficient. Many of the predictions are easily testable and factors like the advantages of specialists, the frequency of change, the magnitude of demand, the size of firms, and the size of tasks, are particularly interesting since they do not appear in other contemporary theories of organization.

In terms of future research, the workhorse model from Section III is deliberately very simple and can easily be extended in any number of directions. One could, with very little effort, look at multiple categories of needs, complementarities between needs, broader areas of expertise, investments in physical assets, incomplete information, and different divisions of gains from trade. A more difficult, but seemingly doable, extension is to allow players to invest in their level of skill.

A less direct extension would be to look at the economy's ability to absorb various shocks. The use of the generalist/specialist employees is main novelty of the model and the fixed up front costs \bar{K} make these mechanisms less flexible than the market (Rosen, 1968).

Anticipating problems in case of a negative shock, manufacturers may be reluctant to invest in hiring, preferring instead to fill in with market specialists or generalist-contractors. The workhorse model in the present paper cannot be used to investigate this in any detail, but it seems at least conceivable that a suitable extension could contribute some foundations to the study of labor demand over the business cycle.

APPENDIX: PROOFS

Proof of Proposition 1

PROOF: Note first that the optimal $S_{g\tau} = M_{g\tau} S/M$, since we otherwise end up with some unmatched sellers. Next, let $p(M_{g\tau})$ be the probability that a randomly chosen manufacturer is matched with an expert. This is monotonically increasing in $M_{g\tau}$ and costs are $[1-p(M_{g\tau})] c + p(M_{g\tau}) [c^* + u]$ if $M_{g\tau} > I$ and independent of p if $M_{g\tau} = I$. So the optimal $M_{g\tau}$ is either I or M .

Now assume that $M_{g1} = I$, and use that T_{g1}/T is the probability that a randomly chosen period 2 task is covered by the period 1 agreement. Costs in period 2 are $[c + K(I)][1-T_{g1}/T] + cT_{g1}/T + K(T_{g1})/\delta = [1-T_{g1}/T] K(I) + c + K(T_{g1})/\delta$, and since the second derivative is negative, this is minimized for $T_{g1} = T$ or $T_{g1} = I$. In the former case no further negotiations are necessary (because the agreement covers the manufacturer's needs in period 2), but in the latter case each seller has to negotiate an agreement about the need he is to meet in period 2. So if $M_{g1} = I$, we are left with only two possibilities:

$$M_{g1} = M_{g2} = I, S_{g1} = S_{g2} = S/M, T_{g1} = T_{g2} = I.$$

$$M_{g1} = M_{g2} = I, S_{g1} = S_{g2} = S/M, T_{g1} = T, T_{g2} = 0.$$

Suppose finally that $M_{g1} = M$ such that bargaining costs are $H(T_{g1})$ rather than $K(T_{g1})$. Using the same argument as above the two best alternatives are $T_{g1} = T$ and $T_{g1} = I$. So if $M_{g1} = M$, we are also left with only two possibilities

$$M_{g1} = M_{g2} = M, S_{g1} = S_{g2} = S, T_{g1} = T_{g2} = I.$$

$$M_{g1} = M, M_{g2} = I, S_{g1} = S, S_{g2} = S/M, T_{g1} = T, T_{g2} = 0.$$

The costs of mechanisms in these four classes are

$$[c + K(I)][1+\delta], c[1+\delta] + \bar{K}, [c^* + u + H(I)][1+\delta], \text{ and } [c^* + u + \bar{H}] + c\delta, \text{ respectively.} \blacksquare$$

Proof of Proposition 2

Since the two parts are proved by similar arguments, we only explicate the first:

Experts at t will prefer being market specialists rather than employees if:

$$(A1) \quad f_t - c_t^* \geq w - c = 0$$

So the supply of market specialists, $x(f_t)$, is

$$(A2) \quad x_t(f_t) = S/T \quad \text{if } f_t \geq c_t^* \text{ and } 0 \text{ otherwise}$$

The demand for market specialists, $y_t(f_t)$, is also a one-step function. A manufacturer will prefer to use a market specialist to perform task t if this is cheaper than asking an employee to do it. So

$$(A3) \quad y_t(f_t) = S/T \quad \text{if } f_t + u \leq c + K(|\mathcal{E}|)/(1 + \delta) \text{ and } 0 \text{ otherwise.}$$

Depending on the relationship between the functions (A2) and (A3), there are two classes of equilibria, reflecting whether (3) holds or not: If $c_t^* + u - c + H(1) \leq \bar{K}/(1 + \delta)$, t would be performed entirely by market specialists, while if $c_t^* + u - c + H(1) > \bar{K}/(1 + \delta)$, t would be performed entirely by employees. (An employee will have just enough work on the average, but depending on the stochastic needs of his employer, may occasionally need to perform more or less than one task per period.) ■

Proof of Proposition 3

As in the proof of Proposition 2, the demand for market specialists will be a one-step function, but the supply will now be a piece-wise linear function with a monotonic middle part. The premise in the Proposition is that they intersect on the middle part. ■

Proof of Proposition 4

Consider first the tasks for which $D_t \leq S/T$. In this case the cost of the marginal expert would be $\underline{c}^* + D_t T/S$ and he will prefer being a market specialists over being an employee if

$$(A4) \quad f_t - \underline{c}^* - D_t T/S \geq w - c.$$

As $w = c$ and manufacturers will require that $f_t + u + H(1) \leq w + \bar{K}/(1 + \delta)$, the task t will be supplied entirely by market specialists if the cost of hiring the least efficient market specialists is larger than that of hiring an employee, or if

$$(A5) \quad \underline{c}^* + D_t T/S + u + H(1) \leq c + \bar{K}/(1 + \delta).$$

If (A5) does not hold, the best experts will still prefer working as market specialists as long as

$$(A6) \quad \underline{c}^* + u + H(I) < c + \bar{K}/(I + \delta).$$

However, in this case the rest of the tasks would be performed by employees. If (A6) does not hold, all tasks are performed by employees.

The tasks for which $D_t > S/T$ cannot be fully supplied by experts and the fee f_t would be bid up to $c + \bar{K}/(I + \delta) - u$. Some experts will prefer to work as market specialists as long as (A6) holds and all will prefer to do so if

$$(A7) \quad \underline{c}^* + I \leq c + \bar{K}/(I + \delta) - u - H(I). \blacksquare$$

Proof of Proposition 5

We find a set of wages and fees that implement the equilibrium. Since all tasks are statistically identical, fees, salaries, wages, and quantities will be the same for all t . We define w_t as the negotiated salary of a specialist, while using f_t as the fee of a market specialists, and w as the negotiated salary of an employee. The postulated equilibrium is implemented by prices meeting following IR- IC conditions:

The marginal specialist is indifferent between that and being a market specialists if

$$(A8) \quad w_t = f_t,$$

and the marginal market specialists is indifferent between that and being an employee if

$$(A9) \quad f_t - c^\# = w - c.$$

There are two IC constraints for the manufactures. They prefer specialist-employees over market specialists for their full-time jobs if

$$(A10) \quad w_t + \bar{K}/(I + \delta) \leq f_t + u + H(I)$$

and they are indifferent between market specialists and employees for jobs with small n_{mt} if

$$(A11) \quad f_t + u + H(I) = w + \bar{K}/(I + \delta)$$

The IR constraints for the three groups of sellers are

$$(A12) \quad w_t \geq \underline{c}^* + I - M/S,$$

$$(A13) \quad f_t \geq c^\#, \text{ and}$$

$$(A14) \quad w \geq c.$$

Finally, the IR constraints for the manufacturers are

$$(A15) \quad v \geq w_t + \bar{K}/(1 + \delta)$$

$$(A16) \quad v \geq f_t + u + H(1), \text{ and}$$

$$(A17) \quad v \geq w + \bar{K}/(1 + \delta).$$

Since (A12) – (A17) can be met simply by raising the level of wages, fees, and prices, we focus on (A8) – (A11). The first two conditions are satisfied by $f_t = w_t = c^\#$ and $w = c$.

Since $u > \bar{K}/(1 + \delta)$, these also insure that (A10) is met and they meet (A11) for

$c^\# = c + \bar{K}/(1 + \delta) - u - H(1)$. So the proposed fees and wages implement an equilibrium. ■

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