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Abstract

This is a comment on "Incomplete Contracts and the Internal Organization of Firms" by P. Aghion, N. Bloom and J. Van Reenen, forthcoming in *The Impact of Incomplete Contracts on Economics,* edited by Philippe Aghion, Mathias Dewatripont, Patrick Legros, and Luigi Zingales, Oxford University Press, 2015.

1 Introduction

It is not only a great pleasure to have the opportunity to participate in this conference in honor of Sandy Grossman and Oliver Hart, but it is also a great pleasure to have the chance to comment upon the work of three very distinguished economists. The purpose of "Incomplete Contracts and the Internal Organization of Firms" is to review the theoretical and empirical implications of incomplete contracts theory for the level of decentralization in a firm. The first part of the paper (sections 1 and 2) reviews models of authority with asymmetric information. In these models agents choose the degree of delegation based upon the information held by the agent, and the effect that this information has upon effort (Aghion and Tirole, 1997), or upon the quality of decision making (Dessein 2002). In these papers, like Grossman and Hart (1986) (GH in subsequent citations), it is shown that the allocation of authority has efficiency consequences.

Section 3 discusses the empirical literature that relates features of the environment, such as the level of trust, to the level of decentralization in the firm. Section 4 discusses a literature that measures the impact that decentralization within the firm has upon firm profits.

Aghion et al. (2014)'s review, though inspired by GH and the incomplete contracts literature, focuses upon the role of information flows within the firm. In this note I fill in the front end of this review, and begin with a discussion of the origins of formal incomplete contracts theory (Simon 1951). I then show how GH provides the Simon model with a more rigorous foundation for the importance of authority.

Next, I present a simplified version of GH and show how one can use the Rubin/Holland model of causal inference (Holland 1986) to derive some testable implications from the theory. I then use these observations to make some comments regarding the literatures that are reviewed in sections 3 and 4 of Aghion et al. (2014). Specifically, I point out that the Rubin/Holland model could be more widely used to clearly distinguish between well posed empirical questions and results that are very interesting, but mainly descriptive.

2 The Theory of Authority

The first formal model of incomplete contracts is due to Simon (1951). Relying upon his extensive practical experience with organizations he observed that in complex environments planning is expensive, and hence it may be cheaper to wait for more information before making a decision. He used this idea to model the employment relationship as one in which the precise job requirements are determined after employment. The problem is that once employed, the firm may ask the workers to carry out tasks that are very unpleasant - to deal with this Simon suggested that an employment contract give *limited* discretion to the employer.

In his model decentralization occurs via the sales contract, a contract that specifies the characteristics of the good in advance. This has the benefit of lower production costs *ex ante,* but possibly higher costs *ex post* if an event occurs that make the conditions of the sales contract inefficient. This creates a trade-off in that the sales contract has a cost because it is not flexible enough, while

the employment contract has a cost in that the choices by the employer do not take into account an employee's opportunity cost.

An important observation in GH is that parties to a bilateral agreement are always free to alter the terms *ex post*. As Hart and Moore (1988) illustrate, a contract can be viewed as creating default allocation *ex post,* from which parties can bargain. Thus, while the different contracts in the Simon model may lead to different *ex post* payoffs, once renegotiation is introduced the trade-off in the Simon model disappears (see as MacLeod 2002). This result can be viewed as another version of the Coase (1960) theorem - in the absence of transactions costs the initial allocation of property rights do not matter for the efficiency of the relationship.

The contribution of GH is to highlight the role that authority over residual decision rights has for investment. They show that the initial allocation of authority has implications for performance that cannot be undone through *ex post* renegotiation. Thus, the allocation of decision rights and the extent to which one person has full authority, or authority is spit between different assets will vary with relative importance of the relationship specific investments made by each party. This analysis was significantly extended and generalized by Hart and Moore (1990). In this comment I briefly discuss how to use the Rubin/Holland model to go from this theory to some testable hypothesis.

3 GH Theory in a Nutshell

Since all models are false, the real issue is not whether a model is correct in some abstract sense, but whether it can be used to improve upon previous models.[1] In this regard the Coase theorem plays an import role in organizational economics by providing a counter-factual against which to test organizational models, such as the GH model. Coase hypothesized that in the absence of transactions costs, the initial allocation of property rights and legal liability can have no effect upon economic efficiency. This perspective puts on the table a null hypothesis that can be used to test for the presence of transactions costs.

This is a relatively standard approach in many areas of economics. For example, the competitive model is the (false) benchmark against which we compare models with imperfect competition. The rational choice model is the benchmark against which behavioral economists develop their models. By exploring how a benchmark model fails we can begin to build better models.

Now consider the case of a building project where one person is the principal who knows or cares about the characteristics of the building, and the other is the general contractor with the equipment and manpower to build the project. As in the GH model, each agent makes specific investment $a_i, i \in \{P, C\}$, where P is the "principal" and C is the "general contractor". Let us consider how variations in the importance of their investments affect the performance of different organizational forms.

One possibility is that P is a large firm that acts as it's own general contractor. An example would be a university that has its own architects for small projects, and brings in trades people as sub-contractors. In such a case the university is a general contractor with complete control over how the project is executed. We call this P-integration or PI.

A second case would be a market relationship where the Principal and Contractor negotiate on a project by project basis. This case is denoted by no-integration or NI. The third and final case is one where the firm is a developer that produces a standard building product for market, such as a tract home in a housing development. In this case, the final good (houses) are produced with no

[1]Even in physics it is well recognized that models are good, but imperfect representations of reality. Linus Pauli once quipped regarding a colleague's work that "Not only is it not right, it's not even wrong!" (Peierls (1960)).

contract with the final buyer, and hence there is no *ex ante* investment by the final owner of the house. This case is denoted as C-integration or CI for short.

3.1 A Formal Model

Formally, the incentive to integrate is modeled by letting $\lambda \in [0,1]$ represent the relative importance of specific investments. For example, it might represent the ability to track an truck with goods in transit, as in Baker and Hubbard (2004). The payoffs in the GH model can be defined by:[2]

$$B_P\left(a_P, \phi_1\left(q_P, q_C\right)|\lambda\right) = q_P q_C\left(\lambda a_P + (1-\lambda)\, a_C\right) - \frac{a_P^\alpha}{\alpha}, \tag{1}$$

$$B_C\left(a_P, \phi_2\left(q_P, q_C\right)|\lambda\right) = -c q_C - \frac{a_C^\alpha}{\alpha}. \tag{2}$$

The sunk costs are given by $\frac{a_i^\alpha}{\alpha}$, where $\alpha > 1$ is a measure of how quickly those costs rise with investment. The *ex post* choice is whether to trade or not, given by $q_i \in \{0,1\}$. The variable cost of production is given by c, and it is assumed to be sufficiently small that trade is always optimal.

If the principal owns the contractor's assets - case PI - then she can set both q_C and q_P. Similarly, if the contractor owns the principal's assets - case CI - then he can set both q_P and q_C. Under no integration, the principal is free to choose q_P and the Contractor chooses q_C. Investments are assumed to be non-contractible.

Consider four allocations, denoted by $j \in \{E, NI, P, C\}$. When $j = E$ this is the efficient "Coasean" allocation. The no-integration allocation is $j = NI$. In this case each party gets 50% of the returns from renegotiation. Under $j = P$ the principal owns the assets, and hence the contractor earns only her outside option, assumed to be independent of her investment. Finally $j = C$ is the allocation when the contractor owns the assets, and we get the symmetric case to P ownership. Let $W_j(\lambda)$ be the total welfare for $j \in \{E, NI, P, C\}$. The optimal investment into asset P yields a net benefit of:

$$V(\lambda) = \left(\frac{\alpha - 1}{\alpha}\right) \lambda^{\frac{\alpha}{\alpha-1}}.$$

Using this and the formula for value given by expressions (4) and (5) in GH, it is straightforward to show that total welfare as a function of organizational form is as follows:

Organizational Form	$W_j(\lambda)$
Coasean (E)	$V(\lambda) + V(1-\lambda) - c$
No Integration (NI)	$\beta(\alpha)\left(V(\lambda) + V((1-\lambda))\right) - c$
P-Integration (PI)	$V(\lambda) - c$
C-Integration (CI)	$V(1-\lambda) - c$

Table 1: Effects of Integration

Here the expression $\beta(\alpha) = 2^{\frac{\alpha}{1-\alpha}} \in (0, 1/2)$, has the feature that $lim_{\alpha \to 1^+} \beta(\alpha) = 0$, $\beta(2) = \frac{1}{4}$ and $lim_{\alpha \to \infty} \beta(\alpha) = 1/2$.[3] Under no integration both parties invest, but at a rate lower than under

[2] Here the notation is taken from equation (1) in GH.

[3] With no integration parties split the returns evenly, and we have for a_P:

$$\frac{1}{2}\lambda - a_P^{\alpha-1} = 0$$

$$a_p^{NI} = \left(\frac{\lambda}{2}\right)^{\frac{1}{\alpha-1}}$$

the first best. Under P-integration only the principal invests, while only the contractor invests under C-integration.

The implications of the theory are illustrated in figure 1. The x-axis has the relative importance of Assets P and C, with λ going from 0 (only asset C is relationship specific) to 1 (only asset P is relationship specific). The y-axis is welfare in dollars. The top line corresponds to the payoff at the efficient, Coasean, solution where property rights do not matter. In this example the payoff falls and then rises. This has no particular significance except to illustrate that even if we have data with a measure that can be interpreted as λ we cannot in general expect there to be any relationship between the measure of asset specificity and payoffs.

Next we have three curves that correspond to the payoffs in the GH model under the three asset allocations. The parameter α is set so that each of the three asset structures is optimal for some value of λ. Observe that for low values of λ the model predicts that it is second-best efficient for the contractor to own all this assets. For intermediate values no integration is second-best efficient, and then finally for high values having the principal own all the assets is second-best efficient.

4 Empirical Implications

Next, let us explore the GH model in the context of the Rubin/Holland causal model[4]. Though the Rubin/Holland model is deceptively simple, it is quite helpful in precisely hi-lighting the empirical content of a theory. It begins by supposing there is a unit to be treated U (e.g. person, firm, country...), a potential treatments T (e.g.. drug, law change, organizational change...) and potential outcomes Y (e.g.. health, profits, growth,...). Let $Y(U,T)$ be the outcome when treatment T is applied to unit U. The *causal effect* of treatment T_t^1 relative to treatment T_t^2 at date t is

$$CE\left(U,T_t^1,T_t^2\right)=Y\left(U,T_t^1\right)-Y\left(U,T_t^2\right).$$

This expression captures exactly the information one would like to have when making a decision between treatments T^1 and T^2. Notice that these are indexed by date t - the causal effect requires comparing outcomes from treatments administered at the same time! Without some sort of time machine, this is clearly impossible. Holland (1986) calls this the "Fundamental problem of causal inference".[5] Much of modern empirical work can be viewed as proposing different solutions to this problem - with every solution requiring some theoretical assumption (namely a plausible, but unprovable hypothesis) that leads to the identification of a causal effect.[6]

In economic theory one typically supposes that preferences and payoff possibilities are exogenous, and then one works out the equilibrium allocation given this information. Given that neither preferences nor the technology are observable in practice, it is not in general obvious what are the empirical implications of such a theory. The Rubin/Holland model provides a solution.

In the context of the GH model a natural unit of analysis is the pair of assets $\{A_1,A_2\}_\lambda$, indexed by $\lambda\in[0,1]$. Notice that λ is characteristic of the asset. The possible treatments are the three

and hence

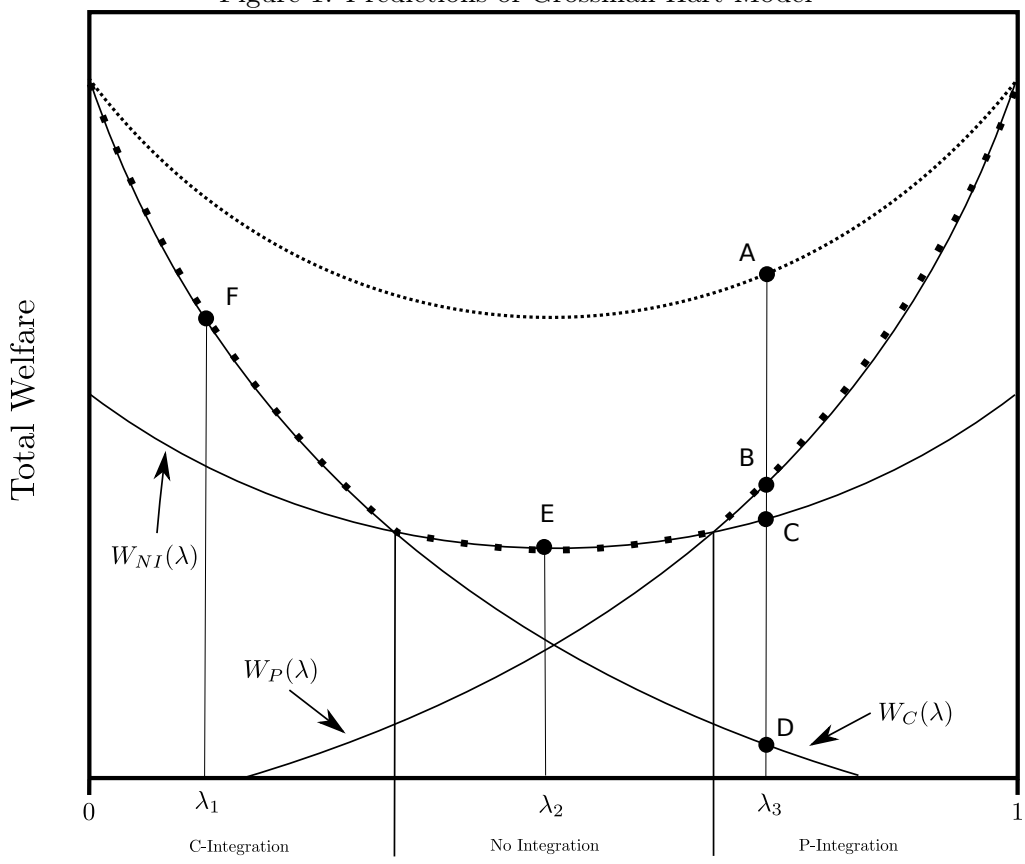
$$V^{NI}(\lambda)=\left(\frac{\alpha-1}{\alpha}\right)\left(\frac{\lambda}{2}\right)^{\frac{\alpha}{\alpha-1}}=\left(\frac{1}{2}\right)^{\frac{\alpha}{\alpha-1}}V(\lambda)$$

[4]See Holland (1986). Imbens and Rubin (2011) provide a book length treatment.

[5]Page 947, Holland (1986).

[6]Holland discusses a number of these. They include assumptions such as the effect does not change over time, or that one can identify characteristics of the units that allow one to suppose that the effects are the same for units with the same characteristics. This is essentially what one does when running a regression with a large number of control variables.

Figure 1: Predictions of Grossman-Hart Model



Coase Theorem Prediction ($W_E(\lambda)$) .....

GH Theory Prediction
$max\{W_{NI}(\lambda), W_P(\lambda), W_C(\lambda)\}$ - - - -

organizational forms $j \in \{NI, P, C\}$. Notice that the Coasean case is not a treatment, but the hypothesis that the treatment will have no effect. In this model the outcome variable is total welfare $W_j(\lambda)$. We now consider the possible testable implications of the theory.

Section 3 of Aghion et al. (2014) discusses various determinants of decentralization in the firm. For example, they observe that "trust can affect the internal structures of global firms". Trust here as used here is a characteristics of the firm, and what is being asked is whether firms with different measures of trust have different levels of decentralization. Holland (page 946) point out that one need to distinguish between a treatment (the decentralization choice) and unit characteristic (trust in the firm). For example he observes that gender cannot be a treatment, and hence not a cause of an effect.

To measure the causal effect of gender one would have an individual apply for a job, observe the outcome. Next we would change their gender and do the application again. In that case, the difference in employment outcomes would be "caused" by the change in gender. This is in general not possible. Rather, the usual treatment is to change the information available to the employer and look at the causal effect of the information treatment upon the employer (the "unit"). For example, Goldin and Rouse (2000) consider the treatment to have musicians play behind a screen or not, while Bertrand and Mullainathan (2004) manipulate the surnames of job applicants. In these examples gender or race is never a cause or treatment. Rather the cause is the change in information that the treatment unit/employer receives, and the outcome is the employment decision.

In the context of the GH model, the parameter λ corresponds to an observable characteristic like trust or degree of complementarity discussed in section 3 of Aghion et al. (2014). Figure 1 illustrates that the theory predicts that if the characteristics of the assets vary from λ_1 to λ_2 and then to λ_3, then the outcome moves from F to E and then to B. This results in a move from C-integration (CI) to no-integration (NI) and finally P-integration (PI). Notice that this prediction consists of the following joint hypothesis. First, that payoffs vary with the level of integration, and second that the agents choose the most efficient arrangement.

Notice that observing variation in organization form as a function of λ does not prove nor disprove the GH model. It could be the case that the Coasean hypothesis is correct, in which case the observed variation in organizational form may be due to factors completely unrelated to the holdup problem. What we can see from figure 1 is that the strong implication of the GH model comes not from the variation in λ, but from the variation in profits conditional upon organizational form. That is, the causal effect of P-integration (PI) relative to no integration (NI) is defined by:

$$CE\left(\{A_1, A_2\}_\lambda, PI, NI\right) = W_{PI}(\lambda) - W_{NI}(\lambda).$$

In order to *measure* the causal effect we would have to find some way to carry out an experiment that *constrains* the choice made by parties. Assuming this experiment can be carried out, it provides a rather strong and clean test of the GH model. Comparing points B and C in figure 1 we see that the GH model predicts $CE\left(\{A_1, A_2\}_{\lambda_3}, PI, NI\right) > 0$. In contrast if the Coasean hypothesis were correct then $CE\left(\{A_1, A_2\}_{\lambda_3}, PI, NI\right) = 0$.

In practice it may not be possible to measure λ with any precision, in which case we may not know where we are in figure 1. What we do know is that if we were able to carry out this experiment, then the Coasean model would be rejected in favor of the GH model (assuming these are the only two alternatives) if we find that $CE \neq 0$ for some λ.

It is certainly useful to measure how organizational form varies with some characteristic, as is done in section 3, but one has to be very cautious when interpreting such observations as having a causal interpretation. Section 4 of Aghion et al. (2014) provides a more direct test of decentralization theory because they ask if there is any evidence of changes in management practices affecting firm

productivity. A nice example of a good research design is the important work of Bloom et al. (2012). They report the result of an experiment where firms are treated with free consulting services, and find strong evidence that these services provide a positive causal effect upon firm performance. It would be useful to know why? We are still faced with the dual hypothesis issue discussed above. If indeed firms are profit maximizing then why are they not already choosing the most efficient management practices?

In the labor literature these issues have long been studied in the context of the Roy model. We now know that in general one cannot identify a causal effect from observational data without some rather stringent conditions (see for example Heckman and Honore (1990)).[7] Appendix C of Aghion et al. (2014) discusses the general point that the organizational literature has not yet made identification a central issue, an observation that extends to the literature on holdup.

An example of a non-experimental paper that makes some progress is Card et al. (2014). They measure the extent to which workers and firms share rents in the Veneto region of Italy. In this paper the unit is the union-firm pair, and the outcome is the rent share for each group. The treatments are shocks to firm productivity. To provide a causal estimate of the rent sharing rule Card et al. (2014) argue that variations in sales by industry outside of the Veneto region are exogenous and hence can be used as an instrument for rents in bargaining pair.[8]

Grout (1984) shows that if there are no binding commitments between parties, then we can expect trade unions to capture some of the rents from firm investment in physical capital, leading to underinvestment by the firm. At the time he wrote his paper, trade unions in the United Kingdom could not make long term contracts - contracts were of fixed durations, and then renegotiated from scratch when a new contract was needed. The goal of the paper was to illustrate the implications of this rule for investment. In contrast, Card et al. (2014) find no evidence of this form of holdup in Italy. Rather union-firm pairs share the rents from the relationship after subtracting the cost of investments made by the firm.

This does not necessarily imply that the GH insight on the importance of ownerships is incorrect. A key assumption in GH is that parties in a long term relationships efficiently renegotiate contract terms and conditions. Crawford (1988) has shown that if parties can enter into binding short run commitments, then it is possible to have an efficient long term contract. This suggests that what may be driving the Card et al. (2014) results may be the ability of parties to make some short term commitments, and not holdup per se (Card et al. (2014) provides a nice model to illustrate how this would work). This leads to a clear, open, empirical question - what is the causal impact of a change in the contracting possibilities set upon organizational form and performance?

The studies discussed in Aghion et al. (2014) show that we are beginning to have a large portfolio of data sets with information on organizational form. From the Rubin/Holland model we learn that for each data set both the GH model and the theory reviewed in Aghion et al. (2014) can be used to explore an almost unlimited set of questions, the answers to which may help us better understand the causal impact of integration/centralization upon performance.

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[7] See also MacLeod (2013) for a discussion of the Roy model in the context of measuring the performance of economic systems.

[8] Angrist et al. (1996) show how to view instrumental variables estimates through the lens of the Rubin/Holland model.

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