

Discussion of

“The Economics of Multidimensional Screening”
(J.-C. Rochet and L.A. Stole)

And

“Testing Contract Theory: a Survey of Some Recent Work”
(P.A. Chiappori and B. Salanié)

By

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Each of these surveys is a “must read”: anyone who wants to analyze multidimensional screening models should start by reading Rochet and Stole (RS) and anyone who wants to do empirical work on contracts should begin with Chiappori and Salanié (CS). I will start this discussion (section 1) by what I perceived to be the main message of each survey. While the two papers are quite different in nature and in focus, they both remind us why we should be interested in contracts and organizations: when markets are incomplete or imperfect, contracts and organizations are the relevant allocation devices and are not neutral from an “efficiency” point of view. Therefore, if we want to understand the effects of economic policies, of macro-economic shocks, of technological shocks on the performance of firms, or of the economy, we are bound first to answer two questions.

- (A) What are the effects of contractual and organizational choices on behavior and economic performance?
- (B) What are the determinants of contractual choices?

RS and CS show how answers to these questions can be enhanced by theoretical and empirical work in contract theory. Reading these surveys and the literature, it seems fair to acknowledge two tendencies: first, that empirical work has been an active consumer of theory but that theory has been a more timid consumer of empirical work and, second, that we seem to have many answers to (A) but fewer answers to (B). I will therefore develop two themes in my discussion: the necessity of a *constructive dialogue* between theory and empirical work and the necessity to provide theoretical models that will more accurately capture market forces. While the first theme is clearly present in RS and CS, the second theme is less present in these surveys but is a logical consequence of the agendas described in RS and CS. Section 2 develops the two themes and section 3 illustrates these themes with some examples taken from CS.

1. Rochet-Stole and Chiappori-Salanié

1.1. RS: Multidimensional Screening

The difficulty in multidimensional screening models is the lack of a natural order on types. The problem is not so much one of feasibility since RS show an algorithm by

which the solution can be computed. The problem is rather the possibility to obtain robust qualitative results (similar, for instance, to the “no inefficiency at the top” result in the one dimension). RS provide a useful classification of the multi-dimensional models into three categories. They show that for two of them (aggregation and separability) such robust results can be obtained.

The properties of the solution in the aggregation case, i.e., when the multi-dimensionality can be reduced to a one dimension by using an aggregator, are (obviously) related to the distribution of the aggregator. RS footnote 21 nicely illustrates this point. More important differences arise in the separability case (when transversality conditions can be ignored): bundling at the bottom and the possibility of efficiency at the top *and* at the bottom when one looks at one dimension only. RS convincingly show that a rich new set of economic problems can be studied by going from one to two (or more) dimensions. Budgetary constraints, sequential screening, multiple product purchase, are naturally modeled as multidimensional screening problems that can be analyzed at times as simply as in the one-dimensional case.

Since in practice not all dimensions can be quantified or instrumented, a challenge faced by theory is to provide results like those in Figure 6 of RS, i.e., to establish a relationship between the endogenous variable and the quantifiable dimension. Figure 6 summarizes the relationship between the noise in the distribution of outside options and the quantity schedule contingent on the first dimension in a parametric example. Since outside options are not observable, the relevant exogenous variable in a regression would indeed be the first dimension only (the residual would then be the noise in outside options). We observe that all solutions are increasing in the first dimension, and that the schedule becomes “flatter” as the noise in outside options becomes larger. Note also that there is a U-shaped relationship between the noise and the size of the bundling region at the bottom. The comparative static results in Figure 6 are therefore quite useful from a theoretical perspective since they tell us how noise in outside options yields different quality-price schedules than the fixed (and uniform) outside option case.

However, it is not clear how easy it will be to identify these results. For instance a change in the flatness of the optimal schedule could be obtained in the one-dimensional case by changing the distribution function (since the flatness is related to the hazard rate). It is not clear at this point how one can empirically distinguish a multidimensional model where the second dimension is a (random) outside option from a one-dimensional model. There is a sense however in which this difficulty is also a strength since the interpretation of the residual as unobserved outside options might be more satisfying than the interpretation in terms of measurement error.

1.2. CS: Capturing (Endogenous) Heterogeneity

CS survey covers a lot of ground. They identify early on the main challenge that empirical work must face: controlling for heterogeneity and endogeneity of the contractual relationships. If agents self-select into firms or contracting relationships, the outcome of the relation as well as the contract itself are explained by the characteristics of the agents while the modeler would be tempted to see the contract as the endogenous variable and the characteristics of the agents in the relationship as the exogenous variables. Their warning should also echo to theorists.

CS show that it is possible to create or find good data sets to test a variety of important questions: incentive effects of compensation schemes, relative importance of adverse selection and moral hazard to explain behavior in markets, role of reputation, effects of contractual instruments (e.g., insurance deductible, technology that make contracts more complete). At the same time CS make clear the difficulties in meeting their challenge: controlling for the selection effect, distinguishing between the available theoretical models, controlling for quasi-rents.

The task of identifying the incentive effect is already daunting. Trying to identify whether the *form* of contracting is “optimal”, as they set to do in their section 3 is certainly even more daunting. For instance, principal-agent theory simply tells that for a *given* outside option of the agent, there exists a second-best optimal contract that maximizes the level of utility of the principal. Changing the outside option might – and often will - also change the *form* of the second-best contract. Hence, unless there is a good way to proxy for the outside option, or for the market forces that affect this outside option, it is not clear how one can answer the question “Are contracts optimal?” This problem is even more severe when other organizational instruments like monitoring, auditing, size of the hierarchy, etc., define the form of the contract.

2. Towards a Constructive Dialogue

2.1. More Theory or More Facts? Necessity of a Dialogue

Research in contract theory has proceeded like most other scientific endeavors: one step at a time. It has isolated sources of imperfections and has analyzed the consequences of these imperfections for contracts, prices or organizations. This literature has generated a large “toolbox” consisting of a host of models, e.g., adverse selection, moral hazard, multitasks, teams, principal-agent, principal-agents, principals-agent, principals-agents, additive noise, multiplicative noise, complete contracting, incomplete contracting, dynamic contracting, career concerns... Do we now have an embarrassment of riches? To paraphrase the title of a recent paper¹, is contract theory plagued by too many theories and too few facts? I will argue in fact that we need more facts *and* more theory.

A dialogue between theory and empirical work is necessary in order to identify the relevant *omitted variables* in theoretical and empirical research. Omitted variables are usually associated with econometric analysis. Theory is useful because it helps the econometrician pinpoint the relevant omitted variables, and how these variables affect the observed outcome. Here the “embarrassment of riches” becomes in fact the solution. Less appreciated perhaps is the fact that theoretical work also faces (by nature?) a problem of omitted variables. An analysis based on a moral hazard model will fail if the essence of the imperfection is adverse selection. If *both* moral hazard and adverse selection are important, a new model combining the two effects might be necessary if new effects emerge when the two imperfections are taken simultaneously into account. Here empirical work helps by providing a “sanity check” on the relevance of a model in a given situation and by suggesting new avenues for research.

Now, it is easy to make a model “more general”: generalize some assumptions. Ignoring issues of tractability, such generalizations seem to be useful for the dialogue

¹ Baker and Holmström (1995).

with empirical work if they yield robust theoretical results that are qualitatively different from the simpler case *and* if these differences can be identified in empirical work. CS and RS are excellent illustrations of the benefits of such a dialogue between theory and empirical work. The main focus of RS is on finding robust theoretical results and the main focus of CS is on identifying theoretical results in the data.

However, and this is another theme of this discussion, while existing theoretical and empirical work can generate a dialogue to answer (A) – do incentives matter and how? – the theoretical literature uses a modeling paradigm that will eventually limit the possibility to pursue the dialogue successfully and answer (B) – what determines contracts? This modeling paradigm is the use of outside options for capturing market effects, i.e., forces external to the contract or the organization. Outside options capture the underlying market forces at play in the economy. The question is then *which* outside options correctly capture market forces. As I argue in the next section, there is a need for theoretical constructs that “bypass” the outside options and that capture directly the relationship between observable data and market forces. This would facilitate, for instance, the identification of the effects in the random outside options model of RS, or the completion of the agenda set forth in section 3 of CS.

2.2. Omitted Variables

Contracts are shaped by a variety of forces or variables. Contract theory has mainly focused on the *internal forces* that shape an organization or a contract but has been relatively silent on the *external forces* that shape an organization.² Examples of “internal” variables are

- *Agents’ characteristics*: risk aversion, talent, productivity, ...
- *Contractual instruments*: monitoring, auditing instruments, delegation rights, screening devices, compensation schemes, ...

while examples of “external” variables are

- *Policy variables*: competition policy, regulation, ...
- *Market variables*: distribution of characteristics, product market competition, process of matching, interest rate, market imperfections, ...

For instance, we understand quite well that monitoring will reduce the cost of inducing productive effort and that more monitoring will be associated with flatter compensation schemes. We understand less well why seemingly identical economies have firms with different monitoring intensities. We understand that an entrepreneur with more liquidity will need to forfeit less control in order to finance an investment. We understand less well the effects of economy wide changes in liquidity on control structures. Interestingly, CS emphasize as one of the main sources of bias in empirical work on contracts the endogeneity of the match between contracting parties, i.e., an illustration of how market forces influence the characteristics of contracting parties, a question on which theory is most silent.

Now, market forces are already taken into account in most models in contract theory, albeit in a shortcut sort of way. The “optimal contract” in a principal-agent model

² Nevertheless a small, and growing, theoretical literature exists, e.g., Fershtman-Judd (1987), Legros-Newman (1996), Schmidt (1997), Aghion-Dewatripont-Rey (1999).

is the solution to a constrained Pareto problem: maximize the welfare of the principal subject to a set of incentive constraints and subject to giving the agent his outside option (the participation constraint). The *outside option* of the agent captures his “market value”. By changing the outside option, one changes the nature of the optimal contract. Here is already a sense in which market forces matter for organizations. There is also a sense in which it is futile to test for the efficiency of contracting by using this type of model: by changing the outside option, we can generate as optimal contracts a large set of contracts. The fact that we do not observe directly outside options is another impediment. I will come back to this point in the examples at the end of this discussion.³

Therefore, the outside option is a *convenient theoretical shortcut* but is not an instrument that can be *directly* used in empirical work for capturing market forces. What seems needed is a theoretical apparatus that will articulate how outside options are determined. Such a mechanism will then link directly some observable and hopefully quantifiable variables to contractual or organizational forms, bypassing the outside options. Some of the work cited in footnote 2 goes in this direction but much remains to be done on this front.

3. Revisiting Some Examples

Two of the examples in CS enable me to illustrate the benefits of a dialogue between theory and empirical work and the need to instrument for external forces. The first example is about the role of risk in shaping contracts. The second example is about the form of compensation schemes between fixed wage and piece-rate.

3.1. The Risk-Incentive Tradeoff

Independently of the risk attitude of the agent, the creation of incentives requires variations in output-based compensation. The cost minimizing schedule for a risk neutral principal who wants to give a risk-averse agent his outside option is a perfectly flat compensation schedule. Because a fixed compensation is incompatible with incentives, some variation in compensation characterizes the second-best contract. If the risk inherent in production increases, two effects come into play: first, more insurance should be provided to the agent in order to meet his outside option (for a *given* effort level), second, because the marginal expected return from effort changes, the incentive compatible level of effort changes (for a *given* compensation scheme). How the two effects interact is ambiguous; what is not ambiguous is that risk in production will have an effect on contracting. Some models⁴ predict a negative correlation between risk in production and variation in output-based compensation. A natural place to test this prediction is contracts for sharecropping: lands with more risky crops should be associated with sharecropping (tenant shares the risk with the owner) while lands with less risky crops should be associated with rental contracts (tenant faces all the risk). The

³ What about many agents or many types of agents? Most of the literature has been developed under the assumption of a unique outside option. More generally, the outside option of a type can vary with the type (as in the countervailing incentive literature) or can be a random variable (as in RS). In each case, the relationship between types and outside options is quite important for the qualitative properties of the optimal contract. Because we do not observe directly the distribution of outside options, it is not clear how the new effects from these generalizations can be identified.

⁴ E.g., the normal noise model with CARA utility functions and linear sharing rules.

empirical literature has shown that there is no such positive relationship between risk and sharecropping.

CS cite the explanation of Akerberg and Botticini (1999). Let us embed the basic sharecropping model in a two sided matching model where one side, the workers, are differentiated by their risk attitude, and the other side, the crops, are differentiated by their riskiness. We will in a competitive equilibrium have more risk averse agents be assigned to less risky crops while risk neutral agents would be assigned to more risky crops. Risk neutral agents are willing to accept to bear all risk, i.e., we should observe rental contracts for risky crops and sharecropping for less risky crops, which is consistent with stylized facts but is the opposite to what a model with homogeneous workers would predict. Hence theory omits both an “internal variable” – the heterogeneity in workers risk attitude – and an “external variable” – the competitive determination of the assignment of workers to crops. Here “facts” force theory to identify relevant omitted variables.

However this is not the end of the dialogue. Imagine that workers indeed have the same risk attitude and that crops have different riskiness. Can theory still make sense of “the facts”? If yes what are the relevant omitted variables? We can follow here an early work of Rao (1971)⁵. Since the ability to contract on output is linked to its verifiability, riskier crops prevent the use of output contingent contracts - absent technologies that make output verifiable. Hence, a profit maximizing land owner who can allocate resources between technologies that make input verifiable and technologies that make output verifiable will tend to favor output monitoring when crops are risky and to favor input monitoring when crops are less risky. Now, if there is input monitoring, it is easier to contract directly on the worker effort and the contract should reflect first best risk sharing arrangements while if there is output monitoring, incentives will be created by having the worker bear more risk. Here again we obtain a negative correlation between riskiness of crop and sharecropping, absent heterogeneity in risk attitudes. Theory therefore points out an omitted internal variable – the ability to monitor (or measure) input and output⁶ – and emphasizes the tradeoff between rent-extraction and incentives.

3.2. From Fixed Wages to Piece-Rates

3.2.1. Incentives Matter

CS cite the papers by Paarsch and Shearer (1999) and by Lazear (1999) who show how going from fixed wage to piece-rates will generate (large) productivity gains. For those of us who are interested in incentive theory this is good news indeed. In the case of Paarsch and Shearer, the firm uses both piece-rate and wage contracts while in the case of Lazear there was a change in management that coincided with a change of compensation scheme from fixed wage to piece-rate. In the first case, the observed productivity reflects both the

⁵ See also Allen and Luck (1995), Newman (1999) and Prendergast (2000). Leffler and Rucker (1991) show also that contractual choices are best explained by variables like enforcement costs or measurement costs rather than differences in risk attitudes. Interestingly, Akerberg and Botticini (2000) conclude that there is no empirical support for the risk sharing hypothesis but that there is empirical support for the moral-hazard and the imperfect capital market hypotheses.

⁶ A corollary of this story is that riskier crops should also be correlated with more delegation of authority to the worker. See Rao (1971) or Prendergast (2000).

contractual terms and the land condition (piece-rate is associated to good planting conditions).⁷ In the second case the observed productivity *seems* to reflect only the contractual change.

Both studies are related to question (A). Shearer et al. also partially answer question (B) since they see as a possible source of contractual choice the quality of the land. Lazear is more silent on (B). For both situations, outside options are not taken into account. This raises a natural question in the case of Lazear: why did we observe the contractual change following the change of management? There are at least three possible answers.

- Is it because there was some type of organizational innovation? This is not likely given the prevalence of piece-rate contracts elsewhere.
- Is it because the previous management did not realize the productivity benefits of using piece-rates? Possibly (and could explain why the previous management was replaced!) In this case, the contractual change generates sorting effects: high types are paid more and therefore will tend to “flow” toward the firm more than before.⁸
- Or is it because the change of management coincided with a change in outside options (or other market conditions) of the workers?⁹ In this case, sorting effects generate the contractual change. It is because high types have a relatively larger outside option than low types that the contract must be piece-rate in order to minimize the cost to the firm of giving each type of agent his outside option. Here the omitted variable is external.

3.2.2. Outside Options Matter

In the work cited by RS and by CS, moral hazard or asymmetric information were key to explaining the performance and the nature of the contracts. As I have argued, external variables are also important. Here, I would like to propose a simple example showing how external variables could be sufficient to explain, for instance, the choice of piece-rate versus wage contracts.

Consider a risk neutral principal *who has limited liability* (this is the first “market variable”, there is a missing insurance market) and who contracts with a risk averse worker. Assume that output is verifiable *and that effort is contractable*. To simplify assume that there is a unique level of effort consistent with production and that there is an equal probability that a low output R_0 and a high output R_1 are realized.

The principal will therefore choose a contingent contract (w_0, w_1) that minimizes the expected wage bill subject to two constraints: (i) the limited liability constraint that wages cannot exceed available output and (ii) the participation constraint that the expected utility of the agent is greater than his outside option \underline{u} (this is our second “market variable”). The principal solves the problem

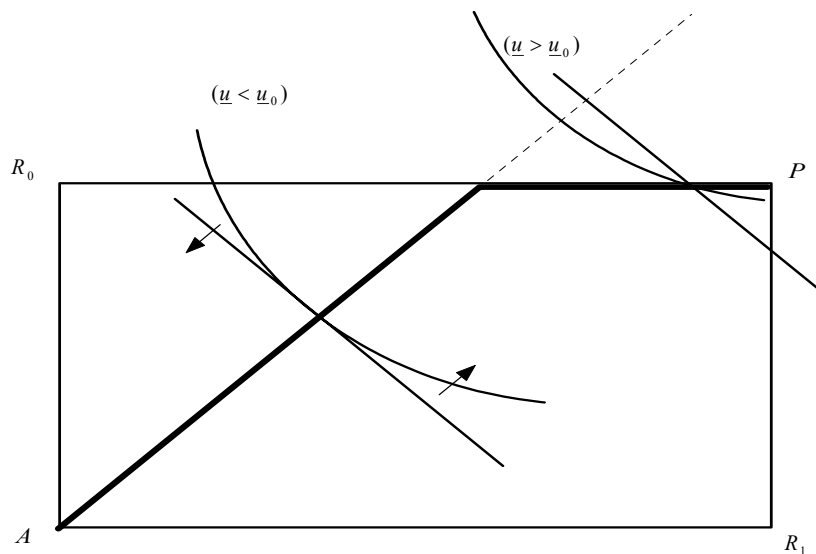
⁷ Note the parallel with the previous explanation for correlation between sharecropping and riskiness of crop.

⁸ This is the observation of Lazear (1999).

⁹ Think of a situation where the type of a worker affects his private cost of production but not the level of production. It is easy to show that if there is any cost to implementing menu contracts, we will observe for relatively equal outside options a unique wage-effort contract while if the outside options are more unequal we will observe a menu contract that can be implemented by a piece-rate contract.

$$\begin{cases} \min w_0 + w_1 \\ u(w_0) + u(w_1) \geq 2u \\ w_i \in [0, R_i], i = 0,1 \end{cases}$$

It is straightforward to show that the cost minimizing schedule is of the form $w_1 = w_0 + b (R_1 - R_0)$ and that there exists a cutoff level $\underline{u}_0 = u(R_0)$ such that when the outside option is smaller than \underline{u}_0 the optimal b is equal to zero (wage contract) and when the outside option is greater than \underline{u}_0 the optimal b is positive and increases in the outside option (piece-rate contract). This is also simply illustrated in the following Edgeworth box diagram where the contract curve corresponding to the above problem is the thick line.



For low values of the outside option, the contract curve is the full insurance line and for high values of the outside option the limited liability constraint of the principal binds and prevents full insurance. A change from wage contracting to piece-rate contracting is therefore directly due to an increase in outside options, absent any agency problem.

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