Testing for the Interaction of Formal and Informal Contracts

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Abstract

As documented by Macauley (1963) and others, informal contracts are pervasive in modern economies. Yet, systematic empirical evidence on their importance and role is still limited. In this paper, we provide a methodological framework to test for the presence of informal contracts and their interaction with formal ones. First, we present a model that organizes the main testable predictions from economic theories of informal contracting. Next, we examine how, and to what extent, existing empirical works support the model's predictions. Finally, we discuss strategies for testing theoretical predictions for which conclusive evidence is still missing, as well as unexplored research opportunities offered by available studies and data.

1. Introduction

Thanks to scholars like Coase, Williamson, Hart, Holmstrom, and to the empirical works inspired by their theories, the importance of formal contracts as vehicles of commitment and exchange is now well understood in economics.[1] At the same time, economists, sociologists and legal scholars alike have documented the existence and pervasiveness of *informal contracts*—that is, contracts that are enforced by parties, markets or communities through the threat of terminating bilateral or multilateral relationships, rather than by courts (Macauley 1963; Klein and Leffler 1981; Williamson 1983, 1991; Asanuma 1989; Milgrom et al. 1990; Ostrom 1990; Greif et al. 1994; Lafontaine and Raynaud 2002; Foss 2003; Scott 2003; Helper and Henderson 2014).[2]

Inspired by these works, a rich theoretical literature has emerged in economics, investigating the conditions that make informal contracts feasible (Bull 1987; MacLeod and Malcomson 1989), their dynamic patterns (Levin 2002, 03; Ray 2002; Halac 2012; Li and Matouschek 2013), and the way formal contracts help sustain and enforce informal ones by reducing the parties' temptation to renege on their promises (Klein and Murphy 1988, 1997; Klein 1995, 2000; Baker et al. 1994, 2001, 02, 11; Battigalli and Maggi 2008; Zanarone 2013).[3]

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[1] For comprehensive reviews of the empirical evidence on contracts see, for instance, Lafontaine and Slade (1997, 2012).

[2] The economic literature often refers to contracts that are not enforced by courts as "relational". However, some economists, and many legal scholars, define relational contracts more broadly as those that govern long-term relationships, and include in their definition contracts that are enforced by courts based on non-standard legal rules (e.g., McNeil 1978; Williamson 1979; Schwartz 1992). To avoid confusion, we refer to contracts that are not enforced by courts as "informal", rather than "relational".

[3] Up-to-date reviews of the theoretical literature on informal contracts can be found in MacLeod (2007) and Malcomson (2013).

Despite the abundance of theories, case studies, and anecdotes, systematic empirical evidence on informal contracts and on their interaction with formal ones is still scarce.[4] In a way, that is not surprising given that, by definition, informal contracts are difficult to identify and measure. At the same time, testing for the interaction of formal and informal contracts seems both a worthwhile endeavor—given their economic importance—and a feasible, albeit challenging, one. On one hand, as shown by some of the articles discussed here, direct data on the use of formal and informal contracts can sometimes be obtained, as firms seem to be aware of, and to optimize upon, these two contractual forms (Gil 2013). On the other hand, the existing theories can be used to develop indirect empirical tests that may be performed using more conventional data on contracts and outcomes. In this paper, we take upon these challenges by providing a critical review of the existing evidence on informal contracts, as well as a methodological framework that may guide empirical researchers on how to produce new evidence. To the best of our knowledge, this is the first such study in the literature.

In the first part of the paper, we present a simple principal-agent model that illustrates how formal and informal contracts can be optimally used and combined. In a sense, the model is general, as it captures a broad range of contracting situations that have been analyzed in the theoretical literature. At the same time, the model is deliberately specialized in that we focus on informal contracts that are optimally stationary—that is, that do not change over time. We do this primarily because the theoretical literature on the dynamics of informal contracts is so recent that a body of empirical evidence testing those theories has not emerged yet.

[4] For a discussion of early evidence and case studies consistent with the presence of informal contracts, see Shelanski and Klein (1995).

Our model generates three sets of testable predictions. The first set relates to factors that discourage the use of purely informal contracts, as opposed to purely formal, or formal and informal in combination—namely, the parties' intertemporal discount rate, their fallback option after the relationship breaks down, and their opportunity cost of honoring contractual obligations. The second set of predictions relates to how the formal contractual provisions and outcomes, and their comparative static variations, that we expect to observe when informal contracts are being used, differ from those we would expect in the absence of informal contracts. The third set of predictions highlights how informal contracts become more effective when the parties are embedded in networks, which we model, following Levin (2002), as multilateral contracts where non-performance by the principal triggers termination of his relationship with multiple agents, rather than with a single agent.

In the second part of the paper, we discuss a number of empirical works that may be interpreted as tests of our theoretical predictions. The evidence varies from CEO compensation (Gillan et al. 2009) and movie exhibition (Gil 2013) to procurement contracts (Johnson et al. 2002; Corts and Singh 2004; Camuffo et al. 2007; Shi and Susarla 2011; Gil and Marion 2013), franchising (Zanarone 2009, 2013), international trade (Macchiavello and Morjaria 2013; Antras and Foley 2014), and taxi transportation (Jackson and Snyder 2011). We find support for most theoretical predictions from the model, although a few predictions, perhaps due to their demanding empirical requirements, are still awaiting clear supportive evidence.

In the final part of the paper, we provide some guidance for future research by discussing empirical strategies that may allow us to explore untested predictions of

informal contracting theory, and by commenting on further research opportunities offered by the existing data. In particular, we discuss three recent empirical studies on contracts (Forbes and Lederman 2009; DeVaro et al. 2013; Bolton et al. 2014) whose data, alone or in combination with the data from other studies, could be used to further test the predictions from our illustrative model.

We should be clear in that the goal of this paper is to provide a methodological discussion of the testability of mainstream theories of informal contracts, rather than an exhaustive review of the empirical literature. Hence, we deliberately focus on a selected set of recent empirical works that 1) test clear theoretical predictions, offer 2) systematic econometric evidence with 3) strong identification and 4) accurate measurement of variables, 4) use promising datasets that may span future work, or satisfy at least some of the above criteria. For the same reason, we do not discuss purely anecdotal evidence.

The rest of the paper is organized as follows. Section 2 presents our illustrative model of the interaction between formal and informal contracts and derives testable implications. Section 3 associates existing empirical works on informal contracts to the model's testable predictions, and describes the sources of variation and the identification strategies exploited by these papers. Section 4 extends the analysis of informal contracting to transactions backed by business and social networks. Section 5 discusses the existing evidence on informal contracts in networks. Section 6 discusses opportunities for future research. Section 7 concludes.

2. An illustrative model

2.1. Model setup

There are a principal (P) and an agent (A). Both P and A are risk-neutral, live forever, and discount next-period payoffs by the factor $1/(1+r)$. Time evolves in discrete periods.

In any given period, A chooses an action vector $\mathbf{a} \in \mathbf{A}$, which produces payoff $\pi_P(\mathbf{a})$ for P and $\pi_A(\mathbf{a})$ for A. We define a contract implementing action plan $\mathbf{a} = \mathbf{x}$ as a payment schedule $b_{\mathbf{x}}(\mathbf{a})$ such that, if A accepts the contract, $\mathbf{x}$ is his preferred action plan—that is, $\mathbf{x} = \arg\max_{\mathbf{a}} \pi_A(\mathbf{a}) + b_{\mathbf{x}}(\mathbf{a})$. Typically, $b_{\mathbf{x}}(\mathbf{a})$ is a function of jointly observed variables that depend on $\mathbf{a}$, and it specifies a payment from P to A (or from A to P, if it is negative) for any possible action plan $\mathbf{a} \in \mathbf{A}$. If P and A do not enter a contractual relationship, P obtains payoff $\underline{\pi}_P$ and A obtains payoff $\underline{\pi}_A$, yielding joint surplus $\underline{S} \equiv \underline{\pi}_P + \underline{\pi}_A$. We assume P and A jointly observe $\mathbf{a}$ (equivalently, we may assume they jointly observe the realized payoffs $\pi_P(\mathbf{a})$ and $\pi_A(\mathbf{a})$).

The sequence of events in each period is as follows: at stage 1, P offers to A a contract implementing action plan $\mathbf{a} = \mathbf{x}$, which includes the contingent payment schedule $b_{\mathbf{x}}(\mathbf{a})$, and a fixed payment s. If A rejects, the game ends and P and A receive their outside options $\underline{\pi}_P$ and $\underline{\pi}_A$, respectively. If A accepts, P pays him the fixed sum s, and the game proceeds to stage 2. At stage 2, A chooses an action plan $\mathbf{a}$. At stage 3, the contract terms may be enforced, in which case A receives the contingent payment $b_{\mathbf{x}}(\mathbf{a})$. At stage 4, the payoffs $\pi_P(\mathbf{a})$ and $\pi_A(\mathbf{a})$ are realized.

Relation to existing models

The above formulation captures a fairly general set of contracting situations. For instance, P may be A's employer, **a** the unobservable effort spent by A on various tasks, s the base salary that P pays A, and $b_x(\mathbf{a})$ a bonus contingent on some performance measures that depend on A's actions, as in models of incentive contracts (e.g., Holmstrom and Milgrom 1991; Baker 1992, 2002).

Alternatively, A may be P's supplier, **a** a vector of specific investments affecting the quality of the good or service that A supplies to P, s the pre-agreed price, and $b_x(\mathbf{a})$ a price adjustment that P and A expect to negotiate ex post given the initial allocation of assets and decision rights, as in property rights and holdup models (e.g., Grossman and Hart 1986; Hart and Moore 1988, 1990). If the initial contract involves a reallocation of asset ownership, s may also include the price of such reallocation, averaged on a per period basis, and $b_x(\mathbf{a})$ may include the stream of asset returns and payoff rights that are transferred from P to A (or from A to P, if $b_x(\mathbf{a})$ is negative) after the reallocation, as in incentive-system models of firm boundaries (e.g., Holmstrom and Milgrom 1991, 1994; Gibbons 2005).

Finally, **a** may be a set of managerial or administrative decisions that P wants A to implement (within an organization, or as part of a supply or distribution network, a strategic alliance, and the like), and $b_x(\mathbf{a})$ a bonus or penalty contingent on such decisions, as in adaptation models (e.g., Simon 1951; Williamson 1991; Baker *et al.* 2008, 2011; Hart and Holmstrom 2010).

Formal and informal contracts

The key feature of our model is that P and A may contract either formally or informally. A formal contract is enforced by the threat of court-imposed damages, whereas an informal contract is enforced by the threat of terminating the principal-agent relationship. Since courts are backed by the State's coercive power, we assume a formal contract is automatically enforced—that is, P has no option, at stage 3, to withdraw the payment $b_x(\mathbf{a})$ once A has chosen **a**, whereas P has such option under an informal contract. On the other hand, since a formal contract is enforced by courts, it must depend on variables that courts can verify. In contrast, an informal contract can depend on any variables that P and A jointly observe, particularly on A's action plan **a**.

To capture this disadvantage of formal contracts, we define the cost of formally contracting action plan $\mathbf{a} = \mathbf{x}$, $f(\mathbf{x})$, as the minimum expenditure necessary to make a contingent payment that implements plan **x** court-verifiable. Without loss of generality, we assume that $f(\mathbf{x})$ is paid by P at the time of contracting. We interpret $f(\mathbf{x})$ as the cost—in terms of time and lawyers' fees—necessary to draft the contract in such a way that a court will correctly interpret P's and A's obligations and enforce them as specified.[5]

The costs of formal contracting are implicitly present in the literature, where key variables are assumed to be "non-contractible". For instance, in models of formal

[5] For a discussion of the costs of specifying contracts in order to make them court-verifiable, see Battigalli and Maggi (2002), and Schwartz and Scott (2003). An alternative interpretation of the contracting cost f(**x**) is as the cost of proving breach in court. In that case, f(**x**) will not be incurred unless breach arises in equilibrium. However, f(**x**) will still shape A's equilibrium actions under formal contracting by imposing a credibility constraint that P and A be willing to pay f(**x**) in case of breach. For the purposes of this paper, the predictions from such a model are qualitatively equivalent to those presented here.

incentive contracts the cost of paying a bonus that is directly contingent on A's actions is infinite, and so is the cost of paying a bonus based on the outputs $\pi_P(\cdot)$ and $\pi_A(\cdot)$. As a result, the second-best contingent payment $b_x(\mathbf{a})$ (that is, the one that maximizes the difference between the joint surplus from A's actions and the costs of contracting), tends to be distortionary—for instance, because it induces A to spend an inefficient amount of effort in some states (Baker 1992; Baker *et al*. 1994), or to misallocate effort across tasks (Holmstrom and Milgrom 1991; Baker 2002). In holdup and property rights models, it is assumed that contracting on the outcomes of A's actions is infinitely costly before A chooses such actions, and costless afterwards. Moreover, decision rights about the outcomes of A's actions are costlessly contractible. Hence, the only way a formal contract can affect A's actions is by allocating asset ownership and decision rights, which will influence bargaining between P and A about the actions' outcomes, and hence A's ex ante choice of actions.

2.2. Purely formal contracts

Under formal contracting, in every period P offers to A a contract implementing the action plan $\mathbf{a}^F$, which solves

$\max_{\mathbf{x}\in\mathbf{A}} \pi_P(\mathbf{x}) - b_x(\mathbf{a}=\mathbf{x}) - s - f(\mathbf{x})$, subject to P's and A's participation constraints:

$$\pi_P(\mathbf{x}) - b_x(\mathbf{a}=\mathbf{x}) - s - f(\mathbf{x}) \geq \underline{\pi}_P, \text{ and} \quad (1)$$

$$\pi_A(\mathbf{x}) + b_x(\mathbf{a}=\mathbf{x}) + s \geq \underline{\pi}_A. \quad (2)$$

Substituting for the lowest fixed payment s consistent with (2), we can write

$\mathbf{a}^F \equiv \arg\max_{\mathbf{x}\in\mathbf{A}} \pi_P(\mathbf{x}) + \pi_A(\mathbf{x}) - f(\mathbf{x}) - \underline{\pi}_A$, subject to

$$\pi_P(\mathbf{x}) + \pi_A(\mathbf{x}) - f(\mathbf{x}) \geq \underline{S}. \quad (3)$$

Two things are noteworthy. First, in the absence of contracting costs, A's action plan under the optimal formal contract coincides with the first best action plan. Second, the joint surplus under an optimal formal contract, given by $S^F \equiv \pi_P(\mathbf{a}^F) + \pi_A(\mathbf{a}^F) - f(\mathbf{a}^F)$, is non-increasing in the contracting cost $f(\cdot)$.

2.3. Purely informal contracts

Under purely informal contracts, no contracting costs are incurred because courts are not involved and P perfectly observes A's actions. Hence, P and A can agree on a simple contingent payment scheme whereby P pays $\pi_A(\mathbf{a}^0) - \pi_A(\mathbf{x})$ if A takes the action plan $\mathbf{a} = \mathbf{x}$, and zero otherwise. The action plan $\mathbf{a}^0$ is the one that maximizes A's gross payoff $\pi_A(\cdot)$, so that the payment scheme above induces A to choose $\mathbf{x}$ at the minimum cost to P.

At the same time, under informal contracts P and A do not benefit from the State's commitment to enforce, so their future losses from terminating the relationship must be sufficiently large to deter non-compliance. As standard in the literature, we model informal contracts as stationary, trigger-strategy equilibria of the infinitely repeated game: P and A keep honoring the informal contract until either party breaches and, in case of breach, they revert to the optimal equilibrium without informal contracts forever after. Given risk-neutrality and the absence of liquidity constraints, stationary trigger-strategy equilibria are without loss of generality (Levin 2003).

Let $S^{SP} \equiv \max\left\{S^F, \underline{S}\right\}$ be the parties' fallback option—that is, their joint surplus in the optimal post-breach equilibrium (either an optimal formal contract or termination)—and let π_P^{SP} and π_A^{SP} be P's and A's individual fallback payoffs, so that $\pi_P^{SP} + \pi_A^{SP} = S^{SP}$. Then, under informal contracting, P offers to A a contract implementing the action plan $\mathbf{a}^I$, which solves

$$\max_{\mathbf{x}\in\mathbf{A}} \pi_P(\mathbf{x}) - \left[\pi_A(\mathbf{a}^0) - \pi_A(\mathbf{x})\right] - s,$$

subject to P's and A's participation constraints

$$\pi_P(\mathbf{x}) - \left[\pi_A(\mathbf{a}^0) - \pi_A(\mathbf{x})\right] - s \geq \pi_P^{SP} \text{ and} \tag{4}$$

$$\pi_A(\mathbf{x}) + \left[\pi_A(\mathbf{a}^0) - \pi_A(\mathbf{x})\right] + s \geq \pi_A^{SP}, \tag{5}$$

and to P's incentive constraint, which insures that P prefers to make the promised payment once A has executed the action plan:

$$-\left[\pi_A(\mathbf{a}^0) - \pi_A(\mathbf{x})\right] + \frac{1}{r}\left[\pi_P(\mathbf{x}) - \left[\pi_A(\mathbf{a}^0) - \pi_A(\mathbf{x})\right] - s\right] \geq \frac{1}{r}\pi_P^{SP}. \tag{6}$$

Substituting for the lowest fixed payment s consistent with (5), constraint (4) becomes $\pi_P(\mathbf{x}) + \pi_A(\mathbf{x}) \geq S^{SP}$, whereas constraint (6) becomes

$$\pi_P(\mathbf{x}) + \pi_A(\mathbf{x}) \geq S^{SP} + r\left[\pi_A(\mathbf{a}^0) - \pi_A(\mathbf{x})\right]. \tag{7}$$

Since (7) is more restrictive, it is both necessary and sufficient for a purely informal contract to be enforceable, so that

$\mathbf{a}^I \equiv \arg\max_{\mathbf{x}\in\mathbf{A}} \pi_P(\mathbf{x}) + \pi_A(\mathbf{x}) - \pi_A^{SP}$, subject to (7).

It follows from (5) that the joint surplus under informal contracting, $S^I \equiv \pi_P(\mathbf{a}^I) + \pi_A(\mathbf{a}^I)$, is non-increasing in r. At the limit, when r is close to zero, A's actions under an informal contract coincide with the first best actions. Moreover, S^I is non-decreasing in $f(\cdot)$, the cost of formal contracting. That is because, when $S^{SP} = S^F$, so that P and A revert to formal contracting if P breaches the informal contract, an increase in $f(\cdot)$ reduces P's post-breach payoff, thereby making informal contracts easier to enforce.

2.4. Informal contracts backed by formal contracts

While we have so far analyzed formal and informal contracts as alternative governance structures, in practice they are often used together. For instance, Lincoln Electric notoriously uses both formally contracted piece rates and discretionary bonuses to incentivize workers (Fast and Berg 1975; Baker *et al*. 1994). As discussed in several papers by Klein and by Baker, Gibbons and Murphy, one reason for using formal and informal contracts together is that formal contracts may be used as defaults within an overarching informal contract in order to reduce the parties' temptation to breach.[6] In this section, we use our framework to broadly state this point.

When formal and informal contracts are used together, P offers to A an informal contract implementing the desired action plan **a** = **x**, and a formal contract implementing the default action plan **a** = **α**. If A accepts and then breaches on the informal contract, P can enforce the formal one, so that the cheapest informal payment schedule implementing

[6] On inter-firm contracts, see Klein and Murphy (1988), Klein (1995, 2000), Lafontaine and Raynaud (2000), and Baker et al. (2011). On vertical integration, see Klein and Murphy (1997) and Baker et al. (2002). On employment relationships, see Baker et al. (1994, 1999, 2001).

the action plan **a** = **x**, given the formal payment schedule $b_{\boldsymbol{\alpha}}(\mathbf{a}=\boldsymbol{\alpha})$, is one where P pays $\pi_A(\boldsymbol{\alpha})-\pi_A(\mathbf{x})+b_{\boldsymbol{\alpha}}(\mathbf{a}=\boldsymbol{\alpha})$ if A chooses **x**, and zero otherwise. With this in mind, P chooses $\mathbf{a}^{I+F}$ and $\boldsymbol{\alpha}^{\mathbf{F}}$ to solve

$\max_{(\mathbf{x},\boldsymbol{\alpha})\in\mathbf{A}} \pi_P(\mathbf{x})-\left[\pi_A(\boldsymbol{\alpha})-\pi_A(\mathbf{x})+b_{\boldsymbol{\alpha}}(\mathbf{a}=\boldsymbol{\alpha})\right]-s-f(\boldsymbol{\alpha})$, subject to the participation constraints

$$\pi_P(\mathbf{x})-\left[\pi_A(\boldsymbol{\alpha})-\pi_A(\mathbf{x})+b_{\boldsymbol{\alpha}}(\mathbf{a}=\boldsymbol{\alpha})\right]-s-f(\boldsymbol{\alpha})\geq\pi_P^{SP}, \text{ and} \tag{8}$$

$$\pi_A(\mathbf{x})+\pi_A(\boldsymbol{\alpha})-\pi_A(\mathbf{x})+b_{\boldsymbol{\alpha}}(\mathbf{a}=\boldsymbol{\alpha})+s\geq\pi_A^{SP}, \tag{9}$$

and to P's incentive constraint, which guarantees that, given A's action plan **x**, P prefers to pay the promised informal bonus instead of the formal bonus that corresponds to such plan:

$$\begin{aligned}&-\left[\pi_A(\boldsymbol{\alpha})-\pi_A(\mathbf{x})+b_{\boldsymbol{\alpha}}(\mathbf{a}=\boldsymbol{\alpha})\right]\\&+\frac{1}{r}\left[\pi_P(\mathbf{a})-\left[\pi_A(\boldsymbol{\alpha})-\pi_A(\mathbf{x})+b_{\boldsymbol{\alpha}}(\mathbf{a}=\boldsymbol{\alpha})\right]-s-f(\boldsymbol{\alpha})\right]\geq-b_{\boldsymbol{\alpha}}(\mathbf{a}=\mathbf{x})+\frac{1}{r}\pi_P^{SP}.\end{aligned} \tag{10}$$

Substituting for the minimum fixed payment s consistent with (9), we have

$(\mathbf{a}^{I+F},\boldsymbol{\alpha}^{F})\equiv\arg\max_{(\mathbf{x},\boldsymbol{\alpha})\in\mathbf{A}} \pi_P(\mathbf{x})+\pi_A(\mathbf{x})-f(\boldsymbol{\alpha})-\pi_A^{SP}$, subject to

$$\pi_P(\mathbf{x})+\pi_A(\mathbf{x})-f(\boldsymbol{\alpha})\geq S^{SP}+r\left[\pi_A(\boldsymbol{\alpha})-\pi_A(\mathbf{x})+b_{\alpha}(\mathbf{a}=\boldsymbol{\alpha})-b_{\alpha}(\mathbf{a}=\mathbf{x})\right]. \tag{11}$$

It follows from (7) and (11) that P and A will use a formal contract to back the informal one only if they can design a formal contract that reduces P's temptation not to pay relative to pure informal contracting (formally, if $\pi_A(\boldsymbol{\alpha})+b_{\alpha}(\mathbf{a}=\boldsymbol{\alpha})-b_{\alpha}(\mathbf{a}=\mathbf{x})<\pi_A(\mathbf{a}^0)$).

2.5. First Set of Testable predictions: The choice of enforcement regime

A first set of testable implications from our model regards the choice of enforcement regime—that is, the extent to which P and A use formal and informal contracting to govern their relationship. First, there is a negative relationship between the intertemporal discount rate r and the post-termination surplus $\underline{S}$ on one hand, and the use of purely informal contracts on the other. For a given $f(\cdot)$, the surplus under pure formal contracting, S^F, does not depend on r and $\underline{S}$ (constraint 3), whereas the surpluses under both pure and mixed informal contracting, S^I and S^{I+F}, weakly decrease in r and $\underline{S}$ (constraints 7 and 11). However, S^{I+F} decreases less rapidly than S^I, because formal contracts reduce P's reneging temptation. Notice that, when $\underline{S}$ grows too large, no informal contracts can be enforced, and P and A terminate their relationship. Conditional on P and A being in a contractual relationship, though, both an increase in the intertemporal discount rate r and in the post-termination payoff $\underline{S}$ disfavor pure informal contracting relative to formal contracting (either pure or in combination with informal contracting).

Second, an increase in $\pi_A(\mathbf{a}^0)$, A's payoff from breaching a purely informal contract, reduces the equilibrium surplus under pure informal contracts (constraint 7) and, therefore, it favors the use of formal contracts as a means to reduce the parties' temptation to breach.

Finally, condition (11) implies that, for a given discount rate r, there is a positive relationship between the cost of formal contracts, $f(\cdot)$, and the use of purely informal

ones when the fallback option following reneging is termination ($\underline{S} > S^F$), whereas the relationship is ambiguous when the fallback option is continuation under pure formal contracting ($\underline{S} < S^F$). When $\underline{S} > S^F$, an increase in $f(\cdot)$ reduces S^{I+F} relative to S^I, and hence disfavors formal contracting, because it weakens the parties' ability to use formal contracts to mitigate P's reneging temptation. When $\underline{S} < S^F$, an increase in $f(\cdot)$ has the additional effect of making P's fallback option after reneging less attractive, and hence it has an ambiguous effect on the use of formal and informal contracts. In other words, as shown by Baker *et al*. (1994) for the case of incentive contracts, formal and informal contracts can be both substitutes and complements.

We summarize our predictions on the choice between formal and informal contracts in the following proposition,

Proposition 1: *Formal contracts are more likely to be used, and purely informal contracts are less likely to be used, when (i) the intertemporal discount rate and the post-termination surplus are large, and when (ii) A's payoff from choosing opportunistic actions is large. Moreover, (iii) the relationship between the cost of formal contracts and the use of purely informal ones is positive when the fallback option is termination of the contractual relationship, and ambiguous when the fallback option is continuation under pure formal contracting.*

Remark. Proposition 1 implies that, as the discount rate decreases, the surplus under pure informal contracting increases so that, for low enough discount rates, it is efficient to use informal contracts alone, without formal ones. This does not imply, as argued at times, that when formal contracts are used, their complexity (formally, the contracting

costs incurred in equilibrium) decreases in the discount rate. To obtain sharp predictions on the relationship between contractual complexity and the discount rate, the model should be further tailored to match the idiosyncrasies of the contracting environment under study.[7]

2.6. Second Set of Testable predictions: Contracts and outcomes under a given enforcement regime

A second set of testable predictions from our model regards the optimal actions and contract terms within a given enforcement regime (purely formal, informal, or mixed). When the predictions differ depending on whether informal contracts are used or not, they allow us to indirectly test for the presence of informal contracting.

First, constraints (7) and (11) imply that, when informal contracts are used, the equilibrium surplus is weakly decreasing in the discount rate r and in the post-termination surplus $\underline{S}$. Formally, as r and $\underline{S}$ increase, S^I and S^{I+F} tend to collapse into $S^{SP} = \max\left\{\underline{S}, S^F\right\}$, the surplus available in the absence of informal contracting.

Second, it follows from equations (3) and (11) that $\left(\mathbf{a}^F, b_{\mathbf{a}^F}(\mathbf{a})\right)$ may differ from $\left(\boldsymbol{\alpha}^F, b_{\boldsymbol{\alpha}^F}(\mathbf{a})\right)$, that is, formal contracts may take different forms depending on whether they are used alone, or to support informal contracts. For instance, a formal contract requiring A to perform actions that produce no net payoff for P ($\pi_P(\boldsymbol{\alpha}) - b_\alpha(\mathbf{a} = \boldsymbol{\alpha}) \approx 0$) but a low payoff for A ($\pi_A(\boldsymbol{\alpha}) + b_\alpha(\mathbf{a} = \boldsymbol{\alpha}) < \pi_A(\mathbf{a}^0)$) is unlikely to be optimal under pure

[7] Some of the existing evidence suggests such a modeling effort may be worthwhile. For instance, in a study of technology development contracts, Ryall and Sampson (2009) find that contracts between long-time partners are more detailed, and interpret their results as evidence consistent with the hypothesis that formal and informal contracts complement each other.

formal contracting (equation 3), but the threat to enforce such contract may reduce the informal payment that P must promise to induce A to perform, and hence P's temptation not to pay (equation 11).[8] This implies that one way to investigate the presence of informal contracts is to look for seemingly suboptimal formal contracts.

Third, (11) implies that $\left(\mathbf{a}^{I+F}, b_{\mathbf{a}^{I+F}}\left(\mathbf{a}^{I+F}\right)\right) \neq \left(\boldsymbol{\alpha}^{F}, b_{\boldsymbol{\alpha}^{F}}\left(\boldsymbol{\alpha}^{F}\right)\right)$, that is, observed actions and payments differ from formally contracted ones when formal contracts are used to facilitate informal contracts but are not enforced in equilibrium.

Fourth, (3) and (11) imply that $\left(\boldsymbol{\alpha}^{F}, b_{\boldsymbol{\alpha}^{F}}\left(\mathbf{a}\right)\right)$ depends on r if, and only if formal contracts are used to facilitate informal ones. Our general model cannot predict the specific patterns of joint variation between $\left(\boldsymbol{\alpha}^{F}, b_{\boldsymbol{\alpha}^{F}}\left(\mathbf{a}\right)\right)$ and r, which will depend on the particular contractual relationship under study. However, the model suggests that, if in any given contracting situation formal contracts are used to support informal ones, they should vary systematically with the discount rate. Hence, empirical studies that aim to identify the role of formal contracts (dictating behavior, as in section 2.2, or facilitating superior informal contracts, as in section 2.4) should test for joint variation between $\left(\boldsymbol{\alpha}^{F}, b_{\boldsymbol{\alpha}^{F}}\left(\mathbf{a}\right)\right)$ and r.

Finally, by the same argument as in Proposition 1(iii), when the fallback option following breakdown of an informal contract is termination ($\underline{S} > S^{F}$), increases in the cost of formal contracting, $f(\cdot)$, reduce the equilibrium surplus, because S^{I+F} collapses into S^{I}. On the other hand, when the fallback option is continuation under pure formal contracting

[8] See Iossa and Spagnolo (2010) for a model in this spirit.

($\underline{S} < S^F$), increases in $f(\cdot)$ have an ambiguous effect on S^{I+F}, and hence on the equilibrium surplus, as they simultaneously raise P's temptation to renege on the informal contract (a surplus-reducing effect), and the P's fallback option after reneging (a surplus-increasing effect).

We summarize our second set of predictions in the following proposition,

Proposition 2: *When informal contracts are used, (i) realized performance is weakly decreasing in the discount rate and in the post-termination surplus, (ii) observed formal contracts may be suboptimal if enforced, (iii) observed actions may differ from formally contracted ones, and (iv) formal contract terms may vary systematically with the discount rate. Finally, (v) the costs of formal contracting have a negative effect on performance when the fallback option is termination, and an ambiguous effect when the fallback option is continuation under pure formal contracting.*

Next we proceed to empirically assess the two sets of predictions obtained from our theoretical model by comparing them to evidence in the informal contracting literature.

3. Existing evidence on informal contracting

In this section, we examine the existing evidence that supports each of the testable implications presented in the previous section. We describe the variations exploited by these studies and formalize better tests when adequate.

3.1. Choice of formal vs. informal enforcement

H1: High discount rate and post-termination surplus increases the use of formal contracts

Ideally, to test this first hypothesis we would need measures for the following variables. First, we would need a dependent variable indicating whether a formal contract exists. Second, we also need exogenous measures for the intertemporal discount rate and the parties' payoffs outside the relationship, where by exogenous we mean that they must be uncorrelated with the quality of the match between the two contractual parties (Ackerberg and Botticini, 2002). If the measures of discount rate and post-termination payoffs are exogenous, a simple correlation will be informative about the causal relationship between the use of formal contracts and the discount rate regardless of whether we use cross-sectional or longitudinal variation in the corresponding data analysis.

Gillan et al. (2009) study the choice between explicit and implicit employment agreements (EAs) for CEOs in S&P 500 firms. They find that the use of explicit EAs (measured by an indicator for whether the firm's SEC filings report an explicit agreement) increases in the CEO's perceived uncertainty about the firm's future prospects (measured by sales volatility, the rate at which firms in the industry change ownership and control, and an indicator for whether the CEO is new to the firm). They also find that the use of explicit EAs increases in the industry's homogeneity (measured by the extent to which variations in industry stock returns are explained by an equally weighted historical industry index).

Both of these results are consistent with hypothesis H1. In particular, when the firm's prospects are uncertain (in terms of our model, the intertemporal discount rate is low), promising a purely discretionary compensation to the CEO is not credible, because there's a high chance that the CEO-firm relationship will soon end, and hence the compensation promise will not be honored. Similarly, discretionary compensation will not be credible when the firm belongs to a homogeneous industry, and hence can more easily replace the CEO, because in that case the firm's fallback option after reneging on the compensation promise will be too attractive. An explicit contract will mitigate these credibility problems, either by reducing the firm's temptation to renege on the CEO or, in the case of severe uncertainty/extreme industry homogeneity, by fully substituting discretionary compensation with formally contracted one.

H2: Agent's opportunism increases the use of formal contracts

To test this second hypothesis, in addition to variation in the use of formal and informal contracting, we need variation in the agent's opportunism—formally, her opportunity cost of honoring an agreement.

Gil (2013) exploits a data set of movie exhibition contracts where 22 distributors place their movies on the screens of one Spanish exhibitor. These distributors may use formal contracts that weekly specify revenue-sharing terms. Alternatively, they may use informal contracts (no formal written terms are in place). If a formal contract is in place, the distributor may pay an additional "kickback" to the exhibitor after her movie has been pulled out of the theater.

The paper shows that movies that did well during their US release (which occurs a few months earlier than the Spanish release) are more likely to use a formal contract than movies that were not released in the US, or were released but did not perform well. This result is consistent with hypothesis H2. When the agreement is completely informal, the exhibitor, who collects revenues upfront, is tempted to renege, and the more so the larger the movie's expected revenues. To mitigate the exhibitor's reneging hazard, movies with high expected revenues are governed by formal contracts, which prevent the exhibitor from retaining revenues at the cost of increasing the distributor's temptation to renege on kickbacks.

H3: The relation between the costs of formal contracts and the use of purely informal ones is positive when the fallback option is termination, and ambiguous otherwise

To this day we are not aware of any empirical paper that provides evidence regarding H3. Note that in order to test this hypothesis we would need, first, to be certain that in the empirical setting under study the fallback option is termination and, second, we would need good measures of both the cost of formal contracts and the use of informal ones. We comment on these and other untested hypotheses later in the paper when we discuss opportunities for future empirical work.

3.2. Contracts and outcomes under a given enforcement regime

H4: Realized performance decreases in the discount rate and in the post-termination surplus

To test this hypothesis, we need clean measures of the discount rate (see above in H1) and measures of realized performance that are relevant to the potential contractual

relationship. We found several papers in the literature that provide supporting evidence for H4.

Gil and Marion (2013) test how relationships between contractors and subcontractors impact their bids. Using data for 10 years of Caltrans (California Department of Transportation) auctions, they are able to account for how often contractors have worked in the past with listed subcontractors in their bids, and how the future value of relationships may influence their bids. To measure the future value of relationships, they use the number and value of projects auctioned over the next calendar year. Since projects are offered when they are needed and not as a response to a particularly good match between contractor and subcontractor, this measure of the potential future value of the relationship is not contaminated by endogenous considerations of how well contractors and subcontractors are matched or were matched in the past. The results show that, consistent with our hypothesis H4, the higher the potential future value of the relationship, the lower the posted bids. This result still holds after controlling for past interactions between contractors and subcontractors—in fact, coefficients of the interaction term indicate that past interactions matter only if future contracts are at stake.

Macchiavello and Morjaria (2013) use cross-sectional data from Kenyan rose exporters to examine the link between the discounted value of long-term relationships and contractual performance. They depart from the observation that the relationships between exporters and buyers are never governed by formal contracts. Because they observe spot auction prices, they can estimate lower bounds for the discounted value of relationships for each buyer-exporter dyad by measuring the largest amount of money that the exporters forgo by honoring their informal contracts with buyers. The authors

then exploit an exogenous shock—namely, a stream of violence that affected only a part of Kenya following a local election—to show that, when the exporters' reneging constraints are binding, contractual performance is correlated with the discounted value of the relationship with their buyers. In particular, they find that, consistent with our hypothesis H4, exporters in the violent area, who experienced a supply cost shock and hence were suddenly forced to prioritize among buyers, were more likely to honor their export agreements when the estimated discounted value of their relationship with the buyers was higher. Moreover, they find no association between exporter reliability and discounted value of the relationship in the subsample of exporters that were not affected by the violence outburst.[9]

Note that while Gil and Marion (2013) exploit exogenous variation over time within a relationship to provide supporting evidence for H4, Macchiavello and Morjaria (2013) use exogenous variation in a cross-section of relationships. Therefore, evidence in support of H4 seems to be robust to the use of all possible sources of variation.

Another paper that offers consistent evidence with H4 is Antras and Foley (2013). In their paper, they investigate the formal financing contracts that are used in international trade and the enforcing mechanisms that are available to exporters. They use data from one large exporter of frozen chicken, who distributes to a network of importers located in over 140 countries. Formal contracts used by the exporter vary on how exposed the exporter is to importer's default. Cash-in-advance contracts (CIA) and letters of credit

[9] In a more recent version of this paper (Macchiavello and Morjaria 2014), the authors no longer present the evidence on informal contracts discussed here. Instead, they show how the correlation between exporters' reliability and the age of their relationship with buyers has an inverted U-shaped form, and interpret the result as evidence that exporters are more concerned about their reputation at the beginning of a relationship than at the end. They also show that the discounted future value of relationships, as described above, is positively correlated with their age.

protect the exporter the most, while open account terms protect it the least. Among other things, the authors find that: (1) as the number and value of accumulated transactions grows within an exporter-importer dyad, the likelihood of using open account terms increases; (2) during the recent crisis the exporter was more likely, all else equal, to use CIA contracts for importers that did not transact with her before the crisis; and finally, 3) customers that purchased a larger share of goods on open account terms before the crisis are more likely to remain active after the crisis.[10] In our view, this last result is similar to that in Macchiavello and Morjaria (2013): once the importers' temptation not to pay becomes more binding due to the crisis, weaker relationships—that is, those governed by cash-in-advance terms that formally protect the exporter—are less likely to survive. This finding is consistent with hypothesis H4 in our model, whereby performance (in this case, survival) is stronger when the discounted value of the relationship is higher.[11]

Johnson et al. (2002) study how informal relationships affected supplier trade credit in transitioning countries that belonged to the former Soviet. Using survey data, and controlling for country and industry fixed effects, they find that a supplier's willingness to give trade credit to his customers increased in the customer's cost of searching for alternative suppliers (negatively measured by the availability of similar suppliers at short distance). This result is consistent with hypothesis H4 because customers that cannot readily replace their supplier stand to lose more if their supplier terminates them

[10] The paper also states (p. 27) that switching contract form over time within a given buyer-seller dyad is rare. Although our model suggests that switching contractual form should take place, we may be omitting important switching costs that are specific to international trade in this industry.

[11] An alternative interpretation, proposed by the authors, is that the exporter is less informed on the creditworthiness of cash-in-advance buyers, so he is more likely to terminate them after the crisis, when the buyers' cash constraints become more binding. This interpretation is consistent with the fact that, before the crisis, cash-in-advance contracts were used for buyers who had not transacted with the exporter in the past.

following non-payment. This makes informal trade credit agreements more likely to be self-enforcing, and hence increase the supplier's willingness to lend.

Finally, Cohen et al. (2013) provide evidence that NBA coaches that are more likely to be terminated are less likely to play their rookies (i.e., novice players) in any given game. In most cases, NBA coaches are responsible for winning games and develop players. Since the former is observable but the latter is not, coaches under high risk of termination will try to outperform in the success measure that is easily observable and therefore give priority to players with experience. Their findings are consistent with H4, in that a coach's termination risk can be interpreted as a measure of his intertemporal discount rate. This evidence differs from others above in that not only match between coach and team is endogenous and could be driving the nature of the informal agreement, different teams may use different informal agreements with their coaches that could be driven by unobserved heterogeneity that the paper does not account for.

H5: Observed formal contracts would be suboptimal if enforced

In order to test this hypothesis, we would need to compare the actual formal contracts with the formal contract that we would expect to observe in the absence of informal contracting. Here again we will comment on several papers that present supporting evidence for hypothesis H5.

Zanarone (2009) studies how vertical restraints in Italian car dealership contracts changed after a 2002 EU regulation prohibited manufacturers to assign dealers to exclusive territories. Among other results, Zanarone (2009) finds that, while contracts before the legal change mostly relied on quantity floors to contain dealers' double

marginalization, contracts after the legal change contained a mix of both quantity floors and price ceilings.

This result is consistent with hypothesis H5 because if dealership contracts were purely formal, retail prices should decrease once intrabrand competition is liberalized. Hence, price ceilings should be *less* necessary after the legal change. Based on a series of field interviews, Zanarone (2009) argues that after the liberalization manufacturers planned to keep enforcing exclusive territories through informal agreements. If such informal agreements were in place and all dealers honored them, quantity floors would be sufficient to prevent double marginalization. However, if an individual dealer decided to deviate from the informal agreement, the new law would allow him to "game" the quantity floor by selling in other dealers' territories, while overpricing in his own territory. Including a price ceiling in the formal contract prevents such gaming, and thus reduces the dealers' temptation to renege on the informal exclusive territory agreement.[12]

Result (2) in the aforementioned paper by Antras and Foley (2013)—whereby during the recent crisis the exporter was more likely, all else equal, to use CIA contracts for importers that did not transact with him before—is also consistent with hypothesis H5. A model of purely formal contracts would predict that, anticipating a more uncertain future and/or tighter cash constraints, the exporter would use CIA contract terms after the crisis for all similarly situated customers (i.e., importers with similar court quality, sales volume, transaction type, etc.), irrespective of whether those importers have or have not transacted with him before. Instead, the result in Antras and Foley (2013) suggests that, consistent with the presence of informal contracts, efficient agreements involving trade

[12] This argument is explicitly modeled in a companion working paper (Zanarone 2007, accessible at gzanarone.cunef.edu).

credit (that is, open account terms) were used for customers who had a relationship with the exporter, while CIA terms were used for new customers.[13]

H6: Observed outcomes are inconsistent with formally contracted ones

In order to test this hypothesis, one needs to observe formal contracts and outcomes. Absent informal contracts, these two variables should coincide, as parties "play by the book". Hence, a discrepancy between formal contracts and outcomes indicates that informal agreements must be in place, and that formal contracts are not being enforced.

Zanarone (2013) provides theory and some evidence on how franchise contracts informally adapt to new contingencies when the law requires formal contract terms to be either uniform across franchisees, or tied to verifiable franchisee characteristics. Using boilerplate automobile distribution agreements for 19 car brands in Italy, and annexes to such agreements issued by 10 manufacturers in one year, Zanarone (2013) finds that, when the formal franchise contract assigns to car manufacturers the authority to modify the dealers' customer service standards, manufacturers set milder standards for smaller dealers even when the standards are aesthetic, and hence unrelated to sales volumes. In addition, Zanarone (2013) provides anecdotal evidence that some car manufacturers selectively tolerate non-compliance by dealers when they have formal authority, and use discretionary or non-monetary payments to reward compliance when they lack formal authority.

[13] One may argue that past interactions provide the exporter with unobservable "soft" information on the importer's liquidity. In that case, as argued before, the result in Antras and Foley (2014) may also be consistent with a model where contracts are purely formal but customers have private information on their own creditworthiness.

These results are consistent with hypothesis H6. Specifically, the evidence on contracts and contractual annexes is consistent with an informal agreement whereby manufacturers spare costly upgrades to customer service standards to the small dealers, who have lower impact on the brand and higher implementation costs, and retain the formal authority to impose uniformly strict standards as a mere threat against non-compliance. The anecdotal evidence also suggests that, in addition to differentiating standards and incentive payments by an objective criterion (dealer size), which is permitted by the law, manufacturers sometimes informally differentiate them according to more discretionary criteria.

Finally, two other papers reflect on Hypothesis H6. First, Camuffo et al. (2007) study the vertical relations between two A/C manufacturers in Italy and a sample of their long-term suppliers. They observe that formal contracts between manufacturers and suppliers rarely include risk-sharing clauses, and yet changes in supplier costs are not followed by equivalent changes in their profits, which is consistent with risk-sharing. The second paper is Gil (2013) already commented above. In that setting, movie exhibitors receive kickbacks from movie distributors that account for lacking movie performance. Their contracts do not include any provision specifying these payments and therefore they must be part of an informal agreement between distributors and exhibitors.

H7: Formal contracts vary systematically with the discount rate

To test this hypothesis, we need variations in observed formal contracts and, as in the case of hypotheses H1 and H4, variation in the contracting parties' intertemporal discount rate.

Corts and Singh (2004) study the choice between turnkey contracts (akin to fixed-price) and day-rate contracts (akin to cost-plus) in offshore oil drilling. Turnkey contracts provide drillers with stronger incentives to cut costs than day-rate contracts, but are also more rigid, and hence costlier to renegotiate. Using a sample of 1476 drilling projects, and an instrumental variable approach to control for the endogenous choice of drillers,[14] Corts and Singh (2004) find that, all else equal, projects are less likely to be governed by a turnkey contract when the oil company and the driller have worked together in the past.[15] They interpret this result as evidence that informal self-enforcing agreements and formal incentive contracts (i.e., turnkey contracts) are substitutes, rather than complements.

The negative association between repeated interactions and turnkey contracts is consistent with hypothesis H7. If past interactions also imply a higher likelihood of future interactions, oil company and driller pairs that have interacted in the past can more easily enforce informal contracts (formally, they have a lower discount rate). The fact that repeated interactions favor turnkey over day-rate contracts would then suggest that drillers are more tempted to renegotiate aggressively than to inflate costs, so that day-rate is the contract form that minimizes the driller's aggregate reneging temptation.

Antras and Foley (2014), mentioned above, find that the frozen chicken exporter is more likely to use open account contract terms with his importers as the number and value of accumulated transactions grows, which is consistent with H7. If one interprets

[14] To control for the endogeneity of driller's choice, Corts and Singh (2004) use characteristics of drillers that had drilling rigs near a well's location before the drilling contract was assigned as instruments for the characteristics of the contracted driller. Their identification strategy relies on the fact that rigs are costly to move, so that drilling projects are likely to be assigned to drillers who are already operating in the project's location.

[15] Similar results are obtained by Kalnins and Mayer (2004) in a study of IT services procurement contracts.

past interactions as a proxy for future ones, as in Corts and Singh (2004), this evidence suggests that contracts that are less likely to be enforced in court (i.e., open account contracts) are chosen only when the parties value their relationship.

Finally, Shi and Susarla (2011) study how reputation and the expectation of future interactions affect the choice between formal fixed-price and cost-plus contracts in IT outsourcing projects. They differ from Corts and Singh (2004) in that they attempt to identify and separate future interactions from past ones. This is not easy and they end up using contract renewal clauses as a proxy, and arbitration and exclusivity clauses as instruments to address the endogeneity of renewal clauses. Despite the endogeneity of both proxy and instruments, their findings are qualitatively consistent with hypothesis H7 and evidence in Corts and Singh (2004). In particular, Shi and Susarla (2011) find that all else equal, clients are more likely to use cost-plus contracts when they expect their relationship with the vendor to last longer.

H8: The relation between the costs of formal contracting and performance is negative when the fallback option is termination, and ambiguous otherwise

Together with H3, we discuss more thoroughly hypothesis H8 later in this paper, in the context of potential opportunities for future research. Once again, the necessary conditions to test this hypothesis are rather demanding, as the researchers would need exogenous measures for the costs of formal contracting and performance, as well as certainty on termination being the only fallback option available to contractual parties.

4. Informal contracting in networks

While we have focused so far on a single principal-agent relationship, it is often the case that P contracts with multiple agents. For instance, an employer typically has several employees, and a manufacturer deals with many suppliers and distributors. In the presence of multiple agents, P may have stronger incentives to honor an informal contract if the agents form a *network*—that is, if *all* agents terminate their informal contracts with P once P breaches his informal contract with any one of them. To incorporate networks into our framework in the simplest possible way, we adapt Levin's (2002) model of multilateral principal-agent contracts. We focus on pure informal contracts, which are notationally simpler. The results immediately extend to the case where formal and informal contracts are used together.

Suppose P has M agents, and let $\pi_{Pi}(\mathbf{a}_i)$ and $\pi_{Ai}(\mathbf{a}_i)$ be the payoffs of P and agent i under an informal contract, respectively. Also, let π_{Pi}^{SP} and π_{Ai}^{SP} be P's and agent i's payoffs once their relationship terminates. Finally, let $S_i(\mathbf{a}_i) \equiv \pi_{Pi}(\mathbf{a}_i) + \pi_{Ai}(\mathbf{a}_i)$ and $S_i^{SP} \equiv \pi_{Pi}^{SP} + \pi_{Ai}^{SP}$ be P's and agent i's joint surpluses inside and outside the relationship, respectively. Given all the definitions and assumptions from the baseline model, when the agents form a network, P offers the action plan $(\mathbf{a}_1^N, ..., \mathbf{a}_m^N)$, which solves $\max_{(\mathbf{x}_1,...\mathbf{x}_m)\in\mathbf{A}^m} \sum_i \left[S_i(\mathbf{x}_i) - \pi_{Ai}^{SP}\right]$, subject to

$$\sum_i S_i(\mathbf{x}_i) \geq \sum_i S_i^{SP} + r\sum_i \left[\pi_{Ai}(\mathbf{a}_i^0) - \pi_{Ai}(\mathbf{x}_i)\right]. \qquad (12)$$

Consider now the case where there is no agents' network, so that P maintains purely bilateral relationships with each agent. In that case, P offers the action plan $\left(\mathbf{a}_1^I,...,\mathbf{a}_m^I\right)$, which solves $\max_{(\mathbf{x}_1,...\mathbf{x}_m)\in\mathbf{A}^m} \sum_i\left[S_i\left(\mathbf{x}_i\right)-\pi_{Ai}^{SP}\right]$, subject to

$$S_i\left(\mathbf{x}_i\right)\geq S_i^{SP}+r\left[\pi_{Ai}\left(\mathbf{a}_i^0\right)-\pi_{Ai}\left(\mathbf{x}_i\right)\right] \text{ for every i.} \qquad (13)$$

Clearly, the network condition (12) is necessary for the M bilateral conditions in (13), but not sufficient—that is, it could be that even though (12) holds, condition (13) does not hold for some agent. Hence, a given action plan can be more easily enforced when the agents form a network and, consequently, having a network is (weakly) efficient. Intuitively, this is the case because, if P breaches his informal contract with agent i and the agents form a network, P does not only lose his relationship with i, but also his relationship with all the other agents. Hence, P's post-breach payoff is not $S_i^{SP}+\sum_{j\neq i}S_j\left(\mathbf{x}_j\right)$, as in the no-network case, but $\sum_i S_i^{SP}\left(\mathbf{x}_i\right)$, which is smaller.

The above results are summarized by the following

Proposition 3: Suppose P has multiple agents. Then, informal contracts perform better when the agents form a network.

5. Evidence on informal contracting in networks

In this section, we discuss empirical evidence that relates to our model's predictions on informal contracting in networks.

H9: Performance improves when the contracting parties belong to a network

There is a large literature on the impact of social and ethnic networks on the access to capital in developing economies (e.g., Banerjee and Duflo 2002; Fafchamps 2002). Our goal here is to study the role of networks in contexts where they coexist with formal court enforcement, rather than fully replacing it.

Jackson and Schneider (2011) use cross-sectional evidence to show that within-network drivers (lease their taxi from owners from the same country) are less likely to have accidents, be convicted for driving violations, or receive summons. Furthermore, the authors also show that drivers who become in-network drivers between 2005 and 2007 improve their driving behavior. Because selection into the network is a pervasive problem when estimating the effect of networks, the authors complement their cross-sectional evidence with a number of imperfect but yet informative empirical tests. On the one hand, they aggregate data at the network level and show that networks with higher percentages of in-network drivers present lower levels of driving violations. On the other hand, given the lack of exogenous variation, they instrument for in-network driving with the number of taxi owners from the same country living in the same neighborhood and find consistent results. The regression coefficients in the three latter empirical strategies is three times as large as the one obtained in the original cross-sectional regression. Aside from concluding that social networks reduce moral hazard and improve performance, the significant change in magnitude is consistent with negative selection into the networks.

A second paper that provides evidence consistent with H9 is Kalnins and Chung (2007). They provide purely cross-sectional evidence that unbranded hotels in Texas are more likely to survive when they are located close to branded hotels run by managers

from the same ethnic network as the unbranded hotel's manager. Because the cross-sectional evidence offered in this paper is at best suggestive, the authors complement their analysis with qualitative and anecdotal evidence from inside interviews with local hotel managers. Contrary to Jackson and Schneider (2011), this paper is silent about the endogeneity of entry, in-network selection, and hotel characteristics.[16]

6. Future and further improvement on existing work

In this final section of our paper, we provide guidance on future research opportunities. First, we point out what theoretical predictions remain untested, and then we discuss how data sets previously used in other studies may be exploited to test for the interaction of formal and informal contracts.

[16] Gil and Hartman (2011) does not directly test hypothesis H9, but it does provide evidence on the impact of networks on outsourcing decisions in Korean drycleaners in Los Angeles. If they had provided evidence on quality (an accepted measure of performance in that industry) or timeliness, their findings would have spoken directly to H9.

6.1. Untested H3 and H8: Non-monotonic impact of formal contracts on informal ones

Based on our review of the empirical literature, two hypotheses out of the nine presented above, H3 and H8, remain untested or without clear supporting evidence.

H3: The relation between the costs of formal contracts and the use of purely informal ones is positive when the fallback option is termination, and ambiguous otherwise

H8: The relation between the costs of formal contracting and performance is negative when the fallback option is termination, and ambiguous otherwise

While we could not find any paper providing evidence that is related to H3, under very stringent assumptions, Johnson et al. (2002) may provide suggestive evidence in favor of H8. In a nutshell, they find that in European countries from the former Soviet bloc, trade credit (performance) increased when courts were believed to enforce contracts. This relationship was weaker when customers were locked into a bilateral monopoly relationship with the supplier and, therefore, the fallback option was less likely to be termination.

An attractive feature of Johnson et al. (2002) is the use of court quality as a measure of the costs of informal contracting. This measure of contracting costs potentially allows for broad empirical studies that may include multiple relationships and industries. On the other hand, our interpretation of Johnson et al. (2002) in terms of hypothesis H8 requires two strong assumptions that cannot be verified in the data—namely, that locked-in pairs of suppliers and customers are less likely to terminate their relationship following breach of an informal agreement, and that non-locked pairs are less likely to use formal contracts

after termination. To overcome this weakness, future research that attempts to test hypotheses H3 and H8 may exploit exogenous changes in contract law that affect the feasibility of termination as a fallback option, such as termination laws in franchising (e.g., Brickley et al. 1991). If H3 and H8 are correct, one would expect court quality to improve performance, and to reduce the use of purely informal contracts, less after laws that restrict contract termination are passed. Since court quality and the regulation of contract termination have been found to vary across countries and industries and within countries, the test we are suggesting may exploit variation across countries, within a country over time, or even within a country and year but across different industries.[17]

6.2. Unexploited opportunities from existing works

As mentioned in the introduction, the conventional wisdom is that there is limited empirical evidence on informal contracts due to a scarcity of data. In this section, we challenge this view by briefly discussing three existing data sets that are potentially suitable for testing the interaction of formal and informal contracts, even though such tests have not been pursued by the authors. In our view, these data represent an opportunity for follow-up studies as well as a reminder that, contrary to the conventional wisdom, novel empirical evidence based on conventional data may be feasible.

A paper that we have not discussed yet is Bolton et al. (2014). They use the recent financial crisis as an exogenous shock in the provision of credit from Italian banks to firms. They identify banks in a given credit transaction as "relationship banks" (as opposed to "transactional banks") when their headquarters are located in the same region

[17] In the US, variations in court quality across States have been documented, among others, by Berkowitz and Clay (2006), and Choi et al. (2008).

as the headquarters of the firm they are lending to. Their evidence shows that the difference in interest rates before and after the crisis is large, but less so for relationship banks. Using the data in Bolton et al. (2014), one could examine which relationships are more likely to end after the crisis. Similarly to Macchiavello and Morjaria (2013), the difference between the interest rates charged by relationship and transactional banks before the crisis may be interpreted as a lower bound for the discounted value of the credit relationship to firms, and therefore should be positively correlated with firms' survival after the crisis and other performance measures, as predicted by our model.[18]

DeVaro et al. (2013) present a model of CEO compensation where current shocks in firm performance predict future shocks. According to their model, CEOs' formal bonuses should be the same during good and bad states, whereas informal bonuses should be larger during good states, because present good states correlate with future ones, and hence imply a greater discounted value from the relationship. While the theoretical prediction in DeVaro et al. (2013) is sharp, they do not have the data required to test it—namely, information on whether CEOs' bonuses are formal or informal. As a partial test, they regress bonus amounts on a state variable (growth versus no growth) and other firm performance characteristics, and find that, consistent with their model, growing firms pay larger bonuses. A clear research opportunity here would be to complement the data on bonus levels and firm performance in DeVaro et al. (2013) with data on whether CEO bonuses are formally or informally contracted, such as those collected by Gillan et al. (2009). By doing so, it would be possible to test for the differential effect of shocks on

[18] A potential caveat, similar to that discussed for Antras and Foley (2014), is that relationship banks may charge lower interest rates to firms they have learned to be more creditworthy, so low interest rates may proxy for superior creditworthiness rather than more valuable relationships. Indeed, Bolton et al. (2014) model "relationship banks" as those that have superior information on their clients.

formal and informal bonuses, and hence for whether the theoretical model in DeVaro et al. (2013) has better predicting power than models of CEO compensation where growing firms pay larger bonuses even in the absence of informal contracts.

Finally, Forbes and Lederman (2009) study vertical integration in the airline industry, and argue that managing flights outsourced to regional airlines requires especially intensive coordination with the national airline in routes characterized by bad weather conditions and hub connections. Consistent with their hypothesis, they find that national airlines are less likely to outsource flights in bad-weather routes and routes that involve a major hub. A potential research opportunity in this context and data (publicly available) is to study within the subsample of outsourced routes and flights whether relationships with major airlines have an impact on the performance of regional airlines. This industry has not been short of exogenous changes lately as national airlines have had to cut back on flights and presence in different airports in response to shocks in oil prices, demand, and the like. When making such decisions, major airlines presumably chose to cut outsourced flights over in-house flights and when doing so they cut those operated by regional airlines with which they had a weaker relationship. In the spirit of Macchiavello and Morjaria (2013), one could estimate lower bounds for the value of relationships by looking at the revenues forgone by national airlines when they give priority to their own connection flight over a flight operated by a regional partner.

In our view, the above discussion illustrates how more data than commonly thought are available to test for the interaction of formal and informal contracts. We believe that those or similar data, combined with appropriate theories of the underlying contractual setting, can and should lead to novel empirical findings.

7. Concluding remarks

In this paper we connect testable implications from a parsimonious model with existing evidence on informal contracting. Because our model produces clear predictions, we are able to link each hypothesis to at least a paper that provides consistent evidence. Overall, we are able to find at least one paper that provides evidence consistent with each of our predictions.

The main takeaway from our paper is that this literature has substantial room to grow and presents plenty of opportunities for future research. We have hopefully proved our point by showing how current tests of the theoretical predictions can be improved, which predictions are left untested, and how current data sets and papers could be exploited for that purpose. We hope our paper will foster future research that will test and feed our theories and understanding of the interaction between formal and informal contracting.

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