Delays in bargaining with incomplete contracts

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Abstract

Existing theories typically focus on asymmetric information to explain delays in bargaining. This is not always appropriate, particularly when the parties are in a long-term relationship. This paper examines the incentive to delay agreement (or innovation) when: there are multiple bargaining periods; previous outcomes affect the subsequent distribution of surplus; contracts are incomplete; and the parties are wealth constrained. Current agreements affect parties' claim on future surplus either by altering their default payoffs (historical bargaining/contractual positions) or by changing their relative contemporaneous bargaining strengths. Delay will occur at different times depending on which assumption applies. If agreement reduces the future default payoffs of a party, delay is more likely when expected future surplus is lower. If innovation reduces current bargaining power, however, a party is more likely to delay agreement when expected future surplus is larger. It is also argued that a party with a narrowly defined set of interests, like a craft union, is more likely to delay than a party with broader interests. *Key words*: bargaining, delay, incomplete contracts. *JEL classifications*: C78, D23.

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1 Introduction

One of the most dramatic industrial confrontations in recent times occurred between the newspaper proprietors and the print unions in the United Kingdom during the 1970s and 1980s over the introduction of photocomposition. This new technology allowed copy to be keyed into the computer, newspaper pages to be organised on a computer screen, then for the printing plates to be made directly from photographs of page bromides (Griffin 1983, p. 42, Martin 1981, p. 30). In terms of output, a linotype operator could set only seven column lines per minute whereas the new electronic typesetting technology increased this rate to 3000 column lines per minute. Given the tight deadlines of newspapers, this difference was very significant (Griffin 1983, p. 42). Photocomposition 'rendered obsolete many of the craft skills possessed by the compositor' as it 'removed the need for linotype machines and linotype operators' (Griffin 1983, p. 42). [1]

The introduction of photocomposition was vehemently opposed by the print unions, in particular by the National Graphical Association (NGA) that represented linotype operators who set the metal type. Initially the NGA rejected a proposal for 'front-loading', where journalists and salespeople typeset words directly without the use of printers. Another proposal was rejected by Fleet Street union members in early 1977 (Willman 1986, p. 127). At *The Times* between November 1978 to November 1979 there was an industrial dispute over the introduction of new technology. The agreement that resolved this dispute, although establishing a style composing-room,

[1] Also see Melvern (1986, p. 5).

was only a partial reform. Further, this dispute enhanced the monopoly position of the NGA at other titles such as the *Daily Express* and the *Observer* (Willman 1986, pp. 128-29). Willman (1986) stated that:

> Overall, therefore, the implementation of new technology in national newspapers has been substantially delayed by union resistance, in the form of strike action and of the imposition of costs (p. 129).

The dispute continued between the Rupert Murdoch, proprietor of the *Sun*, *News of the World* the *Times* and *Sunday Times* and the Fleet Street print unions in the 1980s. This dispute was only settled in January 1987.[2]

Why wasn't such an obvious surplus enhancing innovation made immediately? There are several important characteristics of this dispute. First, as the parties were in an on-going relationship it seems implausible that asymmetric information between the parties could result in a dispute over ten years long.[3] Second, as the parties were in a long-term relationship any new agreement could act to affect future claims on surplus. The introduction of photocomposition would reduce the NGA's bargaining power and control over the workplace as it was their specialist skills, and the restriction on supply, that distinguished its members from outside labour (Griffin 1983, p. 44). Third, knowing that innovation would reduce their claim on future surplus the print unions would require compensation for these losses. In

[2]The eventual settlement with the unions was 60 million pounds. This is compared with Drexel Burnham's estimate that the value of Murdoch's four London papers rose from $300 million to $1 billion just by moving out of Fleet Street and that profits jumped 85 per cent (Shawcross 1997, p. 236). This suggests that the innovation clearly increased total surplus.

[3]In fact, it was Murdoch's secret printing plant at Wapping that helped resolve the dispute, ending the delay in the introduction of the new technology, rather than the reverse.

this case it was difficult for the companies to provide adequate compensation. For example, in 1985 Murdoch's operation was so highly leveraged that the combined earnings of all his companies did not pay his interest bill (Melvern 1986, p. 6). This severely limited the amount he could borrow for compensation payments. Fourth, the parties were unable to write a contingent contract. The invention of the new technology necessitated renegotiation. Further, the labour market was subject to recurrent bargaining given the inability of the parties involved not to renegotiate (Willman 1983, p. 121).[4]

The model presented in this paper incorporates the above features to provide a new explanation for delays in bargaining.[5] In the model two parties can choose to adopt a new innovation in each period of the game. (The basic model has two periods.) The innovation generates a known surplus that can be shared between the parties. Innovation, however, affects each party's claim on surplus in future periods. When an immediate innovation adversely affects a player's future payoff, that player will only be enticed to accept innovation if the immediate returns are sufficiently great so as to compensate her for these future losses. If this is not the case, the player will choose to delay, even if this reduces total surplus.

In the print union example above innovation reduced the future bargaining power of workers. The removal of a closed shop would have a similar effect. Alternatively, a party may wish to delay innovation when the existing contract provides a default

[4]Also see Martin (1981, p. 96).

[5]Failure to adopt a change that increases total surplus is a form of delay (Kennan and Wilson 1993, pp. 45-46).

payoff that it will lose if they agree to the change. That is, innovation changes the contract the parties use as a starting point for negotiations rather than altering the relative bargaining powers of the parties. For example, some workplace rules provide workers with on-the-job leisure.[6] In this case, by agreeing to change the workers would lose their default (on-the-job leisure) payoff. This could reduce their claim on surplus in future negotiations.[7] In order to be induced to agree to change the union would need to be compensated for both current and future losses. If this cannot be achieved through an adequate compensation package or a credible promise of future payments, a union will decline to innovate, even if the change is efficient in the sense that it would increase overall surplus.

The different assumptions concerning how innovation affects the bargaining solution generate important alternative predictions. From the basic model, when innovation affects the default payoffs a party with a high default, is more likely to delay innovation. Further, delay is more likely when expected future surplus is lower. On the other hand, a party that loses its bargaining power when facing an innovation, as in the print union example, is also likely to oppose innovation. Given that it is more likely to face a specific innovation that reduces its bargaining power, a craft union is more likely to oppose change than a union with a broader constituency. In addition,

[6] Workpractices may involve: excessive demarcation; double handling; tea breaks or other idle time; the use of the same number of workers per machine despite the use of new or improved technology; limiting output either per worker or per machine; or requiring excessive overtime (Willman 1986, p. 54). Further, technical change may affect current working conditions, work allocation or the speed of work, all of which may affect an employee's surplus (Willman 1986, p. 47).

[7] The assumption here is that existing work arrangements affect the bargaining power of each party, and hence the distribution of surplus. Cornfield (1987) suggested 'changes in labour relations arrangements reflect and contribute to the continuous redistribution of authority in the employment relationship and, therefore, to the capabilities of labour and management to guide their fortunes' (p. 5).

a party facing an innovation that reduces its bargaining power is more likely to delay when future surplus is higher.

A major contribution of the model presented in this paper is that delays arise without the presence of asymmetric information. In the literature, delays in bargaining typically arise when there is some asymmetric information between the parties (for a review see Osborne and Rubinstein 1990 and Muthoo 1999). With asymmetric information, delays may occur because the informed party uses delay to signal their bargaining strength. These delays, however, may not be lengthy as once the bargaining strength of a party has been revealed it is in the interests of both parties to reach agreement (Sutton 1986, Gul and Sonnenshein 1986 and Gul and Sonnenshein 1988).[8] On the contrary, lengthy delays arise in the incomplete contracts model presented here.

Some recent models have explained delays in the absence of asymmetric information in different contexts. Jehiel and Moldovanu (1995a and 1995b) showed there can be delays in the presence of party-specific externalities. Other models have shown that, with complete information, delays in bargaining can occur when there are multiple equilibria and parties play complicated history-dependent strategies (for example see Haller and Holden 1990, Fernandez and Glazer 1991, Avery and Zemsky 1994, Busch and Wen 1995, Manzini and Mariotti 1997 and In and Serrano 2000). In contrast, the model presented in this paper has a unique subgame perfect equilibrium. Further, delay arises naturally when the bargaining parties play simple and realistic

[8]Further, if it is difficult to screen different bargaining parties from one another, delay may be an ineffective screening device.

strategies.

Finally, the model presented here has links to the hold-up literature. In the incomplete contracts literature a party may inefficiently (under)invest when they do not expect to receive the entire return from their investment. [9] In a similar manner, parties in the model presented here take into account the effect innovation will have on renegotiation in subsequent periods; as a result, innovation (or ex ante investment) may not be efficient. In a related model, Hart and Moore (1994) studied optimal debt contracts between a wealth-constrained entrepreneur and financier in which ex ante inefficiency can arise, in the sense that projects with a certain positive net return are not financed, because of incomplete contracts and wealth constraints. The two models differ, however. For example, in Hart and Moore the bargaining power at the renegotiation stage is determined by the characteristics of the project (maturity, the durability of the physical assets involved) whereas here the bargaining power of the parties is determined by previous bargaining outcomes.

2 The model

This section outlines the model. There are two potential trading partners, denoted here for convenience as a buyer and a seller. These parties may represent, for example, a worker or her representative (seller) and a firm (buyer), however, these terms should be interpreted in the broadest sense. All that is important is that they are two parties

[9] See Grout (1984) and Hart and Moore (1988). Similarly, Frankel (1998) developed a model of creative bargaining in which parties underinvest in the search for options that increase bargaining surplus as they do not receive the entire return generated by their investment.

negotiating about the introduction of a surplus enhancing change in the relationship.

2.1 Timing

Figure 1 shows the time line of the model. There are two trading periods. At time $t = 1$ there is an existing relationship between the parties given by a default contract. This contract could merely describe the parties' existing relationship. Alternatively, it could represent a social norm or precedent.

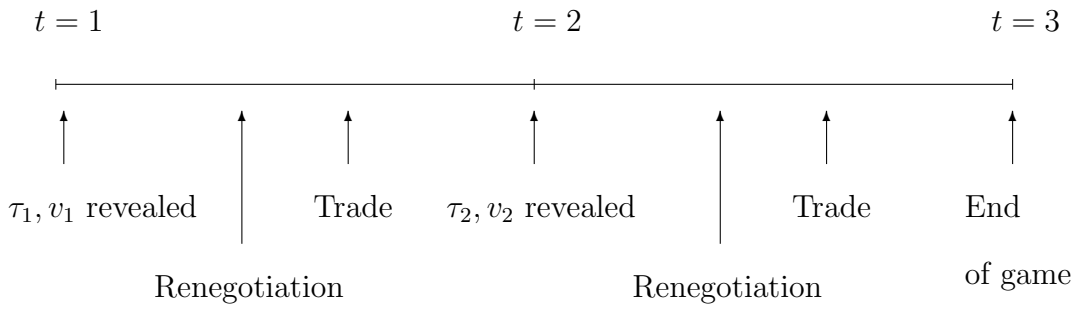

Figure 1: Time line of the model

At this point, an exogenous shock occurs. In the print union example this shock was the development of the new computer technology. As a result of the exogenous event it is revealed to both parties that if the seller performs task τ_1 surplus v_1 accrues to the buyer. Further, the performance of τ_1 is incompatible with the activity (and payoff) the seller receives under the default contract. For example, the default contract may involve some on-the-job leisure for the seller. The new task τ_1, on the other hand, could require the seller to work harder or at a constant speed. If the worker agrees to make the innovation she can no longer receive her default surplus.

Note that the required task in each period is peculiar to that period in that the performance of τ_t only generates surplus in period t.[10]

After this information is revealed to both of the players, the two parties can renegotiate the initial (default) contract. The bargaining process is discussed in section 3, however, due to the primacy of the default a new contract can only be implemented by mutual consent. After renegotiation, trade occurs according to the conditions of the existing contract (either the default contract if at least one party rejected change or according to the new contract if both parties agreed to innovate). Note also that neither party can be forced to trade if they would receive a negative payoff as the players' no-trade returns are normalised to zero. After trade, each party receives their first period payoff.

The game then proceeds to the next period. This additional period captures the on-going nature of the relationship between the parties. The second period has the same structure as the first. The existing contract acts as the default for both parties. Once again, an exogenous event occurs. In light of this new information, it becomes apparent to the two parties that the performance of τ_2 by the seller generates surplus v_2 for the buyer. This is revealed to both parties and they can then renegotiate their default contract. After renegotiation, trade takes place according to the conditions of the relevant contract, the players receive their payoffs and the game ends.

[10]The same results arise when τ_t generates surplus in all future periods but each party cannot commit not to trigger renegotiation.

2.2 Assumptions

Under the initial default contract at $t = 1$ the seller receives surplus of $b \in [0, min\{v_1, v_2\})$, where the buyer's return is normalised to zero. As $b < min\{v_1, v_2\}$, innovation must occur in every period in order for total available surplus to be maximised. This is summarised in the following remark.

Remark 1. *Adoption of the innovation is efficient in every period.*

Prior to its revelation in period t, τ_t cannot be contracted upon. After it has been revealed τ_t becomes verifiable and the two parties may write a contract on this variable. On the other hand, the potential surplus v_t is never verifiable, even in period t. As such, a surplus sharing rule is not a permissible contract. This is similar to assumptions elsewhere in the literature.[11] Further, it is assumed that the seller must perform the task τ_t, perhaps because of specialisation. Consequently, as in Hart and Moore (1988) and MacLeod and Malcomson (1993), the buyer and the seller may not vertically integrate to overcome their bargaining problem. This is an important assumption because if the parties could integrate, for example, by the buyer selling stock to the seller or by the creation of a surplus sharing rule, the incentives to delay innovation could be eliminated.

An important element of the model relates to the parties' inability to provide complete up-front compensation. To simplify the analysis it is assumed that neither party has access to outside sources of finance and wealth is normalised to zero. Although

[11] For example, in Bolton and Scharfstein (1990) a firm's profit is unverifiable to the financier preventing the parties from writing an 'enforceable profit-contingent contract' (p. 95).

this seems like an extreme assumption, it is not essential that the parties have zero wealth or no borrowing capabilities. All that is important is that the parties access to funds is limited in comparison with the compensation required. Limited ability to borrow funds may arise because the parties could expropriate surplus or manipulate financial reports. Another possible reason is that utility may not be able to be transferred between parties, or there may be limits on such transfers. This would be the case when one of the parties received a payoff that was intrinsic to themselves.[12] If the buyer could borrow against future earnings, full compensation could be paid to the other party at the outset of the bargaining process, allowing innovation to occur immediately.

The objective of both of the parties is to maximise their expected surplus. To simplify the analysis, the parties do not discount second period payoffs. The inclusion of discount factors would only serve to scale second period returns.

3 The bargaining solution

The division of surplus resulting from renegotiation is composed of two elements.

First, this model adopts the reduced form bargaining solution used by Chiu (1998).[13] In this bargaining game outside options only affect the division of surplus if players can credibly commit to engaging them in the appropriate subgames. If this is not the case, the outside options do not affect the outcome of the game.

[12]Frankel (1998) studied bargaining when both utility is transferrable (so that side payments are allowed) and when it is not (no side payments are allowed).

[13]This bargaining solution is, in fact, a reduced form solution based on the alternating-offers bargaining game with outside options of Shaked and Sutton (1984).

As shown in the property rights literature (see Chiu 1998 and De Meza and Lockwood 1998) the form of bargaining solution used can significantly alter the predictions of the model. Consequently, it is important that the bargaining solution chosen is appropriate to the applications in mind. Here, it is appropriate to adopt the outside option rule as the assumption is that the outside option (default) can only be enacted if negotiations are abandoned for that period. As a consequence, the seller is unable to adopt the option while continuing to bargain (as would be the case with an inside option). The threat to enact the default option will only be credible if it is binding. In this model the seller has an initial outside option b provided by the default contract; as a result it is the adoption (or otherwise) of a potential innovation affects the default payoffs of the parties and their claim on surplus.

Consider the bargaining solution that applies in the first period if there is innovation in that period or in the second period provided innovation did not occur previously. If, upon renegotiation, the parties agree to adopt a new contract in preference to the default, they divide the surplus in the following manner:

$$\{\alpha v_t, (1-\alpha)v_t\} \text{ if } b \leq \alpha v_t; \text{ or} \tag{1}$$

$$\{b, v_t - b\} \text{ if } b > \alpha v_t. \tag{2}$$

where the first element is the return to the seller, the second the return to the buyer and $\alpha \in [0, 1]$.

Temporarily ignoring the outside option, if innovation occurs the parties split the

surplus with the seller and buyer receiving α and $(1-\alpha)$ of the total available surplus respectively. This is the solution presented in equation 1. In this case α reflects the relative bargaining power of each of the players in the renegotiation process.[14] As discussed above, when the seller's share of the surplus inside the relationship (αv_t) is less than the outside option, the seller receives a payment equal to her default payoff b. This is the bargaining solution presented in equation 2.

Now consider the bargaining outcome in period $t = 2$. As τ_t only generates surplus in period t, if innovation occurred in the first period the period $t = 1$ contract (specifying the performance of τ_1) generates no surplus in the second period. It is assumed that neither party can be forced to undertake a trade that yields a negative utility. Clearly, the first period innovation contract will provide the buyer with a negative surplus in period $t = 2$ as τ_1 generates no surplus while the contract requires a payment to be made to the seller. In this case the buyer will opt for not to trade. Consequently, despite the $t = 1$ contract, the effective default for the parties is the no-trade payoff. Moreover, as innovation has already occurred, the seller's initial default payoff b no longer applies. As such, after innovation in the first period, the default payoffs in $t = 2$ are zero for both the buyer and the seller.

Following the discussion above, if innovation has previously occurred, the bargain-

[14]The relative bargaining strength of the players perhaps reflects each party's expectation of making the first offer, as in MacLeod and Malcomson (1993) and Sutton (1986). Alternatively, it may relate to exogenous rates of time preference (Rubinstein 1982). Another possible interpretation is that α reflects the perceived probability of a irreconcilable exogenous breakdown in bargaining (Binmore et al 1986). It may also reflect a party's position in the market place. This issue is discussed further in section 5.

ing solution then reduces to:

$$\{\alpha v_t, (1-\alpha)v_t\} \tag{3}$$

if the parties agree to innovate at time $t = 2$.

Second, in addition to the division of surplus specified by the bargaining rule, either party can offer a transfer F_t to the other party paid for out of their share of the surplus. The inclusion of this additional fixed payment allows either party to pay compensation to the other for any future costs (or potential losses) that result from innovation. F_t is an intertemporal transfer that can be considered as separate from the extensive form bargaining game that results in the division of surplus outlined above. In fact, one of the purposes of the model is to explore situations in which a party may refuse to innovate despite the presence of compensation. Again returning to the union-firm workplace negotiation example, F_t could represent redundancy payments or a sign-on bonus. As a convention F_t is a payment made by the buyer to the seller. As both parties cannot borrow and have zero wealth, F_t cannot exceed the amount of surplus available to the party in that period.[15] The total payoffs to either party are their bargaining returns net of any transfer payments.

4 Delay in bargaining

The objective of each player is to maximise their expected total surplus over the entire game. As this is two period model with complete information the game may be solved

[15] In the second period the party has access to the surplus they have received from both period $t = 1$ and period $t = 2$. Second period fixed payments can be made by a player using their first period returns. However, this does not turn out to be an issue in this game.

by backwards induction so as to find the subgame perfect equilibrium (SPE). This section breaks down the analysis of the game into stages. The first stage analyses the second period innovation decision of both parties. The second stage analyses the buyer's first period decision. The next stage assesses the seller's decision to innovate in the first period for various values of b. The main objective of this analysis is to assess whether a delay in innovation can exist as part of a SPE.

4.1 Second period reform

First, consider the decision to adopt innovation in the second period for both of the parties. Reform will always occur in the second period, regardless of the outcome in the first period. If reform occurred in the first period the default contract is the period $t = 1$ agreement. As noted above, the performance of τ_1 in period $t = 2$ does not generate any surplus for the buyer. The $t = 1$ contract will also require a payment from the buyer to the seller. As a result, the buyer will not trade on the terms of this contract as his return would be negative. The buyer would choose not to trade according to the default contract as he prefers the zero payoff of no trade. Consequently, the effective default return of the seller is also zero, as there will be no trade in the second period with the period $t = 1$ contract. Further, as innovation occurred in the first period, the seller will not receive her initial default surplus of b.

Once τ_2 and v_2 are revealed the parties can renegotiate from the default contract. As both parties have a default payoff of zero, if they agree to innovate the division of surplus is $\{\alpha v_2, (1-\alpha)v_2\}$ to the seller and buyer respectively. Clearly, it is in the

interests of both parties to agree to innovation in this situation. No fixed payment (F_2) is required to encourage one party or the other to agree to the second period innovation.

Now consider the decision whether or not to innovate in period $t = 2$ when no innovation took place in the first period. Again, once τ_2 and v_2 have been revealed the parties have the opportunity to renegotiate and adopt the innovation. In this case the default payoffs for each of the parties are given by the initial defaults; that is, b and zero for the seller and buyer respectively. As $b < v_2$, the parties can increase total surplus in the second period by adopting the innovation. Given that the second period is the last in the game, there is no strategic advantage to either party from delaying innovation. Further, as innovation increases total surplus, at least one party can be made better off without making the other party worse off. Consequently, both parties will always adopt the second period innovation. The division of the surplus is given by equation 1 or 2.[16]

In summary, both parties will agree to innovation in the second period, regardless of the outcome in the first period. This is summarised in Result 1.

Result 1. *Innovation will always occur in period $t = 2$, regardless of the outcome in the first period.*

[16]In fact, the buyer will always be made better off by reform in the second period, whereas the seller may receive the same payoff as she would have received had innovation not occurred. As $b < v_t$, the two alternative payoffs for the buyer, $v_2 - b$ and $(1 - \alpha)v_2$, are always positive. For the seller, the second period return from innovation is at least as good as her default payoff: if $b < \alpha v_2$, her return is greater with innovation; if $b > \alpha v_2$ her return is the same with innovation as it is without it. Given this indifference we assume that she will agree to reform as it does not make her worse off. Alternatively, we could assume that the buyer undertakes to make a fixed payment $F_2 = \varepsilon$ where ε is arbitrarily small so as to make the seller strictly prefer innovation.

The following remark relates directly to Result 1 and Remark 1.

Remark 2. *As innovation always occurs in period $t = 2$ total surplus is maximised in the second period.*

Following from Remark 2, if any welfare loss occurs it will occur in the first period.

An important element of Result 1 is that in equilibrium neither player requires any compensation (or additional encouragement) to agree to reform, as both players weakly prefer innovation over no innovation. As such, $F_2 = 0$, as summarised in the following remark.

Remark 3. *In equilibrium, $F_2 = 0$.*

4.2 The buyer's first period decision

Now consider the buyer's decision to innovate in the first period. The buyer will never wish to delay innovation at $t = 1$. The intuition for this result is as follows. The buyer can only do better in the second stage from innovation in period $t = 1$ as the seller loses her default, improving the buyer's claim on future surplus in some cases. The worst the buyer can do in the first period if innovation occurs is to earn a return of zero. This would occur when the additional inducement payment to the seller F_1 was equal to his entire bargaining claim of surplus in the first period. So, if the parties reform at $t = 1$, in the first period the buyer is never worse off than when there is no innovation. Likewise, when there is first period innovation the buyer is never worse off in the second period. Moreover, the buyer strictly prefers first period innovation.

This is because when the buyer is indifferent in period $t = 1$ he will strictly gain from first period innovation in the second period of the game, as summarised by Result 2.

Result 2. *In a SPE the buyer never wishes to delay innovation in the first period.*

The result allows us to focus on the seller's decision to delay. Clearly, as the buyer will always agree to innovation in the first period, it is the seller in this model who may act strategically to delay innovation.

Another important element of Result 2 is that the buyer will be willing to forgo his entire claim on first period surplus, via the fixed payment F_1, to induce the seller to accept innovation at $t = 1$. This is restated in the following remark.

Remark 4. *In equilibrium, if necessary the buyer is willing to set the fixed payment F_1 equal to his entire bargaining share of v_1.*

4.3 The seller's first period decision

The seller's decision to delay or adopt the innovation depends on the relative payoffs of two alternatives, namely her two period payoff from delaying innovation in the first period (and accepting it in the second period) and her total payoff from accepting innovation at $t = 1$. If she delays innovation in the first period, her total payoff is her default b in the first period plus her claim on second period surplus. (From Result 1, innovation will always occur in the second period.) If the seller accepts first period innovation her total expected utility is her first period claim on surplus, plus any fixed payments F_1 from the buyer, as well as her claim on second period surplus

given innovation in the first period. In any SPE, the seller will act to maximise her expected utility from both periods.

Consider the seller's decision in period $t = 1$ when $b < \alpha v_1$ and $b < \alpha v_2$. As $b < \alpha v_1$ the seller's surplus from agreement in the first period is αv_1, not including any additional payment F_1 from the buyer. Thus, anticipating the outcome the bargaining game in the second period given that innovation has occurred in the first period, the expected total surplus of the seller from both periods is $\alpha v_1 + \alpha v_2$. Alternatively, if the seller chooses to delay reform in the first period she will receive a payoff equal to her (default) outside option, b. Again, anticipating her claim on the surplus in the second period, her total expected utility is $b + \alpha v_2$.

In this case, it is apparent that the seller will never wish to delay innovation. To see this consider the expected delay payoff minus the expected payoff to the seller when she accepts first period innovation (without any F_1). This relative payoff is $b - \alpha v_1 < 0$. If $b < \alpha v_1$ and $b < \alpha v_2$, first period innovation is always in the interests of the seller as she does better with innovation than without it. Further, as reform is in the seller's interests, the buyer does not need to offer any additional payment F_1 to induce the seller to adopt change.

Now consider the case when $b < \alpha v_1$ and $b > \alpha v_2$. If the seller accepts first period innovation her expected payoff is $\alpha v_1 + \alpha v_2$ plus any fixed payment F_1 forthcoming. This is because when $\alpha v_1 < b$ the seller's default is binding if innovation takes place. On the other hand, if the seller delays first period innovation her utility is $b+b$. This is the case as the outside option is only binding in the second period. The relative payoffs

from when the seller delays innovation and when she agrees to it is $b+b-[\alpha v_1+\alpha v_2]$. If $[b-\alpha v_1]-[b-\alpha v_2]<0$, the seller benefits from immediate innovation. As before, there is no delay and $F_1=0$. If, however, $[b-\alpha v_1]-[b-\alpha v_2]>0$, there is an incentive for the seller to delay. As the return from delay exceeds the expected return to the seller from immediate innovation, the buyer needs to make a payment F_1 to the seller to make her at least indifferent between the payoff when she delays innovation as compared with when innovation occurs immediately. As the buyer has limited funds, he can only make a payment out of his claim on the first period's surplus. Thus, the largest possible F_1 the buyer can make is $(1-\alpha)v_1$. Thus, delay will only occur when the buyer cannot adequately compensate the seller for the loss she will incur if innovation occurs in the first period (relative to her expected delay payoff). That is,

Buyer's funds < Net gain to seller from delay.

Thus delay will occur if

$$(1-\alpha)v_1 < 2b-\alpha v_1-\alpha v_2 \tag{4}$$

or, alternatively, if

$$b > \frac{(v_1+\alpha v_2)}{2}. \tag{5}$$

Of course, if $b \leq \frac{(v_1+\alpha v_2)}{2}$, the buyer will be able (and willing) to adequately compensate the seller. If this is the case, the seller will agree to immediate reform. Furthermore, if $b \leq \frac{(v_1+\alpha v_2)}{2}$, the buyer will set $F_1 < v_1 - b$, so as to make the seller just indifferent between reform and delay. A larger F_1 would not alter the seller's

decision to innovate but would merely act to reduce the buyer's surplus. The implicit assumption here is that the buyer has all the bargaining power as regards to the compensation payment F_1. Any alternative assumption, for example that the seller can make a take-it-or-leave-it offer to the buyer, will not affect the incidence of delay. It will merely act to alter the distribution of surplus.

Now consider when $b > \alpha v_1$ and $\alpha v_2 > b$. If the seller delays first period innovation her expected surplus is $b + \alpha v_2$. Alternatively, if the seller agrees to innovation in the first period her expected return is $b + \alpha v_2$, plus any fixed payment F_1. As the seller's payoff is the same in both cases, there is no incentive for her to delay innovation. Given this, $F_1 = 0$.

Finally, when $b > \alpha v_1$ and $b > \alpha v_2$, the seller will receive $b + b$ if she delays first period innovation. On the other hand, she will receive $b + \alpha v_2$, plus any fixed transfer F_1 forthcoming, if she agrees to innovate immediately. In this case, the seller's delay payoff relative to her innovation payoff, without any fixed payments, is $b - \alpha v_2 > 0$. The seller requires some compensation for $t = 1$ innovation. Adequate compensation is not possible if $F_1 < b - \alpha v_2$. This is the case when

$$v_1 - b < b - \alpha v_2 \tag{6}$$

or if

$$b > \frac{1}{2}(v_1 + \alpha v_2). \tag{7}$$

On the other hand, if $b \leq \frac{1}{2}(v_1 + \alpha v_2)$, the buyer can provide the seller with adequate

compensation, and innovation will be immediate.

The discussion above is summarised in the following result.

Result 3. *(a) In an SPE the seller will accept innovation in the first period when: (i)* $b < \alpha v_1$ *and* $b < \alpha v_2$ *; (ii)* $b < \alpha v_1$*,* $b > \alpha v_2$ *and* $2b - \alpha v_1 - \alpha v_2 < 0$*; (iii)* $b < \alpha v_1$*,* $b > \alpha v_2$ *and* $b \leq \frac{1}{2}(v_1 + \alpha v_2)$ *; (iv)* $b > \alpha v_1$ *and* $b < \alpha v_2$*; or if (v)* $b > \alpha v_1$*,* $b > \alpha v_2$ *and* $b \leq \frac{1}{2}(v_1 + \alpha v_2)$*. (b) The seller will delay innovation in the first period as part of an SPE if: (i)* $b < \alpha v_1$*,* $b > \alpha v_2$ *and* $b > \frac{1}{2}(v_1 + \alpha v_2)$*; or if (ii)* $b > \alpha v_1$*,* $b > \alpha v_2$ *and* $b > \frac{1}{2}(v_1 + \alpha v_2)$*.*

Result 3(b) demonstrates that in certain circumstances the seller may act strategically and delay the adoption of a surplus enhancing innovation so as to increase her overall expected payoff. If agreement reduces a player's claim on future surplus they will require some compensation if they are to accept the change. Without sufficient up-front compensation, or a credible commitment to future payments, a party may wish to delay a surplus enhancing innovation. Consequently, at the end of period $t = 1$, even though it may appear that the parties have forgone a potential Pareto reform, they are in fact maximising their own surplus in the multi-period game. Further, where appropriate, a bargain should be considered as a continuing relationship as this significantly alters the analysis.

Following from Remark 1, when delay occurs total surplus is not maximised. This is summarised in the following corollary.

Corollary 1. *If Result 3(b) holds, so that innovation is delayed, total surplus is not maximised.*

Now consider some comparative statics of the model. Define ΔU as the seller's expected payoff over the two periods from delaying agreement minus her expected payoff over the two periods if she accepts innovation in the first period.[17] Each of the equations below relates to the seller's decision to innovate when she is just indifferent between innovation and delay, that is, when $\Delta U = 0$. Consider first the effect of b when $b < \alpha v_1$ and $b > \alpha v_2$:

$$\partial \Delta U / \partial b = 2 > 0. \tag{8}$$

An increase in the outside option b increases the incentive for the seller to delay. By accepting innovation, the seller gives up her outside option in the second period - this is a cost of innovation. An increase in b means that the outside option allows the seller to capture more surplus in the second period as her outside option is binding in that period. This means it is less likely that the buyer can provide adequate compensation. Further, an increase in b increases the seller's default payoff in the first period, decreasing the cost of forgoing that period's surplus from reform (in the form of payment F_1).

Next, consider the effect of a change in α:

$$\partial \Delta U / \partial \alpha = -v_2 < 0. \tag{9}$$

An increase in α decreases the incentive for the seller to delay first period innovation.

[17] Specifically, let U_D^S be the seller's ex ante expected utility when she does not agree to the first period innovation. Further, let U_A^S be the seller's ex ante expected utility when she does agree to the period $t = 1$ innovation. From this, $\Delta U = U_D^S - U_A^S$.

α represents the seller's claim on surplus in any period when the default is irrelevant. Thus a higher α indicates that the seller will get a greater share of the surplus from any innovation, disregarding the default. Consequently, an increase in α reduces the cost to the seller of forgoing her default b, decreasing the compensation needed to induce innovation.

Both b and α represent different forms of bargaining strength. b represents a historical default or contractual right that acts as a minimum the seller must receive. On the other hand, α could represent current bargaining strength in the renegotiation process. α represents the seller's negotiation skills or patience relative to those of the buyer, regardless of any historical options. Although there may be some correlation between b and α, this is not necessarily the case. For example, a union may have as a default position rights and conditions that were obtained in a different bargaining environment. In negotiations, the union can then refuse any change that fails to provide its members with at least the same level of surplus as this default. However, unions may differ in their ability to bargain with an employer in the absence of a default.

Next consider the effect of v_1 when $b < \alpha v_1$ and $b > \alpha v_2$:

$$\partial \Delta U / \partial v_1 = -1 < 0. \tag{10}$$

An increase in v_1 decreases the incentive for the seller to delay first period innovation. An increase in v_1 increases the probability that the buyer can afford adequate compensation.

Finally, consider the effect of a change in v_2 when $b < \alpha v_1$ and $b > \alpha v_2$:

$$\partial \Delta U / \partial v_2 = -\alpha > 0. \tag{11}$$

An increase in v_2 decreases the expected loss from innovation at $t = 1$ in the second period as it increases the seller's bargaining claim without her default b.

The same comparative statics apply when $b > \alpha v_1$ and $b > \alpha v_2$.

5 Drastic innovation and bargaining power

Some innovations dramatically alter a party's potential bargaining power. For example, the removal of a closed shop could reduce a union's ability to exact surplus. Realising that such a reform will affect its future negotiating potency, a union would require additional concessions if it were to be induced to accept such a reform. More generally, any innovation that shifts a party (the buyer) from a specific to a general relationship will drastically reduce the other party's bargaining power.[18] Another example would be a reform that eliminates the need for the special skills of a particular agent in the production process so that other (outside) parties can compete for supply. As their skill or input is no longer essential, innovation causes the agent to lose their leverage over the other bargaining agent. To distinguish clearly the two different potential effects of innovation, denote an innovation that reduces the seller's contemporaneous bargaining power as a 'drastic' innovation.

[18] See Shaked and Sutton (1984).

To examine delays in bargaining with drastic innovation consider the following alterations to the basic model. First, suppose the seller's initial default is zero ($b = 0$). In the first bargaining period, if the agreement occurs the division of surplus is $\{\alpha v_1, (1-\alpha)v_1\}$ to the seller and buyer respectively. If not, each player receives a payoff of zero (their default payoff). In the second bargaining period assume the bargaining rule is altered such that if innovation has occurred at time $t = 1$ all of the surplus accrues to the buyer; that is, the division is $\{0, v_1\}$.[19] Clearly, innovation eliminates any claim that the seller might have on surplus in future periods. If, on the other hand, no innovation took place in the first period, the division of surplus is $\{\alpha v_t, (1-\alpha)v_t\}$ for the buyer and seller respectively, as given by equation 1.

As discussed previously, innovation will occur in the last period regardless of the outcome in the first period. Thus, if agreement occurred in the first period, the seller's expected return is zero (regardless of the value of v_2). If reform did not occur, the period $t = 2$ return for the seller is αv_2.

In the first period, when deciding whether or not to agree to immediate innovation, the seller will take into account the potential loss in the second period. Delay will occur when

$$F_1 + \alpha v_1 < \alpha v_2. \tag{12}$$

As the buyer never wishes to delay innovation, he is willing to make the fixed payment equal to the highest feasible payment; that is, he is willing to set $F_1 = (1-\alpha)v_1$. As

[19] An alternative model might not have reform reduce α completely, but rather have innovation reduce α by a fraction between zero and one.

such, delay will occur when

$$\alpha v_1 + (1-\alpha)v_1 = v_1 < \alpha v_2. \tag{13}$$

Conversely, the seller will accept immediate innovation when $v_1 > \alpha v_2$. In this case the seller can always receive adequate compensation for her loss in future bargaining power.

Unlike the basic model, the incentive to delay is increasing in α

$$\partial \triangle U / \partial \alpha = v_2 > 0. \tag{14}$$

This, at first appearance, is a seemingly different result to prediction of the previous section. In the basic model the default b represented historical bargaining strength, and a seller was more likely to delay innovation in the first period, at the margin, given an increase in b. Innovation, however, caused the seller to lose this default. In the model in this section, innovation diminishes the bargaining power of one of the parties. As such, what the seller forgoes by accepting innovation in the first period is increasing in α. In this manner, the results relating to these two variables are consistent.

Finally, the comparative statics for v_2 is

$$\partial \Delta U / \partial v_2 = \alpha > 0 \tag{15}$$

suggesting an increase in future surplus, at the margin, increases the incentive to delay first period innovation.

6 Predictions of the model

The two different specifications allow for different predictions, however. The first two predictions below relate to the basic model. The third relates to the model of drastic innovation. The last contrasts the two models.

Prediction 1. *A party with a strong historical position (b) is more likely to delay innovation.*

Prediction 1 follows from equation 8. It suggests, for example, that a union that has won generous conditions for its members over time, reflecting its historical position of strength, is less likely to accept innovation.

Prediction 2 follows from equation 9.

Prediction 2. *A party with a strong claim on current surplus (bargaining power α) is more likely to accept innovation.*

An example of this would be a worker with specific skills who is required by the firm for the new technique or process to be used. Conversely, an agent with relatively weak claim on current surplus is more likely to delay innovation. This is the opposite prediction of most of the asymmetric information bargaining models in which it is the strong agent who endures delay in order to signal their bargaining strength to the other party.

The following prediction relates to the drastic innovation model, and in particular to equation 14.

Prediction 3. *The stronger the initial bargaining strength of a party facing a drastic innovation (α goes to zero), the more likely they are to reject innovation.*

Prediction 3 suggests that a party that faces an innovation that reduces its bargaining strength is more likely to oppose innovation. For example, a craft based union is more likely to oppose innovation than a union that represents a broader range of occupations and interests. This is the case because innovation (new technology) is more likely to reduce a craft based union's bargaining power, whereas a broader union may be better placed to capture any increase in surplus. This prediction accords with the conclusion of Dowrick and Spencer (1994). They argued that union opposition to innovation tends to occur when union preferences are weighted in favour of jobs and labour demand is inelastic. Given the assumption that the elastic of demand is lower at the industry level than at the enterprise level, they concluded that industry or craft based unions are more likely to oppose technical change than enterprise unions. Willman made a similar argument comparing the differing patterns of resistance to innovation from decentralised unions in the UK with the corporatist unions in the then West Germany (Willman 1986, p. 33). Furthermore, taken together, Prediction 2 and Prediction 3 suggest a party is more likely to hold-out on a general investment that reduces their bargaining power than a specific innovation that maintains or enhances their bargaining position. [20]

[20] See Malcomson 1997 for a discussion of specific and general investments.

Finally, Prediction 4 relates equations 11 and 15.

Prediction 4. *A party with a strong historical default is more likely to delay when future surplus is to be low (basic model). A party facing drastic innovation is more likely to delay when future surplus is to be high (drastic innovation model).*

¿From the basic model, in order to accept first period innovation the seller requires sufficient compensation to cover her losses in the second period that are equal to $b - \alpha v_2$. For a given v_1 and α, as v_2 decreases relative to v_1 the size of b required for delay to occur decreases. On the contrary, for drastic innovation delay requires that $v_1 < \alpha v_2$. This is never the case when $v_1 > v_2$. Further, as v_2 increases relative to v_1, it becomes less likely that adequate compensation can be made. As a concrete example, consider a union bargaining with a firm. The basic model suggests that a union is more likely to reject innovation when the industry is in decline, or when future surplus is low. [21] A lower future surplus means that the default would have a greater impact on the union's share, making it less likely that the firm can make a sufficient compensation payment.[22] On the other hand, the drastic innovation model suggests that employees in a declining industry would accept innovation immediately. Instead, a union would delay innovation when future surplus is (sufficiently) higher than today's potential surplus. This would be the case in an industry that expected a growth in demand (ignoring possible entry of other suppliers).

[21] Future surplus may be low because of the impending removal of regulations or the introduction of new competitors, as well as in an industry with declining demand.

[22] This discussion does not consider the possibility that the default exceeds the potential surplus from innovation in the future.

7 Infinite horizon

With the two period model the seller's decision is whether to wait and accept innovation immediately or whether to accept it in the next (and final) period. In reality, as bargaining is typically an on-going process, both parties must decide in which period they wish to accept innovation, if at all. This section extends the model to an infinite horizon.

Consider a model where potential innovation produces a surplus of v in every period. As before, the seller has a default of b that is inconsistent with innovation, the relative bargaining strength of the parties is reflected in the parameter α and the default is binding in the bargaining process for the seller. In addition, assume the seller has a discount factor of $\delta \in (0, 1)$.

Given the stationarity of the model, the optimal action in any one period will also be optimal in every period. Thus, if the seller does not wish to innovate, she will not wish to innovate in any period.[23] In that case, the discounted value of surplus to the seller of delay is:

$$b + \delta b + \delta^2 b + \delta^3 b + \ldots = \frac{b}{(1-\delta)}. \tag{16}$$

On the other hand, the value to the seller from immediate innovation is:

$$b + F_1 + \delta\alpha v + \delta^2\alpha v + \delta^3\alpha v + \ldots = b + F_1 + \frac{\delta}{(1-\delta)}\alpha v. \tag{17}$$

[23]Note that in this section it is implicitly assumed that payoffs cannot be carried over between periods.

As before, the buyer does not wish to delay innovation. The maximum innovation payoff for the seller is:

$$v + \frac{\delta}{(1-\delta)}\alpha v. \tag{18}$$

Delay will occur when:

$$\frac{b}{(1-\delta)} > v + \frac{\delta}{(1-\delta)}\alpha v; \tag{19}$$

or when

$$b > (1 - \delta + \alpha\delta)v. \tag{20}$$

Unlike models with one-sided asymmetric information, the seller is willing to endure a prolonged delay in bargaining. The comparative statics for the delay decision are as follows:

$$\partial\Delta U/\partial b = \frac{1}{1-\delta} > 0; \tag{21}$$

$$\partial\Delta U/\partial v = -\frac{(1-\delta+\alpha\delta)}{1-\delta} < 0; \tag{22}$$

$$\partial\Delta U/\partial\alpha = -\frac{\delta v}{1-\delta} < 0; \tag{23}$$

and

$$\partial\Delta U/\partial\delta = \frac{(b-\alpha v)}{(1-\delta)^2} > 0. \tag{24}$$

The new variable here is the discount factor. Equation 24 shows that delay is more likely the more patient the seller is.

The results of this model are similar to infinite horizon games of tacit collusion,

however, the emphasis here is reversed.[24] Tacit collusion models examine whether the threat of low future payoffs (punishment) is sufficient to sustain collusion without cheating in the immediate term. On the other hand, in the model of delay the emphasis is on whether the immediate reward (compensation) is sufficient to induce the seller to accept a lower payoff in the future. The impact of the discount factor is also reversed. In the standard models of tacit collusion a higher discount factor increases the incentive for the firm to cooperate. Here, a higher discount factor means that the seller is more patient: consequently they require more compensation if they are to agree to innovation.

Thus far in this section it has been assumed that payoffs cannot be carried over between periods. Alternatively, the buyer could accumulate savings over several periods so as to have sufficient funds to compensate the seller adequately. Assume that the buyer receives a small return r from each period of trading that occurs according to the old default contract, where r is never binding and is sufficiently small so as to ensure that innovation is still optimal. Let the accumulated savings of the buyer be represented by S. In this case, delay will occur when

$$v + S + \frac{\delta}{(1-\delta)}\alpha v \leq \frac{b}{(1-\delta)} \tag{25}$$

so that the buyer will wish to accumulate savings $\widehat{S} = [b - v(1 - \delta + \alpha\delta)]/(1 - \delta)$ in order to induce innovation. Delay in innovation will be longer the smaller is r and the larger is $\widehat{S}$.

[24] See Tirole (1988) Chapter 6.

8 Conclusions

The model developed in this paper generates delays in bargaining with: multiple bargaining rounds; incomplete contracts; and wealth constraints. Unlike much of the non-cooperative bargaining literature, delays may occur in equilibrium without the presence of asymmetric information.

The model consisted of two periods and a buyer and seller. At the start of each period a potential new reform or task was revealed to both parties, along with the surplus that it could generate. If the parties agree to adopt the new innovation, they bargained over the potential surplus. A party's claim on surplus depended on their default payoff and their bargaining strength. An effect of innovation was that the seller lost her default payoff (in the basic model) or her contemporaneous bargaining power (in the drastic innovation model).

If the seller anticipates losing out in subsequent bargains from first period reform, she will be only willing to accept innovation if she is adequately compensated. This may not be possible because of wealth constraints. Further, because the parties cannot write a fully contingent contract, they are unable to implement reform on the basis of a surplus sharing arrangement or a commitment to a future remuneration scheme.

The basic model predicts that the incentive to delay for the seller is increasing in the outside option, decreasing in current bargaining strength, decreasing in expected surplus and increasing in the probability that future surplus is low. Allowing (drastic) innovation to affect the relative bargaining power of the parties alters these results.

If innovation reduces the bargaining power of the seller, she is more likely to delay when surplus is expected to be higher in the future (relative to the present potential surplus). Similarly, a seller is more likely to delay a drastic innovation the higher the level of her current bargaining strength.

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