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OPTING OUT: BAZAARS VERSUS «HI TECH» MARKETS

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In an alternating offers bargaining game we allow one player to opt out each time an offer has been rejected. We show that this introduces a multiplicity of equilibria. These equilibria do not vanish when the frictions in the negotiation procedure disappear. We embed this negotiation schedule in a market with matching and bargaining. A single seller meets buyers and bargains with them; he may abandon each buyer to seek another immediately after an offer has been turned down. We show that this market has a continuum of equilibria. To obtain the Walrasian equilibrium as the single outcome of this market the frictions have to vanish in a very specific way.

1. Introduction

In models of bilateral bargaining with an outside option one or both of the bargaining partners may end the game at prescribed points of the negotiation by choosing to opt out. The outside option guarantees a certain payoff to the players.

These models bridge between pure models of bilateral bargaining where the two agents are doomed to continue bargaining forever unless they reach an agreement, and models of large markets where a player may choose to leave his bargaining partner and search for another. Thus, choosing to opt out replaces abandoning the current partner in favour of the matching process, while the outside option itself represents the expected utility of the player after he left his partner.

At which points of the bargaining process should a player be permitted to abandon his partner? To answer this question we should investigate «real life» markets in order to observe the aspects that we wish to model. There seems to be a crucial difference between the more personal markets, where the bargaining partners face each other, and the impersonal ones where negotiations are conducted through telephones or computers.

Consider first a Bazaar: a buyer would arrive at a shop, bargain with the seller and might after a while indicate that he is about to leave and look for

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another shop. It is commonplace for the seller to shout after the leaving customer and make a last price offer. Indeed, no self respecting seller would allow a customer to leave without making the last offer. Thus, if we were to model a bazaar we would have to allow a player to opt out only after he has rejected an offer made by the other player, i.e. we would give the remaining partner the right to make the last offer.

The situation is different in modern financial «Hi Tech» markets. A dealer may conduct his negotiations facing a battery of telephones or computers. He may make an offer on one of the phones and if it is rejected he may immediately turn to another phone and attempt to contact a new partner. In modelling «Hi Tech» markets we should enable a player to opt out immediately after his offer has been turned down by his partner.

Most of the existing models of markets with bargaining and matching do not allow the players to choose whether to opt out; instead, a partner is sometimes swept away by the matching process. Those models that give the players the right to choose to opt out invariably follow the «Bazaar» model. This is also true of all the models of bilateral bargaining with an outside option (Cf. Binmore, Shaked and Sutton (1989); Shaked and Sutton (1984); Rubinstein and Wolinsky (1986); Binmore and Herrero (1988) and Gale (1986)).

This paper studies the «Hi Tech» model, i.e. a sequential offers bargaining model where a player is permitted to opt out immediately after his offer was rejected. It is shown that unlike the «Bazaar» game, this model has, typically, a large number (an interval) of equilibria. In general, this interval does not shrink to a point as the frictions in the market vanish.

The intuition driving the multiplicity of equilibria is simple and derives from a player's ability to exit immediately after his offer has been rejected. To illustrate the intuition consider an alternating offers bargaining game. Assume that only player 2 may opt out, that he may opt out only after his offer has been turned down and that when he opts out, player 1's payoff is zero.

We show that if the outside option payoff of player 2 is sufficiently large or sufficiently small the model has a unique equilibrium. However, it is on the intermediate range of outside payoffs that we focus our attention. There the equilibria depend on how long the privileged player refrains from exercising his option. This is not determined within the model (hence the multiple equilibria) but by a social norm to which all players subscribe.

If sometime in the future, player 2 has a credible threat to opt out, then his last act before leaving will be to demand the whole cake, i.e. to offer player 1 zero, which player 1 will accept given that he is about to receive zero anyway when player 2 opts out. This enables player 2 to obtain the whole cake by (credibly) threatening to opt out. Considering the negotiation stages leading to that opting out point, it will be optimal for player 1 to offer player 2 nearly all the cake and for player 2 to make very high demands on the basis of his opting out threat. However, as we go back in time, player 2's share gradually erodes –this hinges on the intuition of Rubinstein's alternating offer model: a player (player 1) gains a little each time he makes an offer. If we go back in time a long way, player 2's share will approach the solution to Rubinstein's model, receiving about a half of the cake (depending on the discount factor). We go backwards until the first time that player 1 offers player 2 less than his outside option payoff. One period before that, player 2 will have a good reason to opt out, since player 1 is about to offer him less than his outside option tomorrow.

We have thus created a cycle: Given that player 2 opts out sometime in the future (in period k, say), we construct equilibrium behaviour in the periods $j = 1 \ldots k$. In these periods the players play Rubinstein's strategies leading to player 2's last «Take It Or Leave It Offer» at period k. In these periods the payoff to player 2 when he makes an offer is never below his outside option payoff, so that he has no reason to opt out. To complete the description of the equilibrium we need to specify what the players do beyond period k: The equilibrium behaviour is the one described in this cycle, so that it is a credible threat for player 2 to opt out at periods tk for all t. The different equilibria are obtained by letting the game start at various stages of the cycle 1, 3, 5 etc. before continuing with the full cycle forever.

The following example may demonstrate this construction: Given a discount rate δ and given that player 2 opts out in period IV and that his outside option payoff is π, the equilibrium offers in periods I-IV are:

period I	1 makes an offer	$1 - \delta + \delta^2 - \delta^3$	$\delta - \delta^2 + \delta^3$
period II	2 makes an offer	$\delta - \delta^2$	$1 - \delta + \delta^2$
period III	1 makes an offer	$1 - \delta$	δ
period IV	2 makes an offer	0	1
period IV	2 opts out:	0	π

The 3rd and 4th column describe the shares of players 1 and 2 respectively. These offers are the equilibrium path offers, which are accepted along the equilibrium path. If a player deviates by making a more generous offer it is accepted, any other deviation is ignored and the players proceed with planned offers.

Assume now that the outside option payoff to player 2 satisfies:

$$\delta - \delta^2 + \delta^3 < \pi < 1 - \delta + \delta^2$$

To complete the above offers to an equilibrium scheme for the infinite horizon game: At periods $4n + 1$ to $4n + 4$ ($n = 1, 2, 3 \ldots$) the players follow the schemes I-IV respectively. Since in periods $4n + 1$ player 2 is about to receive less than his outside option payoff ($\delta - \delta^2 + \delta^3$), he will plan to opt at the previous period $4n$. At any other period in which player 1 makes an offer he gets more than his outside option and so he will not opt out in the previous period.

To obtain various equilibria let the game start with period I as described (where the equilibrium payoff to player 2 is $\delta - \delta^2 + \delta^3$) or alternatively at period III (where the equilibrium payoff to player 2 is be δ).

The different equilibria correspond to different conventions which require player 2 to stay with his partner for a prescribed length of time before abandoning him. (Compare with Shaked and Sutton (1984) where this convention is exogenously given.)

Markets with bargaining and matching have been studied by Douglas Gale (1986, 1987) to obtain the Walrasian outcome without the help of an auctioneer. Rubinstein and Wolinsky (1985) pointed out how sensitive the Walrasian outcome is to changes in the informational structure of the game and the strategies of the players. The result of this paper indicates another point to which Gale's models are sensitive: The modelling of stepping out of negotiations. If opting out is modelled according to the «Hi Tech» market, then it is very likely that many equilibria exist and the Walrasian outcome is not the only equilibrium.

The paper is organized as follows: Section 2 presents a bargaining model where only one player may opt out, and Section 3 presents a simple model of a market with bargaining and matching. Section 4 concludes.

2. A model where only one player may opt out

Consider a sequential bargaining model in which the two players divide a cake of size 1 and where player 2 may opt out each time an offer has been rejected. Opting out secures the payoffs (α, β) for the players, α for player 1 and β for player 2. Both players have a discount factor δ, so that the cake and the outside option shrink with time. A chance move determines at each stage which of the players will make the next offer.

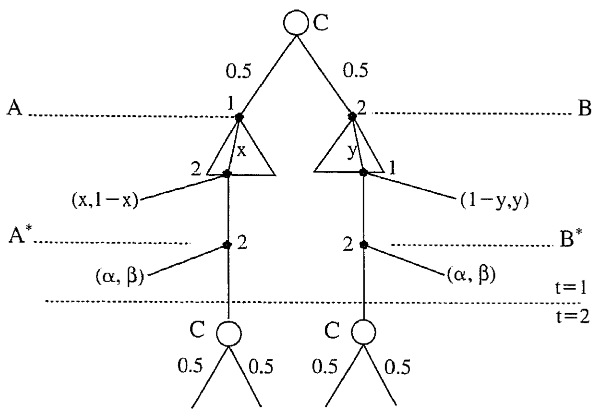

Figure 1

Figure 1 describes the game: At node C, a chance move determines with equal probabilities who will make the (next) offer. At node A player 1 makes an offer to player 2, player 2 accepts or rejects the offer. If the offer is rejected then, at A^*, player 2 gets to choose between opting out and staying on. Similarly at B player 2 makes an offer and if it is rejected he may (at B^*) opt out or stay on. Choosing to continue the game brings the players to a chance move C which determines who makes the next move, and so on.

There are, of course, many bargaining models which will illustrate our point. We have chosen this one because the bargaining procedure is completely symmetric, so that any investigation of a market set-up (Section 3) will depend solely on the friction parameters introduced and not on any specific order of offers.

In what follows we assume that $\alpha + \beta < 1$. This means that once they depart both players need to find similar partners before receiving any payoff, and that the matching process takes time and is therefore costly. We also assume some asymmetry between the players in that $\alpha < \beta$, i.e. player 1's outside possibilities are less promising than those of player 2. This could be due to players of type 1 being in the long side of the market.

Although the central theme of the paper is the multiplicity of equilibria, we will specify the range of parameters for which there is a unique equilibrium. This may help in any application of the game to «Hi Tech» markets, for in market models the outside option will, in general, be endogenously determined.

We show that when β is sufficiently small or sufficiently large the game has a unique equilibrium (Lemma 1), whereas for intermediate β's there is an interval of equilibrium payoffs (Lemma 2). The range of equilibrium payoffs in the latter case is wide.

LEMMA 1: Let $\alpha < \delta/2$. The game has a unique perfect equilibrium for $\beta > \delta(1 - \alpha)/(2 - \delta)$ and for $\beta < \delta/2$.

PROOF: The proof is based on the stationarity of the game (not on the stationarity of the strategies) and constructs an equation for the supremum of the equilibrium payoffs. To simplify matters somewhat we construct equations for the maximum of the equilibrium payoffs. The missing details can be found in Shaked and Sutton (1984) of which this proof is a slight variation.

1. Let $\beta < \delta/2$. The payoff $(1/2, 1/2)$ is an equilibrium payoff, which is supported by strategies that require player 2 never to opt out. This is the unique equilibrium since rather than opting out and getting the payoff β, player 2 prefers to stay on (never to opt out) and get $\delta/2 > \beta$.

2. Let $\beta > \delta(1 - \alpha)/(2 - \delta)$, then $(1 - \alpha + \beta)/2$ is an equilibrium payoff for player 2, supported by strategies in which player 2 always opts out. (Since $\beta > (1 - \alpha + \beta)\delta/2$, player 2 always exits). To show that this is the unique equilibrium payoff, denote by M the maximum equilibrium payoff to player 2.

Assume first that $\delta M \geq \beta$ and calculate the maximal equilibrium payoffs at A, B and C. At A^* (A) the maximal payoff to player 2 is M. At B^* the minimal payoff to player 1 is either α if player 2 exits or $\delta(1 - M)$ if he stays on. If $\alpha \leq \delta(1 - M)$ then player 2 will opt out at B^* to obtain his maximum payoff $1 - \alpha$ (by giving player 1 his minimum α). Hence at C:

$$M = (\delta M + 1 - \alpha) / 2$$

This implies that $M = (1 - \alpha) / (2 - \delta)$. However, the assumption on β is that $\beta > \delta (1 - \alpha) / (2 - \delta) = \delta M$, contrary to $\delta M \geq \beta$. Hence it must be that $\alpha > \delta (1 - M)$, and player 2 stays at B in order to give player 1 his minimum. Thus at C:

$$M = (\delta M + 1 - \delta + \delta M) / 2$$

i.e. $M = 0.5$. But this implies that $\alpha > \delta (1 - M) = \delta/2$, contrary to our assumption. Hence it cannot be that $\delta M \geq \beta$. But if $\delta M < \beta$ then player 2 always exists at A^* and B^* and the unique equilibrium payoff at C is $(1 - \alpha + \beta) / 2$.

This completes the proof of the lemma.

We now demonstrate that for intermediate values of β there are multiple equilibria. The proof will not follow the intuition described in the introduction (the convention of staying with a partner for a given length of time). Instead, to simplify the proof, we use extreme punishment strategies.

LEMMA 2: Let $\alpha < \delta/2 \leq \beta \leq \delta (1 - \alpha) / (2 - \delta)$. Then the set of equilibrium payoffs to player 2 is given by the interval:

$$\left[\beta + \frac{1-\delta}{2}, \frac{1-\alpha}{2-\delta}\right]$$

PROOF: We first show that each point in the intervals

$$\left[\beta, \frac{\delta(1-\alpha)}{2-\delta}\right], \quad [1 - \delta + \beta, 1 - \alpha] \text{ and } \left[\beta + \frac{1-\delta}{2}, \frac{1-\alpha}{2-\delta}\right]$$

is an equilibrium payoff to player 2 at the nodes A, B, and C, respectively. We then prove that these intervals cover *all* the equilibrium payoffs. Note that the assumptions on α, β ensure that the payoff intervals at B, C are not trivial, that $\alpha + \beta < \delta$ and that β/δ is in the interval of payoffs at C.

Note that the conditions on α, β imply that (α, β) lies in the convex hull of the three points: $(0, \delta/2)$, $(0, \delta/(2-\delta))$, $(\delta/2, \delta^2/2(2-\delta))$. All three are below the line $\alpha + \beta = \delta$.

To prove that a given payoff (at A, say) is supported by equilibrium strategies we construct a strategy specifying what the players should do at A

and A^* in any eventuality and what the equilibrium payoff will be at the following node C. This will be one of the proposed payoffs for C. We construct similar strategies for nodes B and C.

To support x where $\beta \leq x \leq \delta\,(1 - \alpha) / (2 - \delta)$ as an equilibrium payoff to player 2 at A, player 1 offers x and player 2 accepts. If player 2 rejects the offer he will not opt out at A^* and the equilibrium payoff at the following node C will be β/δ.

If player 1 offers player 2 less than x, then player 2 rejects, he will stay on at A^* and the equilibrium at C will be $(1 - \alpha) / (2 - \delta)$. Our assumptions ensure that he will stay on at A^* and that player 1 is punished for his deviation, while player 2 gains by rejecting the offer made to him.

To support x where $1 - \delta + \beta \leq x \leq 1 - \alpha$ as an equilibrium payoff to player 2 at node B, player 2 asks for x and player 1 agrees. If player 1 rejects the offer $1 - x$, player 2 will exit at B^*, for the equilibrium at C will be $\beta + (1 - \delta) / 2$. Our assumptions ensure that player 2 will want to opt out and that player 1 is punished for his deviation. If player 2 asks for more than x, player 1 will reject and player 2 will stay on at B^*, for the equilibrium payoff at C will be $[1 - \beta/\delta, \beta/\delta]$. This guarantees that player 2 is punished, and that player 1 will reject the offer made to him.

To support any $\beta + (1 - \delta) / 2 \leq x \leq (1 - \alpha) / (2 - \delta)$ as an equilibrium payoff for player 2 at C, the players will play towards certain payoffs at A and B whose average is x. Note that the interval of payoffs at C is the average of the intervals at A and B. This completes the proof that any value in the intervals can be supported as an equilibrium payoff to player 2.

We now demonstrate that $\beta + (1 - \delta) / 2$ is the minimum and $(1 - \alpha) / (2 - \delta)$ is the maximum of the equilibrium payoffs to player 2 at C. Let m (M) be the minimal (maximal) equilibrium payoff at C. We calculate the maximum and minimum payoffs at A^*, A, B^*, B and find the values of m and M. The calculations for m and M are somewhat different for, due to nature's move at C picking up different players to make an offer, we have to deal with two games simultaneously which are «out of phase».

To find m, note that the minimal payoff that player 2 can get at A^* (A) is β. This occurs when the equilibrium payoff at C is smaller than β/δ. The maximum payoff to player 1 at B^* is the maximum of α and $\delta\,(1-\beta/\delta) = \delta-\beta$. Our assumptions on α, β guarantee that $\delta - \beta > \alpha$, hence the minimum at C will be:

$$m = \frac{1}{2}\,[\beta + 1 - \delta + \beta] = \beta + \frac{1-\delta}{2}$$

To find M, note that if $M \geq (1 - \alpha) / (2 - \delta)$, then $\delta M \geq \beta$ and the maximum payoff at A^* (A) is δM. The lowest payoff to player 1 at B^* is the lowest of the two: α, $\delta\,(1 - M)$. If $\delta\,(1 - M) \leq \alpha$ then: $M = (\delta M + 1 - \delta + \delta M) / 2$, or: $M = 1/2$ which implies that $\delta / 2 \leq \alpha$ contrary to our assumption. Hence $\delta(1 - M) > \alpha$, implying that: $M = (\delta M + 1 - \alpha) / 2$, or $M = (1 - \alpha) / (2 - \delta)$.

This completes the proof of the lemma.

Note that the strategies require that player 2 stays on at A^* and exits at B^* in the case of player 1 deviating at A or B. Note also that our result hinges on β / δ being an equilibrium payoff at C. This is an equilibrium in which player 2's gains from his threat to exit have been reduced to the minimum which still enables him to stay on at A^* or B^*.

Figure 2 describes the payoffs to player 2 as a function of β. Observe that for $\beta \geq 1 - \alpha$ player 2 always exits and that at node B he will make a low offer to player 1 which will be rejected by player 1 and followed by player 2 opting out.

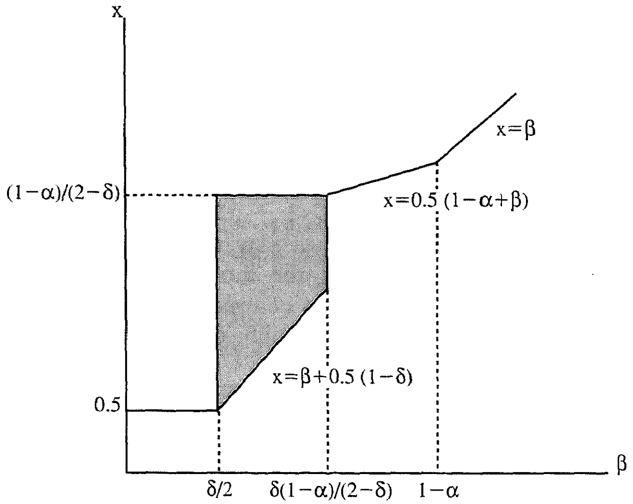

Figure 2
The payoff to player 2 at node C as a function of β.

3. A market model with multiple equilibria

In this section we show that the multiplicity of equilibria transfers to markets with bargaining and matching when modeled along the «Hi Tech» lines. This is by no means obvious since in a market model we are no longer free to choose the value of the outside option. The outside option is endogenously determined and may not fall in the range for which there are multiple equilibria. We show that there exists a range of parameters for which the model has multiple equilibria. In order to illustrate this point we chose a simple market with a single seller and many buyers. The market has frictions in the negotiation procedure and in the matching process. This market will have a wide range of equilibria even in the limit, when the frictions disappear –unless the frictions in the matching process vanish faster than those in the negotiation procedure.

The market has one seller S and many identical buyers B. When a buyer meets the seller they bargain over a surplus of size unity by (sequentially) exchanging offers according to the procedure described in Section 1. After an offer has been rejected the seller may opt out to commence negotiations with another buyer. The matching process is costly in that meeting a buyer may not be certain and it may also take some time. This friction is represented by a discount factor $\mu < 1$, i.e. if x is the payoff to the seller after he met a new buyer, then before leaving his current partner he expects to get μx. We assume that once abandoned, a buyer will never meet the seller again.

We consider only equilibria which are stationary in the sense that buyers are equally treated, i.e. in a given equilibrium, all equilibria of any subgame in which the seller just met a new buyer are identical. Let G be the game beginning immediately after the seller has met a buyer, let x be an equilibrium payoff to the seller in G and let β be the outside option payoff to the seller in this equilibrium, then $\beta = \mu x$. The outside option payoff to the buyer is zero since he never meets the seller again. We first apply Lemma 1: recall that for $\beta > \delta\,(2 - \delta)$ the unique equilibrium payoff is $(1 + \beta)/2$ (here $\alpha = 0$). We look for μ, x satisfying $\mu x > \delta/(2 - \delta)$, $x = (1 + \mu x)/2$, i.e. $\mu > \delta$, and $x = 1/(2 - \mu)$. Similarly, for the lower range of β's in Lemma 1 we find: $\mu < \delta$ and $x = 1/2$.

Applying Lemma 2 we get that for $\delta/2 \leq \mu x \leq \delta/(2 - \delta)$ any $\mu x + (1 - \delta)/2 \leq x \leq 1/(2 - \delta)$ is an equilibrium payoff. These two conditions on x can be written as:

$$\frac{\delta}{2\mu} \leq x \leq \frac{\delta}{\mu}\,\frac{1}{2-\delta}$$

$$\frac{1-\delta}{2(1-\mu)} \leq x \leq \frac{1}{2-\delta}$$

or alternatively as:

$$\max\left[\frac{\delta}{2\mu}\,,\,\frac{1-\delta}{2(1-\mu)}\right] < x < \min\left[\frac{\delta}{\mu}\,\frac{1}{2-\delta}\,,\,\frac{1}{2-\delta}\right]$$

This yields:

$$\text{for } \frac{\delta\,(2-\delta)}{2} \leq \mu \leq \delta \quad : \quad \frac{\delta}{2\mu} \leq x \leq \frac{1}{2-\delta}$$

$$\text{for } \delta \leq \mu \leq \frac{2\delta}{\delta^2-\delta+2} \quad : \quad \frac{1-\delta}{2(1-\mu)} \leq x \leq \frac{\delta}{\mu}\,\frac{1}{2-\delta}$$

Figure 3 summarizes the various cases as a function of μ. The shaded area corresponds to the multiple equilibria case. However, for all $\mu < \delta$ there is an additional equilibrium in which the seller never leaves and for $\mu > \delta$ there is an equilibrium in which the seller always leaves (even after the buyer's offer). These are the equilibria derived from Lemma 1 and represented by the horizontal $x = 1/2$ and the hyperbola $x = 1/(2-\mu)$.

The gaps in the diagram between the shaded area and the isolated equilibria can be filled by allowing for non equal treatment of buyers by the seller. Assume, for example, that $\mu < \delta$ and that the seller has a way to distinguish between buyers. Assume that he marked half of them so that when he meets them he never leaves them (and therefore his payoff is 0.5) and that he treats the others «normally», i.e. he may opt out when he negotiates with them. This will have the effect of lowering the outside option he can get in this market. By varying the percentage of buyers he singles out one can get all the intermediate payoffs between the shaded area and the isolated equilibria.

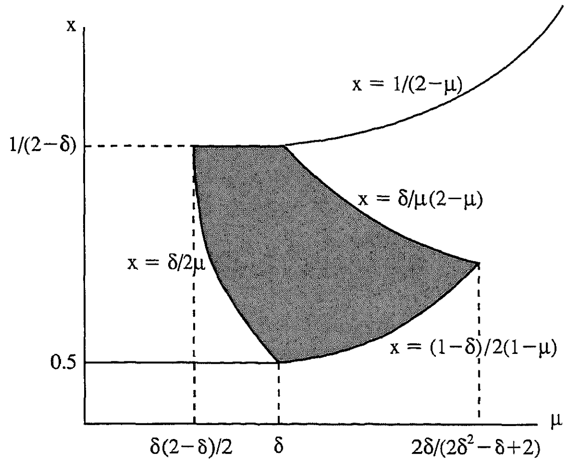

Figure 3
The payoff to player 2 as a function of μ
(The equations describe the boundaries).

Note that for $\mu = \delta$ we obtain the full range of payoffs $[0.5, 1/(2-\delta)]$ which as δ approaches 1 becomes $[0.5, 1]$. Thus if $\mu = \delta$ then the multiplicity of equilibria will not vanish even if the frictions vanish, i.e. when δ becomes 1.

To get a unique equilibrium one can ensure that μ is in the range where there is a unique equilibrium anyway, i.e. where

$$\mu > \frac{2\delta}{\delta^2 - \delta + 2}$$

$$\mu < \frac{\delta\,(2-\delta)}{2}$$

Or make μ go somewhat faster to 1 than δ, i.e. $1 - \mu = \varepsilon$, $1 - \delta = 2\varepsilon$ This will make

$$\frac{1}{2-\mu}, \frac{\delta}{\mu}\frac{1}{2-\mu}, \frac{1-\delta}{2\,(1-\mu)}$$

converge to 1.

Compare this result with a «Bazaar» market. Here the seller cannot opt out after he made an offer. The relevant outside option game will be described by Figure 1, except that player 2 may no longer opt out at B^*, the node B leading directly to node C. Here, if $\mu < \delta$, player 2 will never opt out and his payoff will be 0.5. If $\mu \geq \delta$ then player 2 will always opt out at A^* and his equilibrium payoff will be given by the equation: $x = (\mu x + 1 - \delta + \delta x)/2$ and the equilibrium payoff is $(1 - \delta)/(2 - \mu - \delta)$.

This will converge to 1, the Walrasian equilibrium, only if μ converges to 1 faster than δ.

4. Summary and Conclusions

The theory of sequential bargaining has neglected to investigate models in which a partner may choose to leave the negotiations immediately after his own offer has been rejected. In markets where negotiations are carried out through telephones or computers this is very likely to be the case. We study the implications of this type of modeling in a bargaining game with outside options, and we find that it leads to multiple equilibria. This result is then extended to a simple market with matching and bargaining where we find a range of the relevant frictions for which the market has an interval of equilibria which does not necessarily shrink to the Walrasian equilibrium as the frictions disappear.

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Resumen

Este artículo analiza un juego de negociación con ofertas alternantes en el que se permite a uno de los jugadores salirse del mismo cada vez que una oferta es rechazada. Se demuestra que este juego tiene una multiplicidad de equilibrios que no desaparecen cuando las fricciones en el proceso de negociación se hacen arbitrariamente pequeñas. Este juego de negociación se introduce, a continuación, en un modelo de un mercado en el que un vendedor se encuentra con un comprador y negocia con él, pudiendo abandonar la negociación y buscar a otro comprador inmediatamente después de que una oferta es rechazada. Se demuestra que este modelo tiene un continuo de equilibrios que no convergen al equilibrio Walrasiano a menos que las fricciones tiendan a desaparecer de una manera muy especial.

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