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Abstract

This article develops a noncooperative bargaining model to address the effects of the uniform settlements policy (USP) in international telecommunications. The model predicts that the USP is more likely to increase (decrease) access charges in markets where, under the USP, U.S. firms carry more (less) outbound than inbound traffic. This is due to the model's more general prediction that forbidding price discrimination may allow an upstream monopolist to credibly commit to a take-it or leave-it intermediate product price. Two brief case studies from the international telegraph market lend support to this prediction.

1. Introduction

In April 1979, the Federal Communications Commission (FCC) initiated the first of several actions that are dramatically changing markets for international telecommunications service. Viewing prices as excessive in voice markets, the FCC considered two broad policy options: 1) open formal rate hearings hoping to determine "appropriate" prices or 2) open entry hoping that competition should hold rates down to cost. Their decision was to open entry to the greatest extent possible.[1]

Unfortunately, the welfare properties of a perfectly competitive closed economy cannot be extended to international markets in which the foreign network is monopoly controlled. Most foreign governments are likely to maintain their monopolies well into the future with the consequence that they will remain bottlenecks in the provision of service. To understand the problems that may arise, consider a typical market for international service between the U.S. and a particular foreign country. The foreign monopolist interacts with U.S. carriers in two ways. First, it serves as an upstream supplier of *access* to the foreign network, an input used in fixed proportions by U.S. carriers to produce *calls* to the foreign country. Second, it is also a downstream buyer of access to the U.S. networks. It controls not only the number of U.S. carriers allowed to access its network, but also the allocation of U.S. bound traffic across U.S. carriers. These advantages place it in a relatively strong bargaining position in the negotiations that determine the division of international revenues. The FCC has long feared that these advantages might enable the foreign monopolist to set access charges so as to extract surplus both from U.S. carriers and consumers.

To avoid these potential hazards, the Commission enforces the *uniform settlements policy* (USP), designed to prevent foreign monopolists from playing U.S. carriers against one another to obtain more favorable agreements. The USP requires that 1) all U.S. carriers pay the same price for access to a particular foreign network, and 2) the access charge paid by U.S. carriers to a particular foreign monopolist equals the charge paid by that foreign monopolist to U.S. carriers. Constraint 1 forbids third degree price discrimination and is subsequently referred to as the "price discrimination constraint." Constraint 2 is known as the "50-50 division of tolls."[2] This paper argues that, contrary to the views of the FCC, the USP may result in higher access charges and higher rates for international service. Sufficient conditions are given under which the policy is welfare reducing and welfare enhancing. It turns out the potentially negative consequences of the policy could arise in the voice market should the Commission adopt the stringent enforcement stance currently held in telex. Thus, its recent statements that the policy may be applied in voice may need to be reassessed.[3]

The key to understanding the welfare effects of the USP is to understand how it affects the degree to which the foreign monopolist controls the access charges paid and received by U.S. carriers. Due to the modelling difficulties posed by multilateral bargaining, the usual approach to the price discrimination problem has been to assume that the agent on the "thin" side of the market (i.e. the foreign monopolist in this case) has all the bargaining power, regardless of the regime.[4] But this begs the question: Why is the monopolist more able to commit to being a price leader than a particular U.S. carrier when there are few firms on both sides of the market? In international telecommunications access charges are subject to negotiations. If U.S. carriers have any bargaining power it follows that the effects of the USP on access charges depends partly on how it alters the relative *bargaining* powers of foreign and U.S. carriers.

There are two standard ways one might approach the bargaining problem. One could employ an axiomatic model of bargaining such as the n-player version of Nash's (1950) bargaining solution (see Roth (1979)) or the Shapley Value (Shapley (1953)), to name just two. In international telecommunications, however, the mechanism by which foreign monopolists are thought to play U.S. carriers against one another relies on the credibility of their threats to take actions adversely affecting U.S. carriers and ratepayers. A more natural way to address issues of credibility is to examine an extensive form game.

Employing an extension of the noncooperative bargaining model first introduced by Rubinstein (1982), I develop a model in which the bargaining power of the foreign monopolist is endogenous to the policy regime. The model explicitly incorporates the threat each carrier has to impose costly delays on those with whom it negotiates as well as the threat foreign monopolists have to reallocate U.S. bound traffic away from U.S. carriers refusing their terms. Equilibrium prices reflect how these threats interact with the USP.

Consider negotiations over the per-minute prices two U.S. carriers pay for access to a foreign monopolist's network in order to originate calls from the U.S. This half of the international market is simply a wholesale/retail chain in which an upstream monopolist bargains with downstream oligopolists over the intermediate product price. In the regime where the discrimination is allowed, the monopolist bargains with the each U.S. firm over the incremental surplus generated by an agreement. In general, incremental profits are positive; hence, each U.S. firm can impose a loss on the monopolist by terminating service and therefore has bargaining power. The model thus predicts that the monopolist does not exercise price leadership in subgame perfect equilibrium when discrimination is allowed. When price discrimination is forbidden, in contrast, U.S. carriers cannot bargain over incremental surplus once an initial price is established. This allows the monopolist to credibly set a take-it or leave-it price, leading to strictly higher access charges and strictly lower welfare than when discrimination is allowed.

Although the models are quite different, this result bears a family resemblance to the conjecture of Coase (1972) formalized by Bulow (1982), Stokey (1981), and Gul, Sonnenscein and Wilson (1986): A durable good monopolist unable to credibly refrain from lowering price after making initial "high" priced sales may end up lowering price to marginal cost very quickly to prevent buyers from waiting too long to purchase the good. In those models the monopolist can benefit from committing itself not to lower price below the static monopoly price. In the bargaining model the "durable goods" are access charge contracts sold to multiple U.S. firms with symmetric reservation price schedules.

The mechanism precluding price leadership in the unconstrained regime is not the incentive for the monopolist to lower price; rather, it is the monopsony power held by each buyer. By committing itself not to discriminate in price the monopolist can play buyers against one another to determine *the* equilibrium price. This restores monopoly price leadership.

This result is applied to the international telecommunications market by introducing into the model two way traffic and incorporating the 50-50 division of tolls. Changes in the *uniform access charge* (one satisfying both the price discrimination constraint as well as the 50-50 division of tolls) affect both the foreign monopolist's marginal cost of outbound traffic as well as its revenues from inbound traffic. Thus, whether it raises the uniform access charge above its marginal cost depends on the relative importance of its inbound and outbound traffic. For the intermediate case in which the total demand for U.S. outbound calls is independent of the foreign price and technologies are the same in each country, the USP raises U.S. welfare when the number of calls originating overseas is greater than that originating in the U.S. This is the case in most telex markets. However, when traffic patterns are reversed, as they are in most voice and telegraph markets, foreign monopolists set relatively high uniform access charges. This may result in lower U.S. welfare than in the unconstrained regime.

The remainder of this paper is organized as follows. Section 2 provides background on USP and gives two examples suggesting that the policy may be failing to meet its objectives in the telegraph market. Section 3 develops the model and examines subgame perfect equilibrium access charges in the unconstrained regime. Section 4 introduces the USP. Section 5 compares equilibrium welfare in constrained and unconstrained regimes. Section 6 offers some concluding comments.

2. Background

The three international telecommunications services addressed by this paper are voice (i.e international long distance calls), telex, and telegraph. Although it was monopolized by AT&T until 1985, the entry of MCI and Sprint has raised the question of whether the USP should be enforced in voice. In its recent *Order on Reconsideration* (FCC 1987), the Commission tentatively ruled that the policy applies, though with a weaker waiver procedure than in telex and telegraph markets.[5] In any case, AT&T still controls most of this market so it may be too early to learn much by examining data. However, the USP originated in telex and telegraph markets where rivalry has existed throughout their history. A brief examination of this history provides insight into the effects of the USP in telex and telegraph as well as suggesting potential effects in voice.

The FCC has been very clear about the intended consequences of the USP. They state: "Our primary responsibility...is to facilitate the development of a competitive marketplace characterized by lower rates and greater service/carrier options for users."[6] In pursuit of this goal, they have long feared that unrestrained competition among U.S. firms in telex and telegraph markets might do more harm than good. Frequently, this fear has led them to prevent U.S. firms from signing international agreements that they thought were contrary to the public interest. The first example was in 1936 when they refused to allow Mackay Radio and Telegraph to go into operation between the U.S. and Norway. In the proposed contract, the Norwegian monopolist had agreed to route all new U.S. bound telegraph traffic over Mackay's new circuit. The FCC argued:

> "Inasmuch as the [foreign] telegraph administration controls every word of outgoing radiotelegraph traffic, the competing American radio companies would be dependent upon it for their traffic...Each would be interested in increasing its share of the total traffic. To expect the telegraph administration to play the competing companies against each other is simply to expect that the administration will be headed by good business men, loyal to their national interests. To rely upon companies which are bitter competitors not to make concessions to the administration which controls all outgoing radiotelegraph traffic is to provide an exceedingly tenuous basis upon which to rest public interest"[7]

The Commission's basic fear was that the Norwegian PTT would "whipsaw" U.S. firms into paying more for access to the Norwegian network while accepting less for access to their own. This, they argued, would put upward pressure on the price of final service.

Two potential threats that foreign monopolists might use have been cited. As in the Mackay case a PTT might threaten to divert (profitable) U.S. bound traffic from one U.S. carrier to another if the first carrier does not agree to new access charges. Alternatively, a PTT might threaten to terminate, permanently or temporarily, its operating agreement with any U.S. carrier refusing to accept less favorable terms. The USP developed as an informal, but generally observed, policy in the 1930s as a way in which to address these threats. It wasn't until 1977, however, when a U.S. telex carrier attempted to enter the U.S./U.K market at a lower access charge than currently in effect, that the policy was more formally considered by the Commission. By 1980 they argued that "this Commission has long maintained a policy of uniformity to preclude 'whipsawing' of U.S. carriers by foreign correspondents. The policy protects the interest of the U.S. and, in particular, the U.S. ratepayer from the adverse effects 'whipsawing' can produce."[8]

The puzzling aspect of this and many similar Commission statements is that they never fully describe how the USP benefits U.S. ratepayers. The implicit assumption is that forbidding price discrimination and requiring a 50-50 division of tolls prevents foreign monopolists from credibly threatening (or carrying out threats) to take actions adversely affecting U.S. ratepayers. Yet, neither the threat to reallocate U.S. bound traffic nor the threat to terminate operating agreements is directly affected by either constraint.

Under the USP, any U.S. carrier reaching agreement to operate at access charges in violation of either the price discrimination constraint or the 50-50 division of tolls must file a request for waiver of the USP with the FCC. After reviewing any objections filed by other carriers, the Commission determines whether a waiver of the USP is in the public interest. Citing its "long standing policy of uniformity," it has become standard practice for the Commission to reject waiver requests in both the telex and telegraph markets.[9] Hence, *individual* carriers proposing non-uniform access charges are usually required to bring agreements into line with existing agreements before being granted the right to begin (or renew) service. The USP therefore prevents the foreign monopolist from playing U.S. carriers against one another by sequentially altering individual agreements after an initial agreement is established.

What is missing from the argument, however, is a description of how the initial agreement is established. The policy clearly does not prevent the foreign monopolist from threatening to terminate the operating agreements or adjust the U.S. bound traffic of *all* U.S. firms simultaneously.[10] On two recent occasions foreign monopolists have unilaterally increased uniform access charges to the detriment of U.S. consumers. It is instructive to examine these two cases.

Case 1: The COMTELCA Telegram

In 1983 a consortium of Central American countries known as COMTELCA sent a telegram to each U.S. telegraph carrier announcing that on a given date they would put new higher access charges into effect in the market for telegraph service between the U.S. and each COMTELCA country.[11] The threat used was their assertion that "thereafter, they would deal only with those carriers agreeing to the new charge."[12]

Following the waiver procedure, each U.S. carrier in succession filed a petition with the FCC for waiver of the USP to increase the access charge applicable for service to each COMTELCA country. Subsequently, all the U.S. telegraph carriers operating in these markets sent the COMTELCA administrations a joint telex informing them that the signatories had agreed to the new access charge effective November 1, 1983. Since no U.S. carrier objected to the new charge, the proposed change was allowed by the FCC.

Prior to the change, U.S. carriers paid $.1773 per word for access to each COMTELCA network. After the change they paid $.2365 per word. While final service prices rose only a few percentage points in each market, the net revenues of all U.S. carriers combined (i.e. net of payments to the COMTELCA countries) fell by 28 percent from 1982 to 1984.[13]

Case 2: The CEPT Telegram

In another instance, on August 19, 1983, RCA Global Communications filed a request with the FCC for waiver of the uniform settlements policy in order to raise the access charge for telegraph traffic between the U.S. and 13 CEPT countries.[14] Other U.S. carriers filed similar waiver requests. Each had received a telegram from CEPT that read:

> "If...your agreement cannot be obtained, we will be forced...to reconsider the agreement reached by us up to the present time and we will take measures for a new breakdown of the traffic and therefore a radical change in the infrastructure."[15]

Notice that both the threat to terminate operating agreements and to reallocate outbound traffic was used by CEPT. The access charge paid by U.S. carriers increased from $.1577 per word to $.2365 per word on January 1, 1984.

In both the CEPT and COMTELCA telegrams foreign monopolists were able to raise all access charges simultaneously by using the threats that the USP was designed to address. The fact that every U.S. carrier agreed to the proposed price in each case implies that these threats were credible. The implication is that, had some U.S. carrier rejected the telegram, the outcome of the ensuing negotiations (i.e. "the radical change in infrastructure") would have been no better for that carrier than accepting the terms in the telegram. The next section offers a model of these negotiations. Although the model is designed to address international telecommunications, it should be apparent that many vertical chains of production share similar features.

3. A Bargaining Model of International Settlements.

The Model

Consider an international telecommunications market in which a foreign monopolist, M, and two symmetric U.S. carriers, firms 1 and 2, bargain over the price each pays for a continuous flow of the intermediate product, *access* to the foreign network.[16] Access is used by each carrier in fixed proportions to produce a continuous flow of the final product, *calls* to the foreign country. The foreign monopolist produces access at constant marginal cost c; it produces outbound calls via firm i's network at marginal cost $c + a_i^U$ where c is the unit cost of service due to other competitively sold inputs and a_i^U is the price paid for access to firm i's network. Similarly, firm i produces access at constant marginal cost $w \leq c$ and outbound calls at marginal cost $w + a_i^M$. The assumption that U.S. marginal cost is no higher than that of the foreign monopolist reflects the belief that private U.S. firms are at least as efficient as their foreign publicly-owned counterparts. Initially, there is no constraint on access charges; under the USP, $a_1^U = a_2^U = a^U$, $a_1^M = a_2^M = a^M$, and $a^U = a^M$.

Conditional on negotiated access charges firms are assumed to maximize their instantaneous profit flows at every instant on into perpetuity. This reflects the observation that access charges are usually fixed for a long period of time, while decisions regarding levels of service are made continuously. U.S. firms are Cournot duopolists in the market for calls originating in the U.S.; the foreign carrier continuously produces its monopoly level of service. All firms discount the future continuously at the common rate $\delta = e^{-rz} < 1$ where r is the interest rate and z is the length of time between successive offers in the bargaining game introduced below. To reflect the belief that costs due to bargaining frictions are small relative to the discounted value of profits earned after agreement is reached, attention is focused on the "frictionless" case in which $z \to 0$ $(\delta \to 1)$. The model is one of complete information — demand, cost functions, and the discount factors are assumed to be common knowledge.

Turning to the demand side of the market, the gross U.S. benefits of telecommunications service are given by $W^U(X,y)$ where X is the amount of service originated in the U.S., y the amount originated overseas. Similarly, the gross foreign benefits of service are $W^M(X,y)$. Both functions are assumed to be continuously differentiable. To simplify the exposition it is assummed that $W^U_{xy} = W^M_{xy} = 0$; i.e., gross surplus is additively seperable in inbound and outbound service.[17] Let the inverse demand for service outbound from the U.S. be $P(X) = W^U_x(X,y)$; let that for service outbound from the foreign country be $F(y) = W^M_y(X,y)$.

Welfare Maximization

The FCC has expressed both the desire to maintain "lower rates" for users and to ensure that "U.S. carriers rather than foreign administrations maximize their revenues through accounting rate [i.e. access charge] actions." This is captured by assuming that the Commission's goal is to maximize welfare, which is taken to be a weighted sum of U.S. consumer and producer surplus.

The USP affects welfare through its affect on access charges. Assuming no other instruments are available, the benchmark outcome to compare with other equilibria is that in which the Commission chooses access charges to maximize welfare subject to monopoly pricing overseas and Cournot pricing in the U.S. Let $X(a^M)$ be the Cournot equilibrium level of service in the U.S., $y(a^U)$ the monopoly level of service overseas. U.S. welfare is

$$(1) \qquad US(a^M,a^U) = W^U(X(a^M),y(a^U)) - P(X(a^M))X(a^M) + \alpha\left\{P(X(a^M))X(a^M) - (a^M + w)X(a^M) + (a^U - w)y(a^U)\right\}$$

where $0 \leq \alpha \leq 1$. To maximize welfare the commission solves

$$(2) \qquad \max \{US(a^M,a^U) \mid a^M \geq c,\ a^U \geq w\}.$$

The requirement that the access charges be greater than marginal cost in (2) reflects the assumption that carriers can refuse to accept unprofitable inbound traffic. While one can imagine carriers contemplating agreements to continue service at prices less than marginal cost, there would be incentives for each carrier to reduce inbound traffic by blocking circuits or quality degradation. That is, such agreements would be inherently unstable.

The first order necessary conditions to (2) are

$$(3) \qquad [(1 - \alpha)P_x X - \alpha(P - (a^M + w))]X_a - \alpha X + \lambda = 0$$

$$(4) \qquad [W_y^U + \alpha(a^U - w)]y_a + \alpha y] + \eta = 0$$

and

$$(5) \qquad (a^M - c)\lambda = 0, \ (a^U - w)\eta = 0, \ \lambda \geq 0, \ \eta \geq 0.$$

Let the subscript OPT denote access charges that solve problem (2). Since the first term in (3) is negative, it is clear that $a_{OPT}^M = c$. Intuitively, the Commission sets a^M as low as possible to increase U.S. profits and consumer surplus, while disregarding foreign profits. Whether a_{OPT}^U is greater than or equal to w depends on the whether the marginal profit to U.S. carriers from increasing a^U above w $(\alpha y(w))$ is greater than or less than the marginal reduction in the call externality $(W_y^U(y(w))y_a(w))$. These two possibilities are illustrated in Figures 1 and 2. Notice that in either case U.S. consumer surplus declines as the uniform access charge increases along the 45 degree line in access charge space. Hence, the access charge increases in the CEPT and COMTELCA telegrams reduced consumer welfare in this model.

The Unconstrained Regime: Outbound Traffic

In the unconstrained regime (UR), in which neither the price discrimination constraint nor the 50-50 division of tolls is enforced, negotiations over the access charges for inbound and outbound traffic need not be carried out simultaneously. That is, the foreign monopolist and firm i might negotiate the charge paid for access to the foreign network having already agreed upon that paid for access to firm i's network. Alternatively, some U.S. firm might reach agreement to carry only one-way traffic, in which case there is only one charge under negotiation for that firm.[18] Unless firms can commit to link the decisions to originate and receive traffic, each is essentially involved in two bargaining problems to determine two access charges.

Consider first the market for traffic originating in the U.S. Bargaining proceeds as a sequence of offer/counteroffer and accept/reject decisions in pair-wise meetings between the monopolist and each U.S. firm. In the *Order on Reconsideration* (FCC, 1987), the FCC clearly expressed fears concerning the advantage held by the foreign monopolist in negotiations with multiple U.S. firms. These fears are captured in the bargaining model by assuming an asymmetry in the sequence of moves that gives the monopolist an advantage. In particular, the monopolist can temporarily terminate negotiations with one firm in order to begin negotiations with the other as long as neither firm has reached agreement. However, once an initial agreement has been reached, the monopolist bargains more symmetrically with the remaining U.S. firm. The idea is that the monopolist attempts to play U.S. firms against one another prior to reaching an initial agreement, but then bargains bilaterally with the remaining firm thereafter.

The formal structure of the game, illustrated in Figure 3, is the following. In period zero, one of the U.S. firms, say i, is randomly chosen to meet with the monopolist. During this meeting, the monopolist offers a price; firm i may accept or reject that price. If the offer is rejected, the monopolist chooses whether to 1) open negotiations with firm j firm next period, in which case the monopolist makes an offer to firm j, or 2) consider firm i's counter-offer next period. As long as agreement has not been reached, bargaining continues with the monopolist determining which firm to negotiate with. If an agreement is reached at time t, the firm in agreement begins operations at the (downstream) monopoly level of service, and the foreign monopolist continues negotiations with the remaining firm at time t+1. In this subgame firms alternate offers each period with the monopolist making the first offer. Upon reaching the second agreement, each U.S. firm begins producing its Cournot Nash equilibrium output. The game continues in this way until both U.S. firms have reached agreement.[19] The formal asymmetries, then, are the monopolist's ability to control the timetable of offers and to make the opening offer in each meeting.

Following the usual procedure, a subgame perfect equilibrium (SPE) will be derived by proceeding left on each branch of the game tree, using backward induction. Consider the subgame after the monopolist and firm j agree to begin service at the price a_j^M before firm i has reached agreement. At time t, firm j begins producing the (downstream) monopoly output, $x_m(a_j^M)$, allowing the foreign monopolist to earn an instantaneous profit flow equal to $U_m(a_j^M) = (a_j^M - c)\, x_m(a_j^M)$. At time t + 1, the monopolist makes an offer to firm i. Since it is already earning profits from firm j, the payoff to the monopolist from reaching agreement with firm i is the incremental profit obtained by moving from monopoly to Cournot equilibrium in the U.S. Let $x_i(a_i^M, a_j^M)$ be the Cournot equilibrium output of firm i when the monopolist and firm i agree on the price a_i^M. Letting U_i be the incremental profits earned by the foreign monopolist by agreeing with firm i, and π_i the incremental (and absolute) profits of firm i,

$$(6) \qquad U_i(a_i^M, a_j^M) = (a_i^M - c)\, x_i(a_i^M, a_j^M) + (a_j^M - c)\, (x_j(a_j^M, a_i^M) - x_m(a_j^M))$$

and

$$(7) \qquad \pi_i(a_i^M, a_j^M) = P(x_i(a_i^M, a_j^M) + x_j(a_j^M, a_i^M))\, x_i(a_i^M, a_j^M) - (a_i^M + w)\, x_i(a_i^M, a_j^M).$$

The total profit earned by the monopolist is

$$(8) \qquad U(a_1^M, a_2^M) = (a_1^M - c)x_1(a_1^M, a_2^M) + (a_2^M - c)x_2(a_2^M, a_1^M)$$

Assuming continuous discounting at the interest rate r, the discounted present value (discounted to time t) of the profit streams earned by the monopolist and firm j are

$$(9) \qquad \frac{(1-\delta)}{r} U_m(a_j^M) + \frac{\delta}{r} U(a_1^M, a_2^M),$$

and

$$(10) \qquad \frac{(1-\delta)}{r} \pi_m(a_j^M) + \frac{\delta}{r} \pi_j(a_j^M, a_i^M),$$

where $\pi_m(a_j^M) = P(x_m(a_j^M))\, x_m(a_j^M) - (w + a_j^M)\, x_j(a_j^M)$. In what follows, statements such as "the monopolist receives $(1-\delta)U_m + \delta U$" are taken to mean that it earns $(1-\delta)U_m/r + \delta U/r$ in present value.

Let

$$A(a_j^M) = \left\{ a_i \;\middle|\; U_i(a_i, a_j^M),\ \pi_i(a_i, a_j^M) \geq 0,\ \frac{\partial U_i(a_i, a_j^M)}{\partial a_i^M} \geq 0 \right\}$$

be the set of all individually rational access charges over which the monopolist and firm i have a conflict of interest. The following assumptions are made on profit functions.

<u>Assumption 1</u>. (Existence of individually rational trades). For all $a_j^M \geq c$, there exists some $a_i \in A(a_j^M)$ such that $U_i(a_i, a_j^M),\ \pi_i(a_i, a_j^M) > 0$.

<u>Assumption 2</u>. (Continuity) π_i, π_m, U_i, U_m are twice continuously differentiable on the interval $[c, \infty)$.

<u>Assumption 3</u>. (Monotonicity) π_i is strictly decreasing in a_i^M, π_m is strictly decreasing in a, and

$|\partial\pi_i/\partial a_i| > |\partial\pi_i/\partial a_j|$ where both derivatives are bounded.

Assumption 4. (Monotonicity) U is strictly quasiconcave in (a_1, a_2), and U_m is strictly quasiconcave.

Assumption 1 guarantees that the monopolist and firm i find it profitable to reach an agreement. Assumptions 3 and 4 ensure that the set $A(a_j^M)$ is convex and that the firm paying the lower price earns higher profits in Cournot equilibrium.

Define the functions V_M and V_i as follows:

(11) $$V_M(a_i, a_j^M) = \min \{ a' \in A(a_j^M) \mid U_i(a', a_j^M) \geq \delta U_i(a_i, a_j^M) \}$$

(12) $$V_i(a_i, a_j^M) = \max \{ a' \in A(a_j^M) \mid \pi_i(a', a_j^M) \geq \delta \pi_i(a_i, a_j^M) \}$$

V_M (V_i) is the lowest (highest) input price which, if agreed upon today, would leave the monopolist (firm i) at least as well off as it would be by agreeing to the input price, a_i, tomorrow.

While Assumptions 1 - 4 guarantee existence, the following guarantees uniqueness in the subgame after one firm has reached agreement.

Assumption 5. (Increasing compensation for delay) For $k \in \{i, M\}$, the functions $D_k(a, a_j^M) = a - V_k(a, a_j^M)$ are strictly increasing in a.

Assumption 5 asserts that the increase (decrease) in the input price necessary to compensate the monopolist (firm i) for a delay of one period increases as the profitability to the monopolist (firm i) of that input price increases. Assumptions 1 - 5 are standard assumptions made in two-player alternating offer bargaining models.[20] While they do not include all cases of interest, one can show that they are satisfied in the present model under many downstream demand conditions including that of linear demand.

Equilibrium in the Market for Outbound Traffic

First, the equilibrium to the subgame just described is characterized. Given Assumptions 1 - 5, the following Lemma is a direct consequence of the results in Rubinstein (1982).

Lemma 1. Define the following functions:

$$f(a,a_j^M) = \underset{a' \in A(a_j^M)}{\text{argmax}}\ \pi_i(a',a_j^M) \text{ s.t. } U_i(a',a_j^M) \geq \delta U_i(a,a_j^M) \tag{13}$$

$$k(a,a_j^M) = \underset{a' \in A(a_j^M)}{\text{argmax}}\ U_i(a',a_j^M) \text{ s.t. } \pi_i(a',a_j^M) \geq \delta \pi_i(a,a_j^M) \tag{14}$$

$$S(a_j^M) = k(f(S(a_j^M),a_j^M),a_j^M)), \quad R(a_j^M) = f(S(a_j^M),a_j^M). \tag{15}$$

Under Assumptions 1 - 5, there is a unique subgame perfect equilibrium to the subgame after an initial agreement is reached in which the price $S(a_j^M)$ is agreed upon immediately.

The intuition for why S and R are SPE offers is straightforward. Observe that, conditional on firms always expecting S or R to be accepted whenever they are offered, the best the monopolist (resp. firm i) can do in each period in which it makes an offer is to offer an access charge maximizing its incremental profits subject to leaving firm i (resp. the monopolist) just indifferent between accepting, or waiting for the offer expected next period. It is easy to see that the offers in Lemma 1 satisfy these intuitive conditions. This completes the analysis of the subgame.

Proceeding backwards, the next step is to use Lemma 1 to derive equilibrium strategies in the subgames before either firm has reached agreement. Attention is restricted to stationary subgame perfect equilibria (SSPE) in which, if no agreement has been reached by time t, all firms expect an agreement at time t+1. Let a^* (resp. $\hat{a}$) be the SSPE offer of the monopolist (resp. each U.S. firm) in every period before an initial agreement is reached. By agreeing to the offer a' in period t, firm i receives (discounted to period t)

$$(16) \qquad (1 - \delta)\pi_m(a') + \delta\pi_i(a', S(a')),$$

since it earns monopoly profits for one period and expects firm j to agree to the price $S(a')$ in period t + 1. If it rejects a' firm i's expected profit depends on whether the monopolist continues negotiating with i or begins negotiating with firm j next period. If the monopolist switches to firm j, firm i receives

(17) $$\frac{\delta^2}{2} \pi_i(S(a^*),a^*)$$

since it expects firm j to agree to a^* in period t + 1 and then to agree to the Rubinstein equilibrium price in period t + 2. Hence, the best price the monopolist can receive in a SSPE in which it is switching is

(18) $$h(a^*) = \underset{a' \geq c}{\text{argmax}}\ (1 - \delta)U_m(a') + \delta U(a',S(a'))$$
$$\text{s.t. } (1 - \delta)\pi_m(a^*) + \delta\pi_i(a^*,S(a^*)) \geq \frac{\delta^2}{2}\pi_i(S(a^*),a^*)$$

Alternatively, suppose the monopolist does not switch. Then the best price firm i can induce the monopolist to accept is

(19) $$g(a^*) = \underset{a' \geq c}{\text{argmax}}\ (1 - \delta)\pi_m(a') + \delta\pi_i(a',S(a'))$$
$$\text{s.t. } (1 - \delta)U_m(a') + \delta U(a',S(a')) \geq \delta[(1 - \delta)U_m(a^*) + \delta U(a^*,S(a^*))]$$

The following regularity condition ensures that the present value of firm i's profits are nonincreasing.[21]

<u>Assumption 6</u>. $|S'| < 1$ and $\lim_{\delta \to 1} |S'| < 1$.

Since the present value of the monopolist's profits are nondecreasing in the range of prices over which there is a conflict of interest, the constraint in (19) along with Assumption 6 implies that $g(a^*) < a^*$; hence, in SSPE the monopolist always chooses to switch whenever its offer is rejected. In equilibrium we thus have

$$(20)\qquad a^* = h(a^*);\quad \hat{a} = g(a^*)$$

To examine equilibrium in the frictionless case in which $\delta \to 1$, we employ the following technical Lemma which is proved in the Appendix.

<u>Lemma 2</u>. There is some δ' such that, for all $\delta \in [\delta',1)$, the constraints in problems (13), (14), and (18) are binding in SSPE.

As $\delta \to 1$ suppose that $a^* \to a^M_{UR}$ and $S(\cdot) \to T(\cdot)$. Applying Lemma 2, the constraint in (18) implies that

$$(21)\qquad \pi_i(a^M_{UR}, T(a^M_{UR})) = \pi_i(T(a^M_{UR}), a^M_{UR})$$

By Assumption 3, this implies that $a^M_{UR} = T(a^M_{UR})$.

It remains to examine S as $\delta \to 1$. Consider problems (13) and (14). Expanding the RHS of both constraints about the price on the LHS of each constraint yields

$$(22)\qquad \frac{\partial U_i(t, a^M_j)/\partial a_i}{U_i(R, a^M_j)} = \frac{(1 - \delta)}{\delta} \frac{1}{(S - R)}$$

and

$$(23)\qquad \frac{-\pi_i(S,a_j^M)}{\partial\pi_i(v,a_j^M)/\partial a_i} = \frac{\delta}{(1-\delta)}(S-R)$$

for some t, v ϵ [R,S]. Since the LHS of (23) is bounded, $R \rightarrow S$ as $\delta \rightarrow 1$, and therefore t and v also converge to the same price. Hence, multiplying (22) by (23) and taking the limit as $\delta \rightarrow 1$ yields

$$(24)\qquad \frac{\partial U_i(T,a_j^M)}{\partial a_i}\pi_i(T,a_j^M) + \frac{\partial\pi_i(T,a_j^M)}{\partial a_i}U_i(T,a_j^M) = 0.$$

Since $T = a_j^M$ in the limiting equilibrium, we have

<u>Proposition 1</u>. Let a_{UR}^M be a limiting SSPE price in the unconstrained regime. Then a_{UR}^M solves

$$(25)\qquad \frac{\partial U_i(a_{UR}^M,a_{UR}^M)}{\partial a_i}\pi_i(a_{UR}^M,a_{UR}^M) + \frac{\partial\pi_i(a_{UR}^M,a_{UR}^M)}{\partial a_i}U_i(a_{UR}^M,a_{UR}^M) = 0$$

To interpret the limiting equilibrium, observe Figure 4, where the functions $T_i(a_j) = T(a_j)$, $i \epsilon \{1,2\}$ and the profit contours of the foreign monopolist are illustrated in access charge space. Define the access charge at which the foreign monopolist *exercises price leadership* in the market for U.S. originated traffic as

$$(26)\qquad a^L = \text{argmax}\ \{U(a,a)\ |\ a \geq c\}.$$

From (25), it is clear that $\partial U_i/\partial a_j > 0$ in SSPE; hence, T_i intersects the 45 degree line below a^L, as shown in the figure.

The key idea is that when the time between offers is small, firm i rejects offers greater than $T_i(a_i^M)$ if it then expects firm j to agree to a_i^M next period. For, after rejecting such an offer, i expects to wait a very short time before receiving a lower price, $T_i(a_j^M)$, a short time later. Similarly, the monopolist rejects offers from i less than $T_i(a_j^M)$ if it then expects to agree to a_j^M next period. These two conditions, along with the condition that the agent chosen to propose makes an offer maximizing its profits subject to expecting acceptance, imply that the only SSPE offers are given by a_{UR}^M, the price at which T_1 intersects T_2.

Since, $a_{UR}^M < a^L$, the monopolist does not exercise price leadership in the SSPE to the bargaining game. It is prevented from doing so by each U.S. firm's ability to credibly reject a high price, expecting to agree to a lower price a short time later. This threat is credible because the second firm to reach agreement has bargaining power. That is, given an agreement between the monopolist and firm i, adding firm j shifts out the derived demand for access to the monopolist's network, creating additional surplus over which the monopolist and firm j bargain. It should not be surprising that the monopolist generally does not receive all the surplus in this phase of the negotiation, and therefore, that forward looking U.S. firms do not accept inordinately high prices early in the negotiations before either has reached agreement.[22]

The Unconstrained Regime: Inbound Traffic

Next, consider the market for traffic terminating in the U.S. The foreign monopolist controls the allocation of U.S. bound traffic across U.S. carriers and can shift among them instantaneously at almost no cost, provided each U.S. carrier's capacity is not constrained. But capacity is readily available, and it appears that firms can increase it very quickly to handle potentially profitable inbound traffic.[23] Except for the fact that there is only one buyer, this is a classic example of Bertrand competition with U.S. firms competing for foreign inbound traffic. It is well known that, if sellers have constant marginal cost, no capacity constraints, and face downward sloping market demand, the unique Bertrand equilibrium access charge equals marginal cost.

It turns out that a noncooperative bargaining model similar to that in Figure 3 yields the Bertrand equilibrium as its unique SSPE. Intuitively, suppose the monopolist offers the price w in every period and switches after either firm rejects this offer. Since the monopolist decides which U.S. firm carries its traffic after access charges have been negotiated, it will never agree to a higher access charge in the subgame after agreeing to w. Hence, neither U.S. firm has any incentive to reject w, since it cannot obtain a better alternative by waiting.

<u>Proposition 2</u>. In the unconstrained regime, the equilibrium price paid for access to the U.S. network is $a^{U}_{UR} = w$.

An interesting property of the equilibria described in Propositions 1 and 2 is their relationship to the axiomatic bargaining model of Nash (1950). Assuming that the frontier of the set

$$\{(U_i,\pi_i) \mid U_i = U_i(a_i,a_j),\ \pi_i = \pi_i(a_i,a_j)\}$$

is concave, Binmore (1986) has shown that the price $T(a_j^M)$ satisfies Nash's axioms in the bilateral bargaining problem between firm i and the monopolist. It is not difficult to show that, in international markets with two-way traffic, the prices (a_{UR}^M, a_{UR}^U) satisfy Nash's axioms in the bilateral bargaining between the monopolist and each U.S. carrier simultaneously.

4. Bargaining Under the USP

It is useful to begin the analysis of the USP by considering only the price discrimination constraint in the market for traffic originating in the U.S. Prior to the initial agreement, negotiations proceed in the same way as in the unconstrained regime. After an initial agreement is reached with firm j, however, the only decision made by the monopolist and firm i is whether to begin service at the access charge already established in the first agreement.

Casual arguments at the Commission suggest that the price discrimination constraint should make it more difficult for the foreign monopolist to exercise any advantages it might have in negotiating access charges. The following Proposition, however, argues that just the opposite is true in the noncooperative bargaining model of this paper.

<u>Proposition 3</u>. Suppose price discrimination is forbidden in the market for traffic originating in the U.S. Then, as $\delta \to 1$, the unique subgame perfect equilibrium access charge approaches a^L. That is, the foreign monopolist exercises price leadership.

<u>Proof</u>: Define a^L_δ by

$$(27) \qquad a^L_\delta = \text{argmax } \{(1 - \delta)U_m(a) + \delta U(a,a) \mid a \geq c\}$$

Existence is demonstrated by constructing the equilibrium. Consider the following strategies. The monopolist plans to offer a^L_δ in every period, to switch whenever either U.S. firm refuses a^L_δ, and to accept any offer greater than or equal to $\hat{a}$, where

$$(28) \qquad \hat{a} = \underset{a \geq c}{\text{argmax}} \; (1 - \delta)\pi_m(a) + \delta\pi(a,a) \quad \text{s.t.}$$

$$(1 - \delta)U_m(a) + \delta U(a,a) \geq \delta[(1 - \delta)U_m(a^L_\delta) + \delta U(a^L_\delta,a^L_\delta)]$$

Each U.S. firm offers $\hat{a}$ and accepts offers less than or equal to a^L_δ.

Observe that, since bargaining effectively ends after an initial agreement is reached, neither U.S. firm can credibly reject a^L_δ given the monopolist's strategy. For, by doing so, it expects to agree to the same price two periods later. Clearly, the monopolist has no incentive to offer a higher price, and it receives at least as much by accepting $\hat{a}$ at time t as it does by waiting for a^L_δ at time t+1. Hence, these are SPE strategies. As $\delta \to 1$, $a^L_\delta \to a^L$.

The proof of uniqueness is less intuitive and therefore is presented in the appendix. Q.E.D.

Consider the mechanism transferring price setting power to the foreign monopolist. There are two phases of the negotiations. Phase one is all the subgames beginning in periods before an initial agreement is reached. Phase two is the subgame after an initial agreement is reached. In the unconstrained regime, the monopolist is not a price leader in the market for traffic originating in the U.S. because each firm has bargaining power in phase two. The price discrimination constraint, however, provides the monopolist with a credible commitment not to bargain in phase two. Since it has all the bargaining power in phase one, this allows it to credibly commit to a take-it or leave-it price.

Let us now turn to the regime in which the USP is enforced in markets with two-way traffic. The proof of Proposition 3 relies on two factors present when the price discrimination constraint is enforced. First, by switching after either U.S. firm rejects an offer, the monopolist effectively makes all the offers in the phase of the game prior to the initial agreement. Second, the price discrimination constraint prevents bargaining from occurring in the subgame after the initial agreement is reached. It should be apparent that neither factor is affected by introducing two-way traffic and the 50-50 division of tolls into the model. That is, define

$$\tilde{U}(a) = F(y(a))y(a) - (a + c)y(a) + (a - c)X(a) \tag{29}$$

to be the monopolist's equilibrium profits under the USP, and let a^{M*} maximize $\tilde{U}$ subject to $a \geq c$. An argument nearly identical to that presented in the proof of Proposition 3 implies

<u>Proposition 4</u>. Under the USP, the foreign monopolist sets the take-it or leave-it uniform access charge a^{M*} in the unique (limiting) SPE of the bargaining model.

Noncooperative bargaining models of this sort are not known for being robust to small changes in the structure of the game. One might suspect, therefore, that the ability of the monopolist to unilaterally set the access charge under the USP is due to the advantage it has in always making the first offer after switching. I have also considered an alternative game in which the identity of the proposer in each period is chosen randomly. In this game, each offer is a vector, (a,ρ_i) where ρ_i is firm i's proposed share of U.S. inbound traffic. Subgame perfect equilibria under the USP rely heavily on the monopolist's threat to divert traffic away from U.S. carriers refusing to agree. It turns out that this threat is always enough to allow the monopolist to set a take-it or leave-it uniform access charge in a stationary subgame perfect equilibrium when the USP is enforced.[24]

The advantage of the present model is that it straightforwardly illustrates the role the USP plays in providing the monopolist with a credible commitment. *By assumption*, the sequence of moves is such that the monopolist has more bargaining power than U.S. firms before the first agreement is reached. Hence, it is not necessary to consider the effects of allowing the monopolist to threaten to divert traffic away from U.S. firms refusing to agree in order to get monopoly price leadership in equilibrium under the USP. In the more symmetric game in which U.S. firms make "half" of all the offers before an initial agreement is reached, this threat becomes important. In either case, however, the monopolist has the advantage early in the negotiations before the first agreement is reached. The role of the USP is to provide it with a commitment not to engage in more symmetric bargaining in the subgame after reaching that agreement.

5. The Price, Profit, and Welfare Effects of the USP

The main utility of Proposition 4 is that it allows the welfare effects of the USP to be studied by examining a simple constrained optimization problem. The foreign monopolist solves

$$(30) \qquad \max \{F(y(a))\, y(a) - (a + c)\, y(a) + (a - c)\, X(a) \mid a \geq c\}$$

Recognizing that y(a) is the optimal foreign level of service for any a, the Kuhn-Tucker necessary conditions are

$$(31) \qquad - y(a^{M*}) + X(a^{M*}) + (a^{M*} - c)\, \frac{\partial X(a^{M*})}{\partial a} + \lambda = 0,$$

$$\lambda \geq 0, \quad a^{M*} - c \geq 0, \quad \lambda(a^{M*} - c) = 0.$$

Since $\partial X/\partial a < 0$, the constraint binds ($a^{M*} = c$) whenever $X(a^{M*}) < y(a^{M*})$. Hence, the USP lowers the uniform access charge to foreign marginal cost in markets where the net flow of traffic is inbound to the U.S. Interestingly, this unambiguously improves welfare over the unconstrained regime whenever $w = c$. (See Figure 5). Thus, there is a normative justification for the USP in markets where, under the USP, the net traffic flow is inbound to the U.S.

When $X(a^{M*}) > y(a^{M*})$, the constraint in (30) no longer binds; i.e. $a^{M*} > c$. Whether a^{M*} is higher or lower than a^{M}_{UR} depends on the relative volumes of U.S. outbound and inbound traffic. To see this, introduce the shift parameter $\alpha \geq 0$ into the derived demand for access to the U.S. network by writing it as $y(a,\alpha)$, where $\partial y/\partial\alpha > 0$, $y \to \infty$ as $\alpha \to \infty$, and $y(a,0) = 0$. As α approaches zero, foreign outbound traffic falls to zero, and $a^{M*}(\alpha)$ approaches a^{L}. As α grows large, foreign outbound traffic grows relative to U.S. outbound traffic, and a^{M*} approaches c. If $c \geq a^{M}_{UR}$ for all α, then $a^{M*}(\alpha) > a^{M}_{UR}$ for all α. If $c < a^{M}_{UR} < a^{L}$, then assuming that $a^{M*}(\alpha)$ is continuous there is some α' such that $a^{M*}(\alpha') = a^{M}_{UR}$. Since $a^{M*}(\alpha)$ is monotonically decreasing in α,[25] it follows that for all $\alpha < \alpha'$, $a^{M*}(\alpha) > a^{M}_{UR}$.

Since final product price is an increasing function of the uniform access charge in Cournot equilibrium, these conclusions can be summarized as follows.

<u>Proposition 5</u>. Suppose $w = c$. Then the uniform settlements policy reduces the price of U.S. service whenever, under the USP, the volume of traffic originating overseas is greater than the volume originating in the U.S. When $w < c$ the effects of the USP are uncertain. However, if U.S. inbound traffic is low enough relative to its outbound traffic, then the USP raises the price of U.S. service.

Next, consider the effects of the USP on U.S. profits. When X < y and w = c, the USP increases the profits of U.S. firms. This follows because the charge for access to the U.S. network equals marginal cost in either regime, while that paid by U.S. carriers in the unconstrained regime (a^M_{UR}) is higher than that paid under the USP (c). On the other hand, there are some values of α for which the USP raises U.S. price but also raises the profits of U.S. firms. This follows because when $\alpha = \alpha'$, the USP raises the access charge paid to U.S. firms (from c to a^M_{UR}) but leaves the charge they pay unchanged. As α falls, however, the loss in profits due to the resulting increase in marginal cost eventually outweighs any gains in revenues from inbound traffic. These arguments are summarized as

Proposition 6. Suppose w = c. Then the uniform settlements policy increases the profits of U.S. firms whenever, under the USP, the volume of traffic originating overseas is greater than the volume originating in the U.S. When w < c the effects of the USP on U.S. profits are uncertain. However, if U.S. inbound traffic is low enough relative to its outbound traffic then the USP reduces the profits of U.S. firms.

It follows from Propositions 5 and 6 that, if y is small enough relative to X, the USP reduces U.S. welfare. This can be seen with the aid of Figure 6. When y is relatively large, equilibrium access charges under the USP yield higher U.S. welfare (US^o_{USP}) than equilibrium in the unconstrained regime (US^o_{UR}). As y becomes less important, the iso-US contours eventually become negatively sloped

(US^1_{USP} and US^1_{UR} in Figure 6). Since a^{M*} eventually rises above a^M_{UR}, it follows from the negative slope of U.S. welfare contours that, as y falls, the USP eventually reduces welfare.

While these conclusions are not as sharp as one would like, they do give the policy maker some basis for judging the USP. In many telex markets, most notably those of Western Europe, U.S. firms carry more inbound than outbound traffic. Hence, Proposition 5 suggests that if U.S. and foreign carriers share the same technology, the policy reduces the price of final service; Proposition 6 suggests that it raises the profits of U.S. carriers. Since European costs are probably fairly close to those in the U.S., this model predicts that the USP has probably raised welfare in European telex markets.

It is instructive to consider the important role in this result of the 50-50 division of tolls. In the unconstrained regime, Bertrand-like competition drives a^U down to marginal cost, but a^M is greater than marginal cost because the foreign monopolist has some bargaining power in determining the price for access to its network. Consider the effects of enforcing only the price discrimination constraint. Proposition 3 argues that forbidding price discrimination allows the monopolist exercise price leadership (i.e. charge a^L) in the market for access to its network. This is the worst possible scenario — the monopolist has complete control over both the price it charges and the price it pays U.S. firms. Enforcing the 50-50 division compels the monopolist to consider how raising the access charge affects its own marginal cost of outbound traffic. When it originates more traffic then it receives the monopolist reduces the access charge to marginal cost.

Voice and telegraph markets are different stories altogether. Propositions 5 and 6 suggest that the USP may reduce U.S. welfare in many of these markets, since the volume of traffic from the U.S. to the foreign country often exceeds the volume flowing in the opposite direction. The likelihood that this occurs grows as U.S originated traffic grows relative to that originated overseas.

Traffic disparities were quite large in the markets involved in both the COMTELCA and CEPT telegrams. In the former, U.S. originated traffic was over three times larger than traffic flowing in the opposite direction for all countries except El Salvador. Similarly, U.S. outbound traffic was double that of inbound traffic in many of the CEPT countries. Unfortunately the model does not provide a simple summary statistic saying how large the disparity must be for the policy to reduce welfare.

In the *Order on Reconsideration* (FCC 1987), the FCC was careful to point out that "uniformity is not an end in itself." They state that "departures from uniformity are permissible if the particular departure does not conflict with [the] objectives [for fair treatment of U.S. carriers, and low rates for U.S. consumers]."[26] The mechanism allowing non-uniformity to occur is simple. The carrier desiring to operate at a non-uniform rate applies to the Commission for a waiver of the policy, and if the Commission takes no action after some amount of time (60 days for telex and telegraph, 10 days for voice) the application is granted.

While there are numerous examples of strong enforcement in telex and telegraph, the early indications are that the weaker stance adopted toward voice is being born out in practice. Between 1985, the year MCI and Sprint entered the voice market, and February 1987 the FCC received 37 applications for waiver of the USP for voice service to a total of 61 countries. None of those requests were opposed or even commented upon.[27] The "per se" approach adopted in telex and the "rule of reason" approach adopted in voice are consistent with the model's relatively sharp predictions for European telex, its ambiguous predictions for voice. This same view, however, would recommend a rule of reason approach in the telegraph market, an approach that has not always been adopted there.

6. Concluding Comments

The main achievement of this paper is that it offers an explanation of two apparent instances of price-setting behavior on the part of foreign monopolists in the international telegraph market. Casual arguments at the Commission seem to suggest that, in their view, the uniform settlements policy makes it more difficult for the foreign monopolist to "whipsaw" U.S. carriers. The model in this paper predicts that just the opposite is true. That is, by constraining agreements to be identical, the USP provides the foreign monopolist with a credible commitment not to bargain with additional U.S. firms after an initial agreement has been reached. Due to the bargaining advantage it holds before reaching the first agreement, the monopolist is thus able to credibly set a take-it or leave-it price.

It should be clear that results in this paper extend to markets other than those found in international telecommunications. In particular, Proposition 3 has implications for the effects of forbidding third degree price discrimination in many markets (i.e. those satisfying assumptions 1 - 6) in which an upstream monopolist bargains with downstream firms. In such markets, a rule forbidding price discrimination can act as a credible commitment for the monopolist not to place itself in a bilateral bargaining situation after establishing price with one of the buyers. To the extent that the monopolist has an advantage in negotiating the first price, this commitment is likely to benefit the monopolist.

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Appendix

Proof of Lemma 2.

Suppose the constraint in problem (13) does not bind. Then for all $\delta < 1$, firm i can reduce its offer below R by a small amount while still satisfying the constraint. By Assumption 3 this increases firm i's profits, contradicting the definition of R.

Next, suppose that for all $\omega > 0$, there exists some $\delta' \in (1-\omega,1)$ such that the constraint in problem (14) does not bind. This implies that there is a sequence $\{\delta_t\} \to 1$ such that $\partial U_i(S(a_j^M),a_j^M)/\partial a_i = 0$ for all $\delta_t > 1-\omega$, and therefore that $\partial U_i(S(a_j^M),a_j^M)/\partial a_i \to 0$. I will show that this yields a contradiction.

In equilibrium, U_i is non-decreasing in a neighborhood below both S and R; otherwise both the monopolist and firm i would want to reduce price. Since the constraint in problem (13) binds, this implies that $S > R$ for δ close to 1. Furthermore, by the continuity of U_i and the fact that the constraint in problem (13) binds, either $U_i \to 0$, or $S \to R$ as $\delta \to 1$. But $U_i \to 0$ and Assumption 1 together imply that $\partial U_i/\partial a_i \not\to 0$, yielding a contradiction.

Suppose, then, that $S \to R$. Expanding the right hand side (RHS) of each constraint about the price on the LHS of that constraint and rearranging the resulting expressions yields

$$\text{(A1)} \qquad \frac{-\pi_i(S,a_j^M)}{\partial \pi_i(v,a_j^M)/\partial a_i} > \frac{\delta}{(1-\delta)}(S - R)$$

and

$$\text{(A2)} \qquad \frac{\partial U_i(t,a_j^M)/\partial a_i}{U_i(R,a_j^M)} = \frac{(1-\delta)}{\delta}\,\frac{1}{(S-R)}$$

where t, v ϵ [R,S]. Since $S \to R$, t and v also converge to the same price, call it $\bar{a}$. Multiplying equation (A1) by (A2) and taking the limit as $\delta \to 1$ yields $0 > 1$, which is a contradiction. Therefore, there exists ω such that the constraint in (14) binds for all $\delta \in (1-\omega,1)$.

Next, suppose that the constraint in (18) does not bind. Then $\partial U(a_{UR}^M, a_{UR}^M)/\partial a_1 + [\partial U(a_{UR}^M, a_{UR}^M)/\partial a_2]\ T'(a_{UR}^M) = 0$, which implies that $T'(a_{UR}^M) = -1$ or $\partial U_i/\partial a_i = \partial U/\partial a_i = 0$. The former contradicts Assumption 6, the latter contradicts the preceeding paragraph.

<u>Proof of Proposition 3</u>: Let $\bar{U}(a) = (1 - \delta)U_m(a) + \delta U(a,a)$ and $\bar{\pi}(a) = (1 - \delta)\pi_m(a) + \delta\pi(a,a)$. Define,

G_0 = the subgame beginning in any period t in which the monopolist is about to propose a price,

G_1 = the subgame beginning in any period t at the node in which the monopolist decides whether to stay or switch,

G_2 = the subgame beginning in any period t in which firm i is about to propose a price.

$$A_i = \left\{ a \mid \text{there is a SPE in the game } G_i \text{ in which the monopolist receives } \bar{U}(a) \text{ in present value} \right\},$$

and let $m_i = \inf A_i$, $i \in \{0,1,2\}$.

The method of proof is to show that $m_0 = a_\delta^L$, and therefore that the only equilibrium to the game is that in which the monopolist offers a_δ^L . The proof proceeds by first verifying three claims.

<u>Claim 1</u>. $\bar{U}(m_1) = \max \{\delta\bar{U}(m_0), \delta\bar{U}(m_2)\}$.

<u>Proof</u>: The first term on the RHS of the equation is the least the monopolist receives by switching; the second term is the least it receives by staying. Since the monopolist can always guarantee itself the maximum of these two by deciding whether to stay or switch, the least it can possibly receive in any SPE to G_1 is the maximum of these two possibilities. Q.E.D.

<u>Claim 2</u>. $\bar{U}(m_2) \leq \delta\bar{U}(m_0)$.

<u>Proof</u>: Suppose $a \in A_0$, and let $a'(a)$ be given by $\bar{U}(a'(a)) = \delta\bar{U}(a)$. Consider the following strategies in G_2: firm i offers $a'(a)$, and the monopolist accepts all offers greater than or equal to $a'(a)$. If agreement is not reached immediately then all players continue with the strategies supporting the SPE outcome, a, in the subgame G_0 beginning in the following period. These are SPE strategies. To see this note that, by construction, the monopolist is indifferent between

accepting or rejecting $a'(a)$. And since $\bar{U}$ is nondecreasing, $a'(a) \le a$, which implies that firm i does worse by offering less than $a'(a)$, inducing the monopolist to reject. Hence, for all $a \in A_0$, $\bar{U}(a'(a)) = \delta\bar{U}(a)$ implies that $a'(a) \in A_2$. In particular, $a'(m_0) \in A_2$ where $\bar{U}(a'(m_0)) = \delta\bar{U}(m_0)$, and therefore $\bar{U}(m_2) \le \delta\bar{U}(m_0)$ by the definition of m_2.

<u>Claim 3</u>. $\bar{U}(m_1) = \delta\bar{U}(m_0)$. That is, the monopolist switches in the equilibrium to G_1 in which it receives $\bar{U}(m_1)$.

<u>Proof</u>: Suppose $\bar{U}(m_1) = \delta\bar{U}(m_2)$, or that the monopolist does not switch. Then, from Claim 2, $\bar{U}(m_1) = \delta\bar{U}(m_2) \le \delta^2\bar{U}(m_0)$. This is a contradiction, since the monopolist can always receive at least $\delta\bar{U}(m_0)$ by switching. Hence, the monopolist switches in the equilibrium to G_1 in which it receives $\bar{U}(m_1)$. Q.E.D.

Claims 1 - 3 can now be used to prove the Proposition. Suppose $m_0 < a_\delta^L$. Since the monopolist is switching, the most that firm i can receive by rejecting an offer is $\delta^2\bar{\pi}(m_0)$ if it is the first to agree to m_0 in two periods. Therefore, the monopolist can guarantee itself $\bar{U}(\tilde{a})$ by offering $\tilde{a} = \text{argmax } \{\bar{U}(a) \mid \bar{\pi}(a) \ge \delta\bar{\pi}(m_0),\ a \ge c\}$. Since $\bar{\pi}$ is decreasing, either $\tilde{a} > m_0$, or $m_0 = a_\delta^L$. The former case cannot be true, since then there is not a SPE to G_0 in which the monopolist receives an amount arbitrarily close to $\bar{U}(m_0)$. Hence, $\tilde{a} = m_0 = a_\delta^L$. Q.E.D.

Notes

1."Order in the Matter of Preliminary Audit," Docket No. 20778, released January 29, 1980, pp. 1-2. Eward (1985) and Snow (1986) provide good summaries of other important changes occurring in international telecommunications.

2.Readers familiar with the international telecommunications settlements formula should note that under the USP what I term the "access charge" is termed "one half the accounting rate" in policy discussions. The accounting rate refers to the basic "unit of account" from which carriers in particular country-pair markets determine the access charge they pay. The "division of tolls" determines what share of the accounting rate each country pays. For example, suppose the accounting rate between the U.S. and France is $2.00, and the division of tolls is 75-25 in favor of France. Then France pays the U.S. $.50 per call-minute for access to the U.S. network, while the U.S. pays French Telecom $1.50 per call-minute for access to the French network. In this terminology the USP requires all U.S. carriers to 1) agree to the same accounting rate and 2) agree to a 50-50 division of tolls. It should be clear that the distinction is only in terminology, not in substance.

3.See section 5 for a discussion of how the voice procedures are currently enforced.

4.This is the approach taken, for example, by Katz (1987) in his analysis of the welfare effects of intermediate product third degree price discrimination.

5.See the section 5 for a discussion of how the rules have been relaxed for the voice market.

6.FCC 1985, 28419.

7.FCC 1936, 599.

8.FCC 1980, 128.

9.See, for example, FCC (1974) and (1977), where TRT Communications, an international telex and telegraph carrier, was not allowed to implement a lower non-uniform access charge for telex service between the U.S. and the United Kingdom; see also FCC (1985), (1986), and (1987) for other recent examples.

10.This has also been pointed out by Kwerel (1984).

11.COMTELCA (Comision Tecnica Regional de Telecomunicaciones) is composed of the telecommunications administrations of Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua. The U.S. telegraph carriers operating in these markets were Western Union International, Western Union Telegraph Co., FTC Communications, ITT World Communications, MCI International, RCA Global Communications, and TRT Communications. See (FCC 1985, 28421).

12.FCC 1985, 28422.

13.While the average price per word for service to Costa Rica declined, the price to the other four countries rose by an average of 5 percent from 1982 to 1984.

14.CEPT (Conference European des Administrations des Postes et des Telecommunications) is composed of 26 European PTTs. The countries involved were Austria, Belgium, Finland, France, West Germany, Ireland, Luxembourg, Netherlands, Norway, Spain, Sweden, Switzerland, and Yugoslavia.

15.FCC 1985, 28421.

16.It is straightforward to allow for more than two carriers in the U.S.

17.The qualitative conclusions of this paper hold when this assumption is relaxed. See O'Brien (1989).

18.In fact, there have been many cases in which U.S. carriers have agreed to originate, but not terminate, traffic.

19.One could allow the monopolist or either buyer to choose to leave the game at any time, but these strategies are strictly dominated by choosing to continue bargaining.

20.See, for example, Binmore, Rubinstein, and Wolinsky (1986).

21.It can be shown that this assumption holds when downstream demand is linear.

22.There are also non-stationary asymmetric equilibria in which one firm ends up paying a higher access charge than the other. Since U.S. firms are symmetric in this model, the restriction to symmetric equilibria seems natural. Intuitively, this amounts assuming that "special relationships" of the type examined by Rubinstein and Wolinsky (1987) do not form between the monopolist and either U.S. firm.

23. Firms in the industry have noted that carriers can add additional capacity in a matter of weeks. See "Implementation and Scope..., Report and Order", p. 4742.

24.The details can be found in O'Brien (1988) chapter 5, which is available upon request.

25. That is, $\partial a^{M*}/\partial \alpha = (\partial y/\partial \alpha)/U'' < 0$ by the sufficient second order condition to (30).

26. FCC 1987, 1118.

27. FCC 1987, 1126.

Figure 1

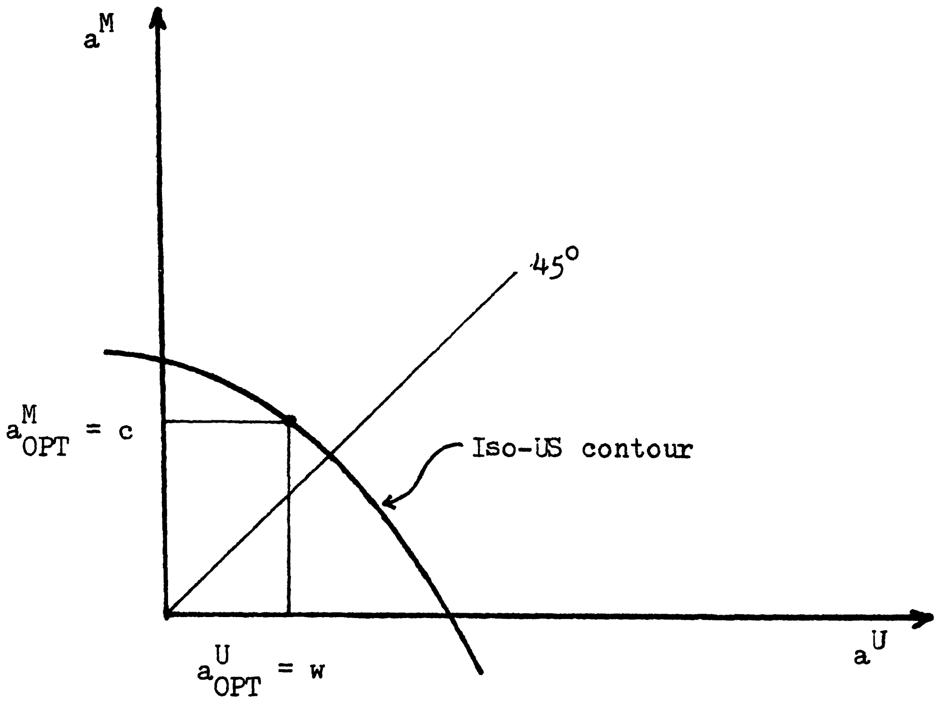


Figure 2

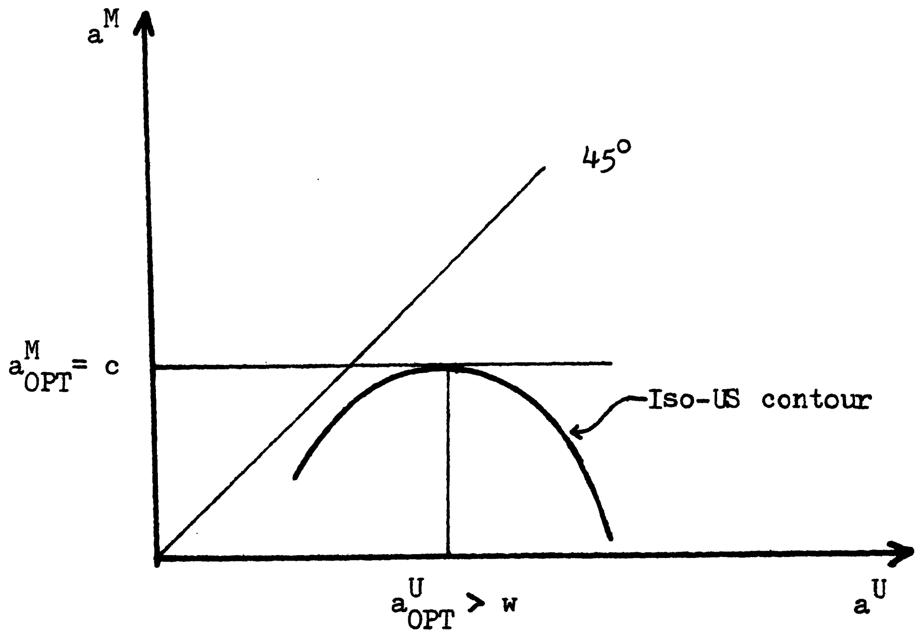
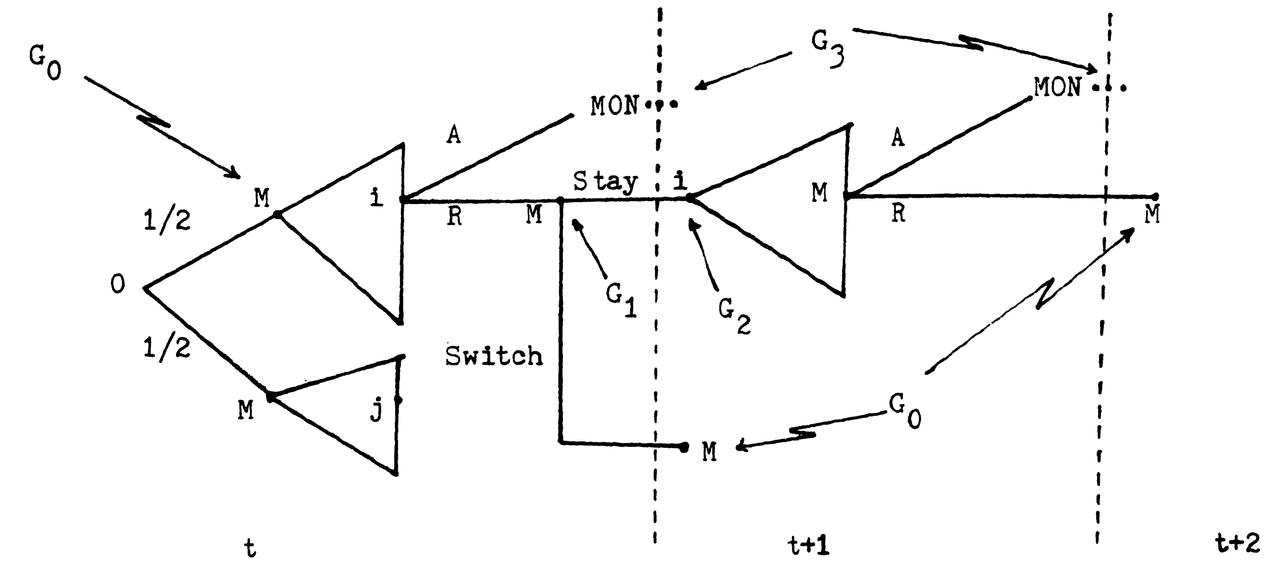


Figure 3



A = "Accept"
R = "Reject"
O = Random Chance Move
MON = Begin Monopoly Level of Service
CNE = Begin Cournot Level of Service

G_0 = Subgame beginning with M's offer before any agreements have been reached
G_1 = Subgame beginning with M's decision whether to stay or switch
G_2 = Subgame beginning with i's offer before any agreements have been reached
G_3 = Rubinstein subgame after an initial agreement has been reached

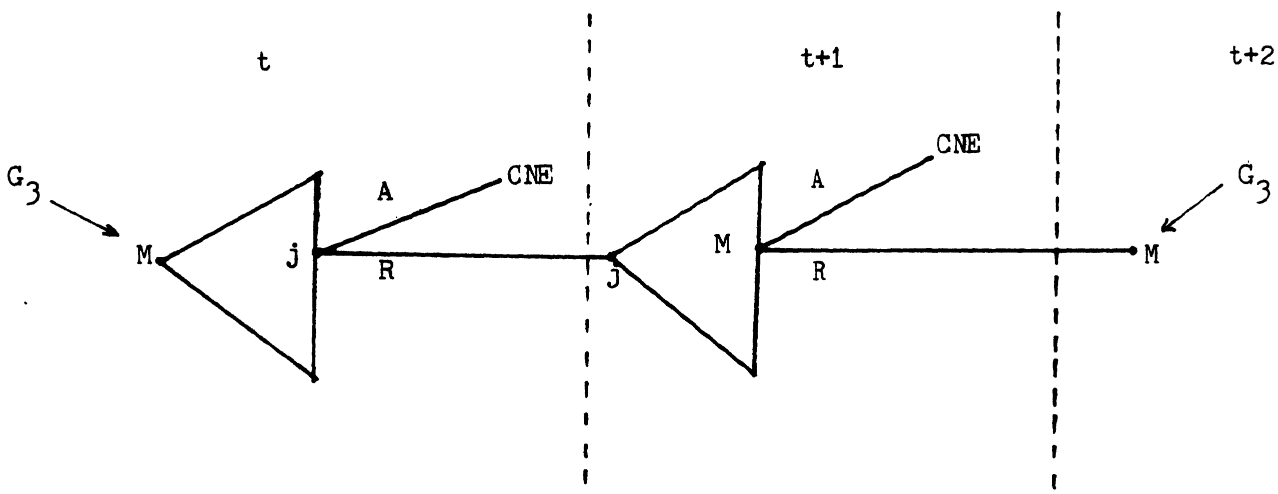


Figure 4

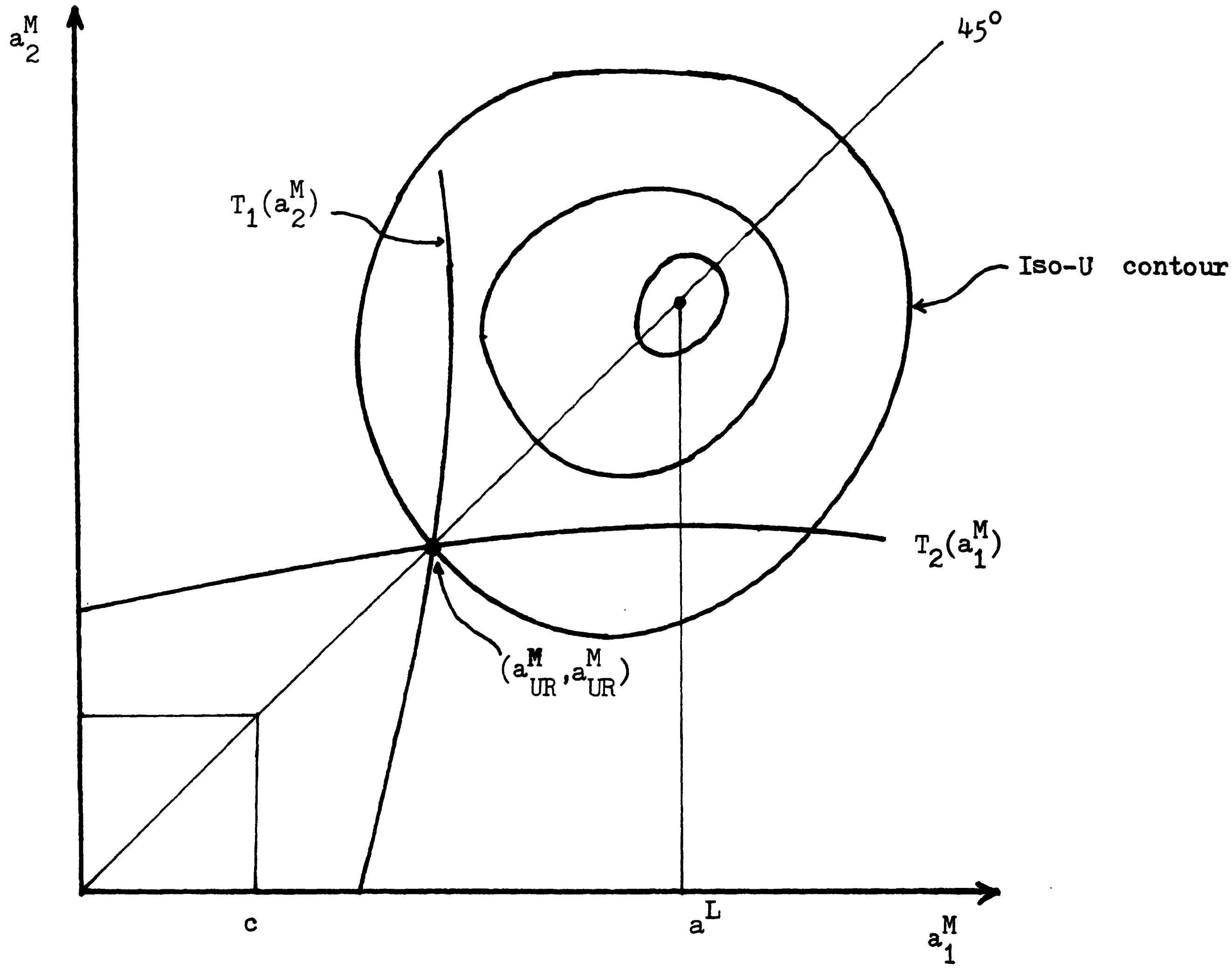


Figure 5

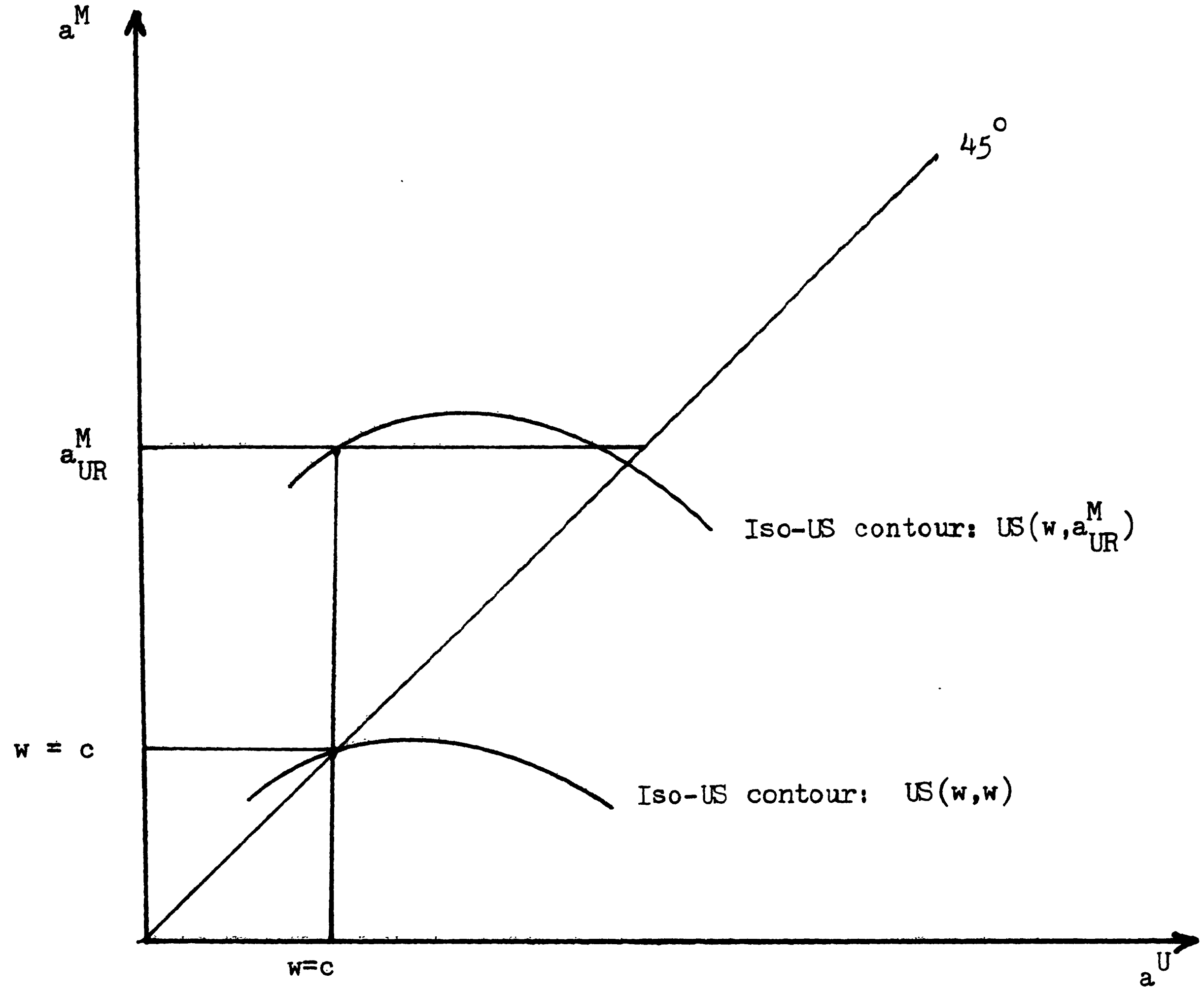
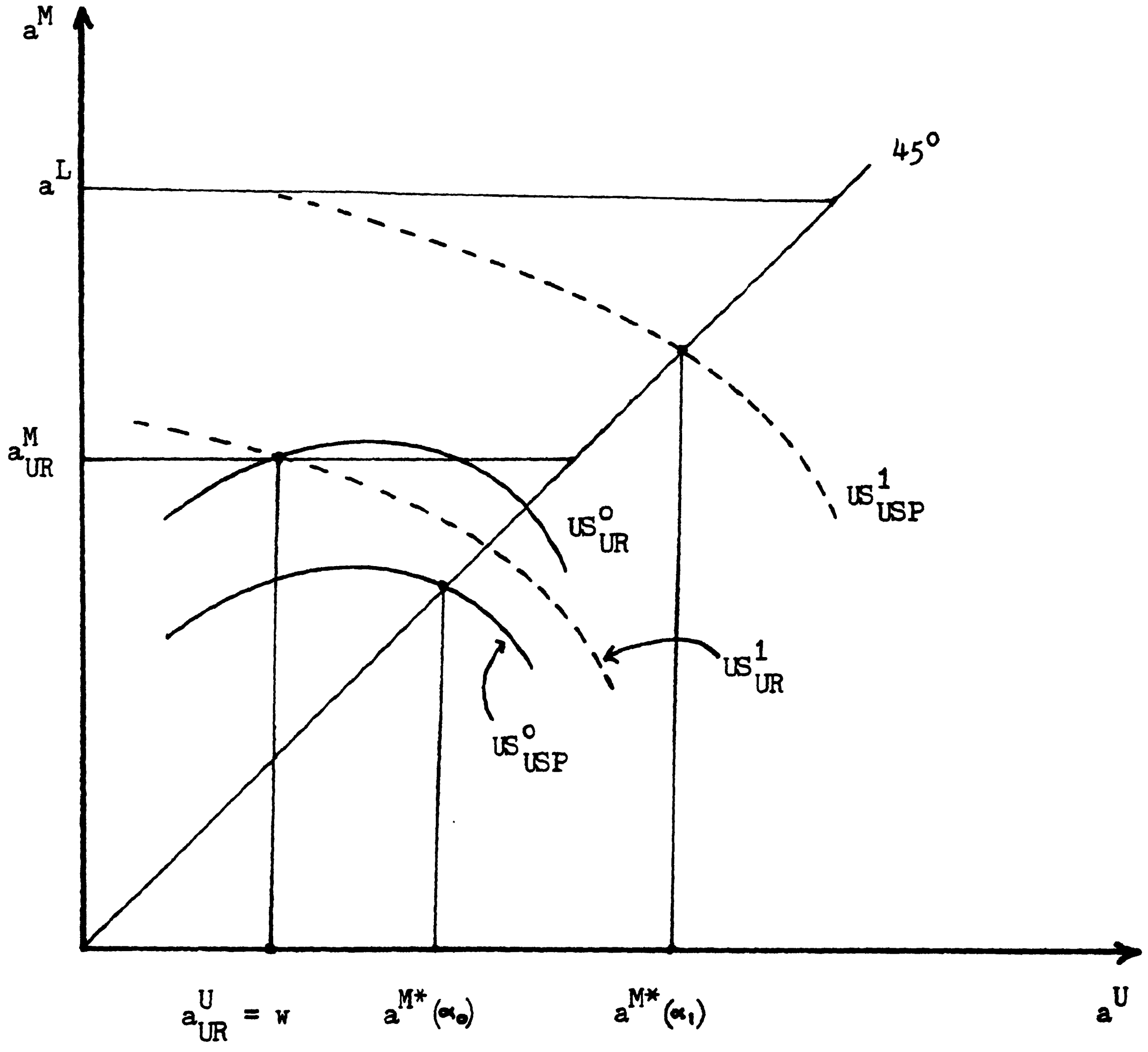


Figure 6



Notes: US^i_{UR} is the equilibrium Iso-US contour in the unconstrained regime when $\alpha = \alpha_i$.

US^i_{USP} is the equilibrium Iso-US contour under the USP when $\alpha = \alpha_i$.

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