The Implications of By-pass for Traditional International Interconnection

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Abstract

An important decision that international telecommunications carriers make is how much traffic to send under traditional international interconnection arrangements (settled traffic) and how much to send under new alternative arrangements (by-pass traffic). This paper presents an equilibrium model of home and foreign carriers' optimal routing choices for international traffic. The model suggests that movements in by-pass prices are likely to play a dominant role in determining the welfare implications of traditional international interconnection arrangements.

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Despite the vast amount of work on the economics of interconnection for telecommunications networks,[1] there has been relatively little analysis of international interconnection arrangements.[2] This is understandable, for it is not obvious why international interconnection arrangements should be distinguished from domestic arrangements. From a global welfare perspective, efficient international interconnection would entail an open, competitive market for international communications bandwidth and an efficient domestic interconnection regime that did not distinguish between domestic and international minutes. There would be no separate regulatory regime for international interconnection.

The history of international communications has, however, traced a distinctive institutional path.[3] National carriers conceptualized international telecommunications as a jointly provided service. They agreed upon collection rates (retail prices), the revenue from which was to be shared equally between the two carriers providing the service. When collection rates (retail prices) diverged in response to country specific factors, carriers continued to share equally rates that were then called "accounting rates".[4] International interconnection thus evolved as a system

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[1] See Armstrong, Doyle, and Vickers (1995), Baumol and Sidak (1994), Kahn and Taylor (1994), Katz, Rosston, and Anspacher (1995), Laffont and Tirole (1994), Mueller (1996), Ralph (1996), and Tye (1994), among others.

[2] A small body of academic work has analyzed these arrangements and alternative regulatory rules for international interconnection. Kwerel (1984; 1987) considered the effect of increasing competition among U.S. international carriers and Stanley (1991) described the problem of ballooning net U.S. international interconnection payments. O'Brien (1989) provided an interesting theoretical analysis of the impact of requiring uniform interconnection rates among U.S. carriers. Other economic models, which also focus on pricing issues, include Hakim and Lu (1993), Carter and Wright (1994), Cave and Donnelly (1996), and Yun, Choi, and Ahn (1997). Alleman, Rappoport, and Stanley (1991) analyzed accounting rate reform possibilities, and Alleman and Sorce (1997) and Galbi (1997) are further work in this area.

[3] See Ergas and Patterson (1991) for a discussion of the historical development of international interconnection.

[4] There is an economic logic for the persistence of this institution. See Galbi (1997).

of bilaterally agreed mutual, i.e. equal, termination rates. These mutual termination rates are traditionally called settlement rates, reflecting linguistically their "accounting" heritage.

The development of multiple international carriers in the United States led to new rules to support settlement rates. The Federal Communications Commission established rules that required uniform settlement rates among U.S. international carriers and that divided the market for terminating foreign-billed international traffic among U.S. carriers, on a country-by-country basis, in proportion to a U.S. carrier's share of domestic-billed international traffic with the corresponding country.[5] Other countries that have licensed multiple international carriers have sanctioned similar rules or are considering adopting such rules. Such rules are called proportional return rules, and international traffic that flows under such rules is known as settled traffic.

New opportunities for by-passing traditional settlement arrangements are rapidly emerging. Under the WTO, 52 countries have committed to liberalize opportunities for carriers to provide public switched voice international service independent of traditional settlement arrangements.[6] More generally, the broad-based move to competition in telecommunications in countries around the world, the convergence of different media to digital signals, the growth of the global internet, and the rapidly falling price of digital signal processing are increasing the number of technical and market possibilities for providing international voice communications.

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[5]See *Implementation and Scope of the International Settlements Policy for Parallel Routes*, CC Docket No. 85-204, 51 Fed. Reg. 4736 (Feb. 7, 1986), recon. 2 FCC 1118 (1987), further recon. 3 FCC Rcd 1614 (1988); *Regulation of International Accounting Rates*, 6 FCC Rcd 3552 (1991), recon. 7 FCC Rcd 8049, Fourth Report & Order, CC Docket No. 90-337, Phase II. This latter order outlines circumstances and means by which the FCC will waive its international settlements policy.

[6] More specifically, these countries have committed to allow public international switched voice service over resold private lines interconnected at both ends to the public switched network.

Internet telephony epitomizes these trends.

Alternative routing opportunities make traffic routing a strategic choice for carriers. This paper considers the implications of by-pass for traditional settlement arrangements. Section I analyzes, for a given volume of settled traffic from foreign carriers, the routing decisions of home carriers. Section II considers equilibria that encompass both home and foreign carrier routing choices. These equilibria show that flows of settled traffic may persist even when by-pass prices in both directions are below the settlement rate. As Section III and IV emphasize, the welfare implications of a given settlement rate depend significantly on by-pass prices. By-pass prices change rapidly in response to markets and technologies while settlement rates are typically negotiated within a sphere of government participation or oversight, with the deliberate speed characteristic of bureaucracies. Policy makers should thus recognize the limitations of their ability to manage through proportional return and settlement rate policies the division of welfare in international telecommunications.

I. Home Carriers' Routing Reaction Functions

This section will consider equilibria among n competing home carriers that send international traffic to a foreign country either as settled traffic under proportional return or as by-pass traffic (for which proportional return does not apply). While international carriers make a variety of important economic choices, the analysis focuses on cost-minimizing traffic allocations, given traffic volumes and international interconnection prices. Such a focus highlights the implications of by-pass for traditional settlement arrangements.

The model is defined as follows. The prices that home carriers face for sending home-billed settled traffic and by-pass traffic are p_a and p_b^F respectively, while the costs that home carriers incur for handling foreign-billed settled and by-pass traffic are c_a^H and c_b^H respectively. For home carrier i, T_i^H is total home-billed international traffic and s_i^H is the share of home-billed traffic sent via by-pass. Then home carrier i's net international interconnection expense is

$$(1)\quad X_i^H = p_a s_i^H T_i^H - p_a(1-\frac{c_a^H}{p_a})\frac{s_i^H T_i^H}{\Phi^H}\Phi^F + p_b^F(1-s_i^H)T_i^H$$

where Φ^H and Φ^F are total settled traffic from the home and foreign countries respectively.

The terms in (1) have straight-forward meanings. The first term represents the total interconnection expense for outgoing settled traffic, the second term represents profit from incoming settled traffic received under proportional return, and the third term represents the expense for outgoing by-pass traffic. Profit from terminating foreign carriers' by-pass traffic is not included in (1). This can be interpreted in two ways. If the amount of foreign by-pass traffic that carrier i terminates does not depend on the share of settled traffic it sends, then the former quantity does not affect the optimal choice of the latter. Alternatively, one can assume that the market for by-pass is competitive ($p_b^H=c_b^H$), so that carriers earn only a normal return on by-pass termination.[7]

Carriers route international traffic so as to minimize their net international interconnection expenses. Carrier i's marginal cost of sending a minute of traffic as settled traffic rather than as by-pass traffic is

$$(2)\quad \frac{dX_i^H / ds_i^H}{T_i^H} = p_a\left[1-\frac{p_b^F}{p_a}-\frac{\Phi^F\Phi_{\neq i}^H}{(\Phi^H)^2}(1-\frac{c_a^H}{p_a})\right]$$

[7] Note that handling by-pass traffic may be more costly than handling settled traffic.

where $\Phi_{\neq i}^H$ is settled traffic sent by all home carriers except home carrier i. Note that carrier i, such that i maximizes $\Phi_{\neq i}^H$, is the carrier with the smallest volume of settled traffic. Equation (2) thus shows that the carrier with the smallest amount of settled traffic has the lowest marginal cost of shifting traffic to the settlements regime. Note that the marginal cost to a particular carrier of sending settled traffic depends on how much settled traffic the other carriers send. In order to minimize (1), each carrier chooses s_i^H such that (2) equals zero.

Consider Nash equilibria with interior solutions to (2) for i=1,...,n.[8] Rearranging (2) shows that

$$(3)\quad \frac{\Phi_{\neq i}^H}{\Phi^H} = \frac{\Phi^H}{\Phi^F r^H} \quad where\ r^H = \frac{(1-\frac{c_a^H}{p_a})}{(1-\frac{p_b^F}{p_a})}$$

Since the right side of (3) does not depend on i, $\Phi_{\neq i}^H/\Phi^H = (n-1)/n$. Hence total settled traffic sent from the home country, Φ^H, is

$$(4)\quad \Phi^H = \frac{n-1}{n} r^H \Phi^F$$

The above Nash equilibrium among home carriers implies a *threshold routing rule*. Home carriers, which may have different total traffic volumes to a given country, choose their settled traffic shares so that each carrier sends an equal amount of settled traffic. In particular, in an interior solution, each home carrier sends Φ^H/n minutes of settled traffic, where Φ^H is given by (4). Additional traffic $T_i^H - \Phi^H/n$ is sent via by-pass. The intuition for this result is the following.

[8] This means that $s_i^H<1$ for all i. As will be apparent subsequently, if $\Phi^F>0$, there are no solutions with $s_i^H=0$ for some i.

Because of proportional return, the cost of switching a minute of traffic from a by-pass route to the settlement system depends on a carrier's share of total settled traffic. Since the cost of by-pass is the same for all carriers, there must be symmetry in the shares of settled traffic.

Carrier reaction functions may also involve boundary solutions. As the volume of foreign settled traffic increases, home carriers will push to the boundary $s_i=1$ in order from smallest to largest T_i^H. Given that some carriers choose to send all traffic as settled traffic, (3) still holds for carriers with $s_i^H<1$, and carriers that send some by-pass traffic all send an equal amount of settled traffic. The effect of boundary solutions is to make Φ^H concave as a function of Φ^F.

Consider the case where there are two carriers, one of which sends all its traffic as settled traffic.[9] Let $\Phi_1^H = T_1^H < \Phi_2^H < T_2^H$ for home carriers 1 and 2. Then (3) implies

$$(5)\quad \frac{T_1^H}{\Phi^H} = \frac{\Phi^H}{\Phi^F r^H} \; for\ \Phi^H > 2T_1^H$$

Solving (5) for home settled traffic gives

$$(6)\quad \Phi^H = \sqrt{r^H T_1^H \Phi^F} \; for\ \Phi^H > 2T_1^H$$

The amount of settled traffic that home carrier 2 sends is $\Phi_2^H=\Phi^H-T_1^H$.

There are several important general properties of the routing functions (4) and (6). First, new carriers have a large incentive to send some settled traffic, and, all else held constant, the volume of settled traffic increases as the number of carriers increases. More significantly, carriers send some settled traffic even if a by-pass option is available at a lower price than the price for settled traffic. The amount of settled traffic sent is a continuous function of the by-pass price, the

[9] The more general case is easily solvable, but will not lead to a closed form expression for the Nash equilibrium in the subsequent section.

settlement rate, the cost of handling settled traffic, and the amount of settled traffic received.

II. Nash Equilibria with Home and Foreign Carrier Routing Choices

Home and foreign carriers' optimal routing choices are in general interdependent. Proportional return simplifies the interdependency: home carriers' routing costs depend only on the total amount of settled traffic from the foreign country, and the analogous property holds for foreign carriers' routing costs. Thus the analysis of foreign carriers' routing choices, for a given volume of home country settled traffic, is analogous to the analysis in the previous section. The overall Nash equilibrium requires a solution for Φ^H and Φ^F consistent with both home and foreign carriers' reaction functions.

Consider first the case where there is a single foreign international carrier. If its by-pass price is lower than the settlement rate, its dominant strategy is to send all its international traffic as by-pass traffic. Given this strategy, if home carriers also face a by-pass price less than the settlement rate, they will also send all their traffic as by-pass traffic. Thus a bang-bang solution, with respect to movements in by-pass prices, can emerge for a Nash equilibrium with a foreign monopolist.

Suppose, however, that a foreign monopolist can commit to a particular routing strategy and hence can act as a Stackelberg leader in the routing game. Such a situation may reflect, for example, the bureaucratic inertia in the decision making of a state-owned telecommunications carrier in contrast to the decision-making process in competitive private carriers. The foreign monopolist's net international interconnection cost, given the home-country reaction function in (4), is

(7) $X^F(s^F) = p_a s^F T^F - p_a(1-\frac{c_a^F}{p_a})\frac{n-1}{n} r^H s^F T^F + p_b^H(1-s^F)T^F$

Thus the foreign monopolist's marginal cost of sending a minute as settled traffic rather than as by-pass traffic is

(8) $\frac{dX^F / ds^F}{T^F} = p_a\left[1-\frac{p_b^H}{p_a}-\frac{n-1}{n}r^H(1-\frac{c_a^F}{p_a})\right]$

The right side of (8) is some constant K. If K>0, the foreign carrier will send all traffic as by-pass traffic, and so will the home carriers. If K<0, the foreign carrier will send some traffic as settled traffic.[10] If the monopolist sends settled traffic, it follows a threshold routing rule, whereby all traffic below a threshold value M is sent as settled traffic and any traffic above that threshold is sent as by-pass traffic.[11] Moreover, the threshold changes continuously in response to changes in by-pass prices, settlement rates, and costs, and hence routing choices do not change abruptly in response to changes in by-pass prices.

With multiple home and foreign carriers there are three possible types of Nash equilibria. One is a simple "no alternative" scenario: with by-pass prices higher than settlement rates, all traffic is passed as settled traffic. With by-pass prices lower than settlement rates, there is another simple equilibrium: all traffic is passed as by-pass traffic. However, these two routing equilibria do not exhaust the possibilities; a third equilibria, featuring some settled traffic and some by-pass traffic, is also possible.

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[10] Note that if $p_b^F > c_a^F$ and $p_b^H > c_a^H$ then for sufficiently large n, K<0.

[11] If there are n equal-sized home carries, then $M = \frac{n\Sigma^H}{(n-1)r^H}$, where Σ^H is total international traffic from the home market.

Consider the case where there are *n* home carriers and *m* foreign carriers, each of which handles settled traffic according to proportional return.[12] The home country settled traffic reaction function is given by (4). The analogous reaction function for the foreign country can be written as

$$(9)\ \Phi^H = \frac{m}{(m-1)r^F}\Phi^F$$

Since the home country reaction is convex in Φ^F and the inverse of the foreign country reaction function is concave in Φ^F, an interior equilibrium exists if and only if

$$(10)\ \frac{m\,n}{(m-1)(n-1)} < r^F r^H$$

Assume that settled traffic is handled efficiently. Thus the price for by-pass, which may involve additional technology and/or additional business and regulatory risk, can be no lower than the cost of handling settled traffic. Hence $r^H>1$ and $r^F>1$. Thus (10) holds when there are sufficiently many home and foreign carriers.

Now assume that there are only two foreign carriers (*m*=2), and in equilibrium foreign carrier 1 carriers sends all its traffic as settled traffic. This adds a concave segment to the foreign country reaction function that is analogous to that given in (6). It can be written as

$$(11)\ \Phi^H = \frac{(\Phi^F)^2}{r^F T_1^F}\ for\ \Phi^F > 2T_1^F$$

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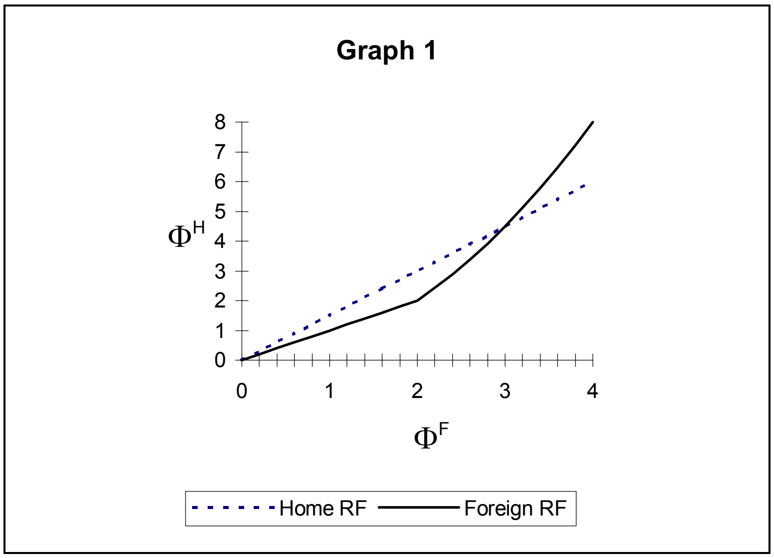
[12] Carrier-by-carrier proportional return is a decentralized approach for ensuring aggregate proportional return. Other approaches to ensuring aggregate proportional return require move intensive coordination of traffic flows among carriers. Without a publicly known mechanism for producing aggregate proportional return, a carrier doesn't know which parties to hold responsible if it doesn’t receive an appropriate traffic allocation.

Graph 1, which plots the home and foreign country reaction functions, shows a possible Nash equilibrium given sufficient total traffic volumes from each home carrier, i.e. interior solutions for all home carriers.[13] Solving (11) and (4) for the Nash equilibrum gives

(12) $\Phi^H = \frac{n-1}{n} r^F r^H T_1^F, \quad \Phi^F = \left(\frac{n-1}{n} r^F\right)^2 r^H T_1^F$



The traffic ratio is

(13) $\frac{\Phi^H}{\Phi^F} = \frac{n}{(n-1)r^F}$

In terms of the effects of successive optimal reactions, this equilibrium is stable while the "no settled traffic" equilibrium is not stable. Suppose, for example, that foreign settled traffic is slightly above the rightmost intersection of the reaction functions in Graph 1. Home carriers' optimal reaction to this level of foreign settled traffic is a level of home settled traffic that in turn

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[13] Equation (10) is assumed to hold.

implies, via the foreign carriers' reaction function, a lower level of foreign settled traffic. In contrast, consider the equilibrium where no carrier sends any settled traffic. If, from that position, some carrier sends some settled traffic, all other carriers have an incentive to send some settled traffic as well. Thus settled traffic flows move further away from the "no settled traffic" equilibrium. Particularly given the historical existence of significant settled traffic flows, these dynamics suggest that the "no settled traffic" equilibrium is much less likely than the equilibrium with some settled traffic.

An important feature of this latter equilibrium is that ratio of home and foreign settled traffic depends on the settlement rate, the cost of handling settled traffic, the foreign by-pass price, and the number of home carriers. The total volumes of traffic sent from the home and foreign countries, which might be considered structural aspects of the market, have no effect on the equilibrium balance of settled traffic. Moreover, increased competitiveness of the home market (larger n) leads to a lower settled traffic ratio. These results at least suggest that policy analysis neglecting the role of by-pass in shaping the balance of settled traffic overlooks crucial aspects of carriers' routing strategies.

III. Welfare Analysis

The threshold routing rules derived in Sections I and II simplify the welfare analysis of international interconnection. Since those rules imply that by-pass prices represent the marginal cost of interconnection (for carriers sending some by-pass traffic), profit-maximizing international carriers will set retail prices based on prevailing (market-driven) by-pass prices. Settlement rates and net settlement payments under the traditional international interconnection arrangements affect only carriers' average costs. Thus in the short run (no entry or exit) settlement rates and net settlement payments affect only the international division of producer surplus, not retail prices or consumer welfare.

Analyzing the international division of producer surplus requires some standard for comparison. In this section the standard of comparison will be taken to be net international interconnection expenses with international traffic terminated at the cost, which may vary among countries, of terminating settled traffic. The cost of terminating settled traffic is taken to represent the least cost means for handling settled traffic. If international traffic was terminated at this price there would no role for by-pass. Moreover, retail prices would reflect this interconnection price rather than a by-pass price, and there would be consumer welfare effects in the short run (without entry or exit). These consumer welfare effects are largely ignored in the following analysis.[14]

The home country would prefer to shift to cost-based international interconnection if doing so lowered net international interconnection expenses. Thus the home country would want to shift to cost based rates if

(14) $c_a^F \Sigma^H < p_a \Phi^H + p_b^F B^H - (p_a - c_a^H)\Phi^F - (p_b^H - c_b^H) B^F$

where Φ^H and B^H are, respectively, settled traffic and by-pass traffic sent from the home country, and $\Sigma^H = \Phi^H + B^H$ is total home country international traffic. An analogous equation applies for the foreign country. Rearranging terms gives

(15) $c_a^F \Sigma^H - c_a^H \Sigma^F - (c_b^H - c_a^H) B^F < p_a(\Phi^H - \Phi^F) + p_b^F B^H - p_b^H B^F$

The right side of (15) represents the home country's net international interconnection payment under the given system. The first two terms of the left side are net interconnection expenses under cost-based interconnection. With $c_b^H = c_a^H$, the third term on the left side of (15) vanishes and the equation becomes negatively symmetric with respect to the home and foreign countries. This means that, holding consumer welfare constant, home and foreign country incentives to shift to cost-based interconnection conflict: if one country prefers cost-based interconnection, the other prefers the given system.

Note that a positive net international settlement payment, i.e. a positive first term on the right side of (15), is not sufficient to imply that the home country is better off with cost-based interconnection. The net payment for by-pass traffic, the cost difference for handling settled traffic, and the relationship between settled traffic costs and by-pass costs also matter for the welfare comparison. As others have pointed out, if the costs of handling settled traffic are sufficiently asymmetrical, a country with a positive net settlement payment would experience an even larger net international interconnection payment under cost-based international interconnection.[15]

Moreover, a country might have lower net international interconnection expenses if it abandoned proportional return. Assume that by-pass prices are lower than settlement prices for home and foreign carriers. If the home country abandoned proportional return, its carriers would send all their traffic as by-pass traffic, and hence so would foreign carriers. The home country's

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[14] Thus the analysis essentially assumes that retail prices do not change if average or marginal interconnection costs change. This situation might be considered the very short run.

[15] See Walker (1995) and Chowdary (1997).

net international interconnection expenses would fall if

$$(16)\ \ p_b^F\Phi^H-(p_b^H-c_b^H)\Phi^F<p_a\Phi^H-(p_a-c_a^H)\Phi^F$$

Rearranging yields

$$(17)\ \ \frac{(p_a-c_a^H)-(p_b^H-c_b^H)}{p_a-p_b^F}<\frac{\Phi^H}{\Phi^F}$$

Taking $c_a^H=c_b^H$ and letting p_b^H approach p_a from below shows that this equation holds for some parameter values. More generally, (17) shows that a home country price advantage for by-pass favors a shift away from proportional return.

Two factors create opportunities for mutual gains from a movement to cost-based international interconnection. The first is that reducing the marginal costs for terminating international calls will, given profit-maximization, lead to a reduction in retail prices, increased traffic flows, and subsequent consumer benefits. Analyzing such benefits requires a more complex model.

A second factor that creates opportunities for mutual gains is that by-pass may be inefficient. Some forms of by-pass traffic involve third-country routing. The extra transit, switching, and managerial coordination required is likely to make handling such traffic more expensive than handling settled traffic under established bilateral arrangements. Other forms of by-pass involve placing voice traffic on alternative networks. The existing international network has been optimized for voice traffic, hence it is likely to be more cost-efficient for such traffic than other alternative networks designed for more diverse traffic streams. In addition, the provision of by-pass services may expose a carrier to significant regulatory and commercial risks. This additional risk raises the cost of by-pass services relative to traditional settled traffic. Reforming the settlement process – making rates more closely aligned with costs, explicitly sanctioning alternative routing practices – can reduce the inefficiencies associated with by-pass.

IV. Numerical Calibration

This section will numerically calibrate the above model. For simplicity the analysis will focus on the case of multiple carriers in the home country and a foreign monopolist. Given that countries are only beginning to move towards competitive international service, while many remain with a monopoly international carrier, this case is also empirically relevant.

The calculations assume a settlement rate of US\$0.45 (p_a=0.45) per minute. The cost of handling settled traffic is assumed to be US\$0.06 per minute in the home country and US\$0.09 cents per minute in the foreign country (c_a^H=0.06, c_a^F = 0.09). The higher cost for the foreign country reflects the cost-inefficiency of a monopoly provider. The cost of providing by-pass service to the foreign country, c_b^F, is assumed to be US\$0.12 cents per minute. The cost of handling by-pass traffic is assumed to be higher than the cost of handling settled traffic because of the additional arrangements and risks associated with by-pass traffic.

Some additional assumptions are needed about traffic volumes and market structure. Assume that there are twice as many minutes of international traffic from the home country to the foreign country as there are in the opposite direction. Assume that there are 4 equal-sized carriers providing international service in the home country (n=4). The assumption that the home carriers are equal-sized implies that either all the home-billed traffic is settled traffic, or there is an interior solution for the home carriers and (4) holds.

Table 1

Home By-pass Price	Foreign By-pass Price	Home By-pass Traffic	Settled Traffic Ratio	Home Rel. Net Expense	Foreign Rel. Net Expense	Eff. Cost of By-pass
0.32	>0	0	2.00	2.83	-4.50	0%
0.30	>0	5	1.95	2.79	-4.35	1%
0.28	>0	28	1.72	2.57	-3.57	3%
0.26	>0	46	1.54	2.35	-2.81	6%
0.24	>0	61	1.39	2.13	-2.07	8%
0.22	>0	73	1.27	1.90	-1.34	9%
0.20	>0.03	83	1.17	1.68	-0.63	10%
0.18	>0.06	92	1.08	1.46	0.08	11%
0.16	>0.09	99	1.01	1.24	0.79	12%
0.14	>0.11	106	0.94	1.01	1.49	13%
0.12	>0.13	111	0.89	0.79	2.18	14%

As Section I showed, carriers have an incentive to send some settled traffic even if the by-pass price is lower than the settlement rate. In Table 1, the first column gives values for the home carriers' by-pass price. The second column gives the lower bound for the by-pass price such that, for any by-pass price above that bound, the foreign carrier will send all its international traffic as settled traffic. By-pass prices considerably below the settlement rate are consistent with the foreign carrier sending all its traffic as settled traffic. Columns 3 and 4 show the home carriers total by-pass traffic to the foreign country and the ratio of home to foreign settled traffic for the home by-pass price in the first column and a foreign by-pass price above the bound in the second column. With a settlement rate of US$0.45, home carriers exploit by-pass only if the by-pass price falls below US$0.32. As the by-pass price falls further, the home carriers send more by-pass traffic. With a by-pass price just below US$0.16, the home carriers send the same amount of by-pass and settled traffic, and the ratio of home-billed settled traffic to foreign-billed settled traffic is 1. A by-pass price of US$0.16 offers a 33% margin over the cost of handling by-pass traffic. These calculations show that, given proportional return, by-pass prices have to be significantly below the settlement rate to affect the settled traffic ratio. Nonetheless, such by-pass prices appear to be economically feasible.

By-pass prices can significantly affect the home and foreign carriers' net international interconnection expenses. Columns 5 and 6 of Table 1 show home and foreign carriers' net international interconnection expenses relative to their expenses with cost-based settlement of international traffic.[16] By-pass reduces the surplus of settled traffic from the home carriers to the foreign carrier, and increases the foreign carrier's relative cost for international interconnection. Note, however, that with a home by-pass price of US$0.16, both the home and foreign carriers would prefer to shift to cost-based interconnection. An advantage of shifting to cost-based international interconnection is that it avoids the efficiency loss associated with by-pass. With a by-pass price of US$0.16, this loss amounts to 12% of the total cost of efficient, cost-based interconnection.

V. Conclusions

By-pass opportunities have important implications for traditional international interconnection. In the simple case of two international carriers negotiating interconnection, by-pass can be interpreted as a non-negotiated option that bounds interconnection prices. Proportional return, however, creates more complex effects. Under proportional return, carriers may follow threshold routing rules and may rationally send some settled traffic even if by-pass prices are below the settlement rate. Moreover, with multiple home and foreign carriers following proportional return, the balance of settled traffic in a Nash equilibrium depends on by-pass prices but is independent of the overall international traffic flows between the two countries.

More importantly, by-pass makes the welfare implications of traditional international interconnection agreements subject to fast changing technological and market developments. The experience of Bell-Atlantic within the United States illustrates how market developments can shift the welfare implications of an interconnection agreement. In interconnection negotiations Bell-Atlantic pushed for relatively high reciprocal interconnection rates, presumably because of past experience that new entrants had a surplus of traffic flowing out from their networks. With such rates in place, the new entrants then pursued new customers, such as internet service providers, that had a high ratio of inbound to outbound calls. The result was that Bell-Atlantic soon found itself accumulating large liabilities for interconnection payments.[17] With respect to international interconnection, settled traffic ratios are rapidly becoming a function of strategic routing and marketing choices. These developments imply that proportional return and extensive regulation of settlement rates are becoming less useful policy tools.

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[16] That is, the exchange of international traffic at the cost of handling settled traffic.

[17] Bell-Atlantic argues that competing local exchange carriers are not entitled to termination fees for ISP traffic. For BA's position and references to FCC enquiries on this issue, see http://ba.com/policy/positions/1997/Oct/19971029013.html

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