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International Accounting and Settlements: A Review of Literature

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In 1997, both the World Trade Organization and the U.S. Federal Communications Commission initiated actions aimed to liberalize international telecommunications. This paper overviews the present regulatory landscape and reviews recent literature completed by research economists. Theoretical research principally revolves around how interconnected national networks determine call transfer and origination prices, as well as how domestic competition and regulatory restriction affect the pricing outcome. Econometric research hinges around the complementarity of outgoing and incoming traffic flow between two nations, the two-part nature of a call (i.e., access and minutes), and the response of calling volume to prices, economic conditions, and demographic factors in each of the correspondent countries.

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1. **Introduction**

International markets have moved to center stage in the telephone regulatory arena in 1997. Negotiating countries in the World Trade Organization (WTO) in February reached an agreement in February to liberalize market entry by foreign carriers. The U.S. Federal Communications Commission (FCC) followed in August with prospective benchmarks for international accounting rates that would drastically reduce the price of international switched traffic to and from the U.S. These prospective reforms beckon the efforts of research economists around the world. This paper is designed to offer a roadmap to the present regulatory landscape and to review the research literature completed to this point.

The key technical relationship between two domestic carrier networks in a correspondent-country pair is that international traffic between them flows in both directions. Each domestic carrier then is simultaneously a provider of upstream (originating) and downstream (terminating) switching and transport, though for different calls. To enable switched interconnection, these carriers must then arrive at rates for passing traffic to one another. An operator that unilaterally chooses to lower rates for call termination would only provide benefit to foreign correspondents (and possibly their originating callers); consequently, no carrier has much unilateral incentive to lower these rates. Furthermore, unlike competitive local carriers that face similar interconnection matters, foreign correspondent networks generally do not compete with one another for international callers. However, some competitive overlap through foreign affiliates is possible and more flexible callers may sometimes choose to initiate calls in the low-price country.

The paper is organized as follows. Section 2 reviews the present process for international accounting and settlements, while Section 3 discusses present reform initiatives. Section 4 discusses theoretical papers, while Section 5 reviews empirical literature. Reviewed articles in Sections 4 and 5 were culled from scholarly books and journals or from promising unpublished material, although material in the trade press and outdated research literature are occasionally cited as well. Section 6 concludes.

2. **The Accounting and Settlements Process**

Per guidelines of the CCITT (International Telegraph and Telephone Consultative Committee), correspondent networks in different nations now reach operating agreements with one another that specify terms for switched interconnection and financial settlement. The two companies usually negotiate a per minute *accounting charge* (e.g., $1.00 per minute) in dollars, gold francs, or SDRs, and then split revenues per a negotiated *settlement rate*, usually 50/50.[1] The originating carrier bills its caller with a *collection rate* that is itemized on the customer's phone bill. Collection rates are sometimes subject to domestic competition. For a critical view of other alternatives -- e.g., revenue-sharing, cost-plus charging, billing from both ends, end-to-end provision, profit-splitting, and bill-and-keep -- see Alleman, et al. (1989) and Ergas and Patterson (1991).

A carrier in one country must actually compensate a correspondent network only if its net

[1]This is despite the fact that outgoing minutes are more costly due to collection, operations, and blockages.

traffic outflow to this network is positive. Total settlements revenues owed are the product of the settlement rate times the net outflow of minutes between the two countries. Net revenue to an originating carrier is the difference between its collection revenues and settlements revenues paid to correspondent networks. Cheong and Mullins (1991) provide statistical evidence that the direction of compensation between two nations more often depends on relative economic development rather than domestic competition and relative collection charges.

Although actual payment between two networks is always "one-way", each carrier faces a marginal cost per minute of outgoing traffic that is equal to the per minute settlement rate plus its own domestic transport charge. Regardless of which country has the revenue outflow, changes in a carrier's prospective marginal payments should then affect its collection rate. This relationship would hold even if outgoing and incoming switched minutes between two countries were perfectly balanced. Therefore, a symmetric system would not be the same as "bill and keep", where marginal settlement cost would be zero.

Settlement rates have always greatly exceeded true marginal costs. Due to satellite and fiber technology and increasing call density, per minute trans-Atlantic transport costs fell from $2.53 in 1956 to $0.02 in 1992 (Cave and Donnelly, 1996). Nonetheless, U.S. consumers now pay an average of $0.88 cents per minute for international calls. The FCC estimates actual incremental cost of these calls to be $0.06-0.09.[2]

Unlike collection rates, accounting rates are not time-differentiated. Therefore, they do

[2]This amount can also be compared with 13 cents per minute for domestic long-distance, which has slightly smaller marginal costs. This domestic charge includes originating and terminating access charges paid to local exchanges that are not part of marginal cost.

not therefore reflect differences in incremental capacity costs by time of day.[3] Accounting rates are generally higher for developing countries, which presumably use the revenue to subsidize domestic network expansion.[4] Foreign carriers often are domestic monopolies and therefore maintain higher collection rates as well. These noncompetitive rates restrain outgoing call volume and therefore heighten the revenue imbalance of liberalizing developed nations such as the U.S., U.K., Sweden, and Australia.

In the U.S., each long-distance carrier bilaterally negotiates per minute rates with each respective foreign carrier. Per the FCC's *uniform settlement policy* (1986), correspondent U.S. and foreign carriers equally share accounting rates. Aiming to eliminate the danger of any foreign monopolist "whipsawing" U.S. carriers for preferable agreements, the FCC also required that accounting rates to any nation be equal for all U.S. carriers.[5]

Under USP, each U.S. carrier is credited with a share of return revenue from a nation based on its respective share of outgoing revenue to that nation. Consequently, a competing U.S. provider that carries an additional outgoing minute earns additional incoming revenue as well. This gain in return revenue decreases its perceived marginal payments that result when

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[3]The optimal tariff would consist of a flat-rate price per circuit plus a traffic-unit price plus a fixed component transfer. Usage charges should also be differentiated for peak and off-peak periods (Carter and Wright, 1991).

[4]For statistical demonstration of the relationship between low per capita GDP and high accounting rates, see Ergas and Paterson (1991).

[5]This expressed concern goes back to 1936, when the FCC (1936) refused to allow Norway's PTT to route all telegraph traffic to MacKay Radio and Telegraph in the U.S. The FCC felt that Norway would "whipsaw" other U.S. carriers into paying more for access and accepting less for themselves.

outgoing volume increases. The reduction would be greatest for the U.S. domestic carrier with the smallest outgoing market share.

There are a number of ways by which callers and carriers can avoid high accounting rates. Where permitted, a carrier may route international switched traffic to a correspondent network using one-way *international private lines* that are not subject to accounting and settlements. *International Simple Resale* arrangements allow two-way private transit, thereby allowing resellers and competing operators to offer full point-to-point service between two countries. In *transiting* or *switched hubbing*, carriers that face a high accounting rate with a particular nation can route calls over private lines to an intermediate nation B to lower overall accounting costs; e.g., the U.S. and Canada may use the U.K as a hub to reach EC members (Portugal, Spain, and Greece) that have inflated settlement rates for incoming U.S. traffic. These routing provisions can erode the holdup power of some PTTs.

With *call-back*, a caller in one country may access a dialtone in a called country to reverse the direction of the call, thus avoiding a higher collection rate (Retske, 1995). *Country direct* service enables U.S. calling card holders in a foreign country to call an international toll free number to access a U.S. operator and reverse charges to U.S. prices. More generally, callers can use both *international value-added networks* and the *Internet* to bypass settlement. Finally, parties in two countries (e.g., family members) may practice arbitrage and deliberately originate telephone conversations in the country where billing prices are lower. This conceivably could involve a short "call me back" message followed immediately by a conversation call. As always,

these forms of bypass are not necessarily economic.6

3. Reform Initiatives

Several important reform initiatives have been undertaken since 1992.[7] Recommendation D.140 of the International Telecommunication Union (ITU, 1992) called for cost-based, nondiscriminatory, and transparent accounting rates for all international calls. The report suggested that tariff components include charges for *international transmission, international switching*, and *national extension* (domestic transport and termination). A 1993 followup, Recommendation D.300R, established a method for determining transit prices for countries in the European/Mediterranean basin based on crowflight distances between respective national borders and on the degree of digitization in the correspondent nations (ITU, 1993). A 1997 report (ITU, 1997) supported these recommendations and advocated that the ITU, World Bank, and WTO cooperatively aid developing countries during a transition. In 1998, European nations will settle all intra-continental traffic using domestic call termination charges that are lower than present accounting rates.

The FCC in the U.S. became particularly concerned about international accounting and

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6 Scanlan (1996, 1997) points out that call-back and other arrangements that reverse the direction of the call may save consumers money but do not necessarily put competitive pressure on the high-rate carrier that would otherwise originate the call. This is because the lost collection rate can be compensated for by the return settlement payment and the additional calling volume that a price decrease may induce.

[7] For a review of the pre-1992 environment, see Johnson (1989) or Stanley (1991). The former is summarized in Johnson (1989/91).

settlements in 1996 as the U.S. revenue imbalance grew to exceed $5 billion.[8] Using price data from 65 countries that accounted for 70% of U.S. international telephone traffic in 1994, the International Bureau (IB) of the FCC estimated service costs from foreign country tariffs charged to domestic users (FCC, 1996b, Appendix). *Transmission charges* were based on per minute converted costs of international T1 or E1 circuits that are commonly sold to provide private line service. *Switching charges* were based on cost information provided by participant countries in D.300R.[9] *National extension charges* were based on domestic tariffs charged for direct dialed telephone service, aggregated appropriately over time of day, day of week, mileage band, etc.

Based on these estimated costs, an August, 1997 Order (FCC, 1997b) set forth settlement rate benchmarks for high, middle, and low income countries of 15, 19, and 23 cents per calling minute. The order will take effect on January 1, 1998; high income countries must comply by 1999 unless the ITU can formulate a suitable alternative. Subsequent annual deadlines were established for four categories of less affluent nations. To bypass settlements, a foreign carrier will be able to route switched traffic to the U.S. over a private line only if 50% or more of its reverse traffic is settled at or below the FCC's benchmark. To enjoin anticompetitive price squeezes against rival U.S. carriers, foreign affiliates of U.S. carriers must charge settlement rates at or below the applicable benchmark.

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[8]The U.S. revenue imbalance has grown from $2.8 billion in 1990 to $5.4 billion.

[9]The per minute charges differed by the proportion of switch digitization -- 4.8 cents (0-30%), 3.4 cents (31-60%), and 1.9 cents (61-100%) -- that were respectively assigned to individual countries based on their per capita income.

On a second reform front, the FCC's Flexibility Order (FCC, 1996a) allowed U.S. long-distance carriers to bid competitively to terminate inbound traffic from foreign countries that provide effective competitive opportunities (ECO). ECO in a foreign country has four criteria (FCC, 1995) : U.S. carriers must be permitted to offer international facilities-based services, interconnection charges and terms must be nondiscriminatory, competitive safeguards must exist to protect against anticompetitive practices, and an independent regulator must exist to safeguard these rules. If the ECO test is not passed, alternative settlement arrangements can be permitted if the resulting rates can demonstrably promote market pricing and enhance competition.

Finally, the WTO in February, 1997 completed a multilateral telecommunications agreement that affects sixty-nine nations and ninety-five per cent of world telecommunications revenue. Fifty-two nations reached liberalizing arrangements that would allow foreign entry and investment in their domestic markets. Sixty-five nations committed to opening their landline networks at any technically feasible point under nondiscriminatory and transparent terms and rates, and to appoint independent regulators to resolve disputes. FCC Commissioner Reed Hundt anticipates that a decline in per minute average international calling prices will decline from $1 to $0.10 as a result (Telecommunications Reports, February 24, 1997, p. 3).[10]

[10]To meet WTO obligations, the FCC must scrap (for WTO signatories) its Foreign Entry Order (FCC, 1995) that allows foreign providers access to U.S. markets only when their respective nations offer ECO. The FCC appears ready to do this, but apparently would retain the right to determine whether foreign entry would threaten domestic competition. If deemed necessary, it would modify dominant carrier safeguards, enforce settlement benchmarks, and impose financial sanctions and conduct remedies. (FCC, 1997a). The European Commission has filed ex parte comments urging the FCC to rethink its reservations.

4. **Theoretical Papers**

We shall first review the theoretical literature. From the above discussion, there are several key market characteristics that bear upon all theoretical research.

1. The prices paid by callers and carriers to complete switched international phone call now greatly exceed marginal cost and are inefficient.

2. Accounting rates for switched traffic are set through bilateral negotiation; the two parties then have incentive and opportunity to set prices cooperatively in order to inflate revenues.

3. Each domestic carrier individually sets its collection rate in monopolistic or competitive access markets. A high collection rate set by one carrier hurts foreign correspondent network but benefits domestic competitors. Greater domestic competition lowers collection rates and helps consumers.

4. Different carriers can perceive different marginal payments due to the allocation of return traffic.

To the greatest degree possible, we shall a define and use consistent notation throughout each paper in Section 4 that will often vary with the original notation in the paper. The subscript i = 1, 2 will designate either of a carrier pair and will be eliminated if clarity permits.

Hakim and Lu

Hakim and Lu (1993) consider a market with two correspondent countries. The terms a

and s respectively represent the accounting rate and settlement share per calling minute in each. Marginal costs for outgoing and incoming calls are c and z (assumed $c > z$). Assuming perfect arbitrage, the market demand function for international usage is q(p), where p represents the per minute collection rate in the low-cost nation. Respective profits in the high- (low-) rate country are $R = [sa - z]q(p)$ and $R = [p - sa - c]q(p)$. If prices are equal, each country originates half the traffic and $R = 0.5[p - c - z]q(p)$.

Using standard first-order conditions, the two carriers set collection prices **p** in a Bertrand, non-cooperative duopoly. If settlement rates are equal and accounting rates weakly exceed both collection rates, each carrier has the incentive to price above its correspondent and attempt to receive calls only. This incentive for each carrier to "price-push" its collection rates stops only when both collection rates exceed the accounting rate. If the carriers can collusively set both a and s, the settlement agreement $a = p_m - c + z < p_m$, $s = 0.5$ is incentive compatible with joint profit-maximization with a final market price of $p_m = \text{argmax}[p - c - z]q(p))$.

Carter and Wright

Carter and Wright (1994) assume that arbitrage is negligible and transferred calls between two monopoly correspondents are neither substitutes nor complements for reverse traffic. The market demand function in country i is $q_i(p_i)$, where p_i represents a country's per minute collection rate. The per minute terminating fee for incoming traffic to nation i is t_i. Total costs in country i for handling outgoing and incoming calls are $C_i(q_i, q_j)$; profits are $R_i = p_i q_i(p_i) - C_i(q_i,q_j) + t_i q_j - t_j q_i$.

Without collusion on termination fees **t**, the two carriers play a two-stage noncooperative game where they sequentially set **t** and **p**. Each carrier sets its own prices without regard to its correspondent. The resulting levels of **p** are above monopoly levels.

With collusion on **t**, both producers are made better off and collection prices **p** are lower as well. Intuitively, the producers avoid double marginalization and therefore increase profits and lower prices. If the two firms are symmetric, both transfer prices are equal to marginal cost under collusion.

Cave and Donnelly

Cave and Donnelly (1996) assume no substitution or complementarity between inbound and outbound traffic and allow monopoly carriers to bargain over accounting rates. Using notation from Hakim and Lu, profits for operator i are $R_i = [p_i - s_j a_j - c]q(p_i) + [s_i a_i - z]q(p_j)$, where $q(p_i)$ represents outgoing demand from country i. In a two-stage game, providers first bargain over rates **a** and shares **s** and then determine collection rates **p** noncooperatively.

As in Carter and Wright, the authors determine a two-stage noncooperative equilibrium with first-stage levels of **a** and **s** that are unilaterally determined. The resulting profit outcomes serve as threat points in a cooperative bargaining model. In the Nash solution to this latter model, the carriers maximize the product of their incremental profits above respective "threat point" levels. Each country's eventual settlement price will be somewhere between its noncooperative preferred level and its trading partner's preference (which is zero).

Settlement prices will be equal to one another and to incremental cost if and only if

carrier profits are equal. When settlement equality in other cases is constrained, carrier preferences coincide only if traffic flow is balanced. Otherwise, one carrier gains and the other loses when equality is enforced.

Yun, Choi, and Ahn

In a two-stage model, Yun, Choi, and Ahn (1997) consider the consequences of asymmetric economic development and domestic competition. Monopoly providers first cooperatively determine accounting rate a and country shares **s**, and subsequently select respective output levels in a non-cooperative second stage (Cournot). Assuming linear demand functions and equal costs for incoming and outgoing traffic, carrier profits are $R_i = [A_i - Bq_i]q_i - c_i[q_i + q_j] + a[s_iq_j - s_jq_i]$ When $s = 1/2$, equilibrium carrier output $q_i = [A_i - c_i - a/2]/[2B]$ is negatively related to both c_i and a; lower output implies higher collection rate. Traffic imbalance $T = [A_j - A_i + c_i - c_j]/2B$ depends on differences in respective A and c, while payment imbalance ($= Ta/2$) depends on rate a as well.

Assuming that A and c are unequal across carriers, preferred accounting rates $a_i = 2[A_j - A_i + 2c_i - c_j]$ differ across carriers. Using simple algebra, one preferred rate must be above combined cost $c_i + c_j$, and the other below. A carrier's preferred rate increases (decreases) with home (correspondent) cost and with correspondent (home) parameter A. We can expect that carriers in developing nations will have low A and high c, and carriers in developed nations the reverse. Therefore, conflict inevitably arises in negotiations between them. A similar conflict would hold for their surplus-maximizing governments, where preferred rates $a_i = 2[2(A_j - c_j) -$

$3A_i + 5c_i]$). Both carriers can be made better off if accounting rates are cooperatively set and side payments instituted.

With competition, all m (n) carriers in country i (j) are assumed identical. Total outgoing and incoming traffic to country i are now $m[A_i - c_i - a/2]/[(m + 1)B]$ and $n[A_j - c_j - a/2]/[(n + 1)B]$. Competition in liberalizing countries reduces collection rates, stimulates demand, and increases net traffic imbalance. In reducing price markup, competition also reduces carrier profit loss when caller demand decreases. Consequently, a nation's preferred accounting rate level *increases* with the number of carriers in its home or correspondent country. Carrier-negotiated accounting rates would then tend to increase with domestic competition. Government agreements can be used to offset this tendency.

Galbi

In an unpublished paper, Galbi (1977) explores key interdependencies between settlement rates sa, termination costs z, and bypass prices b. There are respectively m and n competing international carriers in the foreign (F) and home (H) country. With proportionate return and zero origination costs, respective costs (net of proportioned termination revenues) for each home carrier $i = \{1, 2, ...n\}$ are $C_i = saf_iS_i + b[1 - f_i]S_i - [sa - z][f_i S_i /T_H]T_F$ where f_i and S_i respectively represent switched share and traffic total of carrier i, and T_H and T_F respectively represent total outgoing switched traffic from countriesH and F.

Differentiating C with respect to fS, per minute marginal cost increases with a carrier's switched volume. Consequently, for a given T_F, there exists a threshold level $L(T_F)$ such that all

carrier switched traffic f_iS_i below (above) $L(T_F)$ is routed over switched (bypass) facilities. The author then proves that if some traffic is settled with multiple carriers in two countries, at least one carrier in each will be exclusively settled. Settled traffic totals increase with bypass costs; national total outgoing traffic increases with volume and profitability of return traffic. These predictions are all testable.

There are other interesting results. Since return earnings grow in rough proportion to a carrier's outgoing volume, each home carrier can underestimate the marginal costs of settled traffic and consequently oversend settled traffic. As a result, the group fails to minimize interconnection expenses.[11] If sa = b, one country will prefer cost-based interconnection prices and the other will not (or both may be perfectly indifferent). However, the supporting carrier will *not necessarily* be the nation with revenue outflow; relative bypass costs, traffic symmetry, and termination costs matter here as well. With bilateral monopoly, bypass technology can be used even if less efficient, thereby lowering total home and foreign country producer surplus.

O'Brien

O'Brien (1991) considers whether the FCC's uniform settlement policy really protects competing U.S. domestic carriers from "whipsawing" by a foreign monopolist. He assumes two symmetric U.S. domestic carriers (i = 1, 2) and one foreign monopolist. Let c, t_{iF} , and t_{iU}

[11]However, if one foreign carrier is monopolized, it will use exclusively bypass if b < sa, assuming nonstrategic behavior. With no possibility of earning return revenue, alll return carriers will exclusively use bypass as well. However, the monopolist will continue to send settled traffic if it is a Stackelberg strategist and can stimulate return traffic.

respectively represent the marginal cost of outbound calls, carrier i's settlement price to access the foreign network, and the settlement price paid for access to carrier i's network. For originating U.S. traffic, respective customer demands for carrier 1 under monopoly and duopoly are $q_m(t_{1F} + c)$ and $q_1(t_{1F} + c, t_{2F} + c)$ where subscript m designates that carrier 1 is a monopoly. Respective profits are $[p(q_m) - t_{1F} - c]q_m$ and $[p(q_1 + q_2) - t_{1F} - c]q_1$. Analogous terms are derived for carrier 2. The foreign carrier facing U.S. monopoly and duopoly earns respectively $[t_{iF} - c]q_m$ and $[t_{1F} - c]q_1 + [t_{2F} - c]q_2$.

Initially assuming no return traffic, domestic carrier i and its foreign correspondent bargain over settlement price t_{iF} for outgoing U.S. traffic. In period zero, the monopolist offers an initial price to U.S. carrier i that can be accepted or counter-offered. If not accepted, the monopolist may continue negotiations or begin talks with carrier j. If negotiations are opened, talks with carrier j proceed similarly. Once a bilateral agreement is reached, a U.S. domestic carrier may begin service immediately. Bargaining between the foreign carrier and the remaining U.S. carrier continues until a second agreement enables duopoly.

Using backward induction, O'Brien solves the model with payoffs in each stage set at Nash bargaining levels. When discrimination between U.S. carriers is permitted, the second carrier is found to have considerable bargaining power with the foreign carrier. This is because the transition from domestic monopoly to duopoly lowers U.S. collection prices, stimulates traffic outflow, and increases foreign carrier profit. In first-round negotiations, a U.S. carrier will anticipate this second-round outcome and consequently gain some bargaining leverage in the first round as well. Consequently, the foreign monopolist cannot set its most preferred settlement charge.

If first-round discrimination is not permitted, the second U.S. carrier must immediately accept the first-round access price. Therefore, it cannot delay agreement and duopoly in order to reach a more favorable outcome. Without a strong second-round outcome and a consequent fallback threat, the first-round bargaining carrier is hurt as well. Indeed, O'Brien demonstrates that the foreign carrier may set its most preferred price p^*, take-it-or-leave it, when discount rates are zero. *This exceeds the first-round outcome when discrimination is allowed.*

O'Brien then introduces return traffic to the U.S. He first assumes that incoming and outgoing settlement rates can differ but nondiscrimination is enforced. Using analogous reasoning to the "outgoing case", he shows that a foreign monopolist will negotiate with U.S. domestic carriers a take-it-or-leave it rate for return traffic as low as feasible; i.e., marginal cost .

If incoming and outgoing rates also must be equal to one another (as in the USP), the foreign monopolist will be more concerned with outgoing payments if its *incoming traffic to the U.S. exceeds outgoing* (as is the case for telegraph). It therefore will continue to press for settlement at marginal cost . As this traffic imbalance lessens or reverses, its preferred level will move in the direction of p^*.

If the U.S. has a positive traffic balance with a particular foreign monopolist, both U.S. firms and consumers may favor the uniform settlements policy in order to settle their outgoing calls at marginal cost. However, if incoming traffic is smaller or nonexistent, both groups may suffer as the foreign carrier aims to extract p^*. A third outcome is also possible; when incoming traffic is slightly smaller, U.S. carriers and consumers are respectively better and worse off with USP and appropriately support and oppose it.

5. **Econometric Research**

In all likelihood, ongoing reforms will spawn considerable amounts of econometric research on international switched telephony. Research in the past decade (1988-1997) is reviewed below. Readers interested in earlier works are referred to Lago (1970), Yatrakis (1972), Rea and Lage (1978), and Schultz and Triantis (1982).

A few general points are in order. International caller demand principally depends on own-price, level of economic activity, and number of access lines. Telephone calls are most appropriately viewed as two-part goods with distinct prices for setup and usage (Taylor, 1980). Separate demand models for total calls and usage minutes would be ideal. If these totals comprise several service categories (e.g, person-to-person, station-to-station), an additional submodel can handle the apportioning.

Depending on whether traffic to one country represses or stimulates traffic in the reverse direction, outgoing and incoming international calls/minutes can be substitutes or complements (Larson, et al., 1988). Consequently, cross-price elasticities can be positive or negative and cross-income effects can be heightened. A complementary effect between outgoing and incoming traffic between two regions has been repeatedly confirmed for U.S. carriers for domestic long-distance service (Taylor, 1994). The opportunity for arbitrage exists if the price differential between two countries is nonzero; i.e., callers may originate conversations in the low-cost country.

Bewley and Fiebig

Bewley and Fiebig (1988) explain the aggregate levels and apportionments of outgoing calls and minutes from Australia to ten different countries. In order of ascending price, there are three kinds of outgoing international traffic – direct-dial (DD), operator-assisted (OA) station-to-station (SS), and OA person-to-person (PP). Direct-dial service was not available to all callers.

Separate econometric equations were estimated for total numbers of calls and minutes. Respective per minute charges for DD and OA calls were P_{DD} and P_{OA}. With a three-minute minimum duration, setup charges for SS and PP calls were $F_{SS} = 3P_{OA}$ and $F_{PP} = 3P_{OA} + S$, where S is a surcharge. With no minimum duration, DD setup prices were $F_{DD} = kP_{DD}$, where k was econometrically fitted.

Date were pooled quarterly time-series cross-section from 1976:3 to 1983:1. The dependent variable in each "total calls equation" was aggregate call volume. Independent variables included deflated real average setup price of an international phone call, deflated GDP, the first difference in call volume, and a dummy variable for a fourth-quarter shift. In three separate but related "call share equations", component shares for DD, SS, and PP were regressed upon F_{SS}/F_{DD}, F_{PP}/F_{DD}, number of subscribers connected to direct-dial, the lagged dependent variable, and a fourth-quarter dummy. The log-log format was used.

The dependent variable in each "total minutes equation" was excess minutes-of-use (i.e., beyond minimum duration). Independent variables included deflated average per minute price, deflated GDP, the first difference in call minutes, and a fourth-quarter dummy. Because the per minute price for all operator-assisted (OA) calls is the same across SS and PP, only two component shares were meaningful and only one equation needed to be estimated. In one

"minute share equation", share for operator-assisted minutes was regressed upon P_{OA}/P_{DD}, total excess minutes, the lagged dependent variable, and a fourth-quarter dummy. The log-log format was used

International correspondent countries were divided into short-haul and long-haul groups. Except for price elasticity, different coefficients were estimated for long-haul and short-haul traffic. Each model was estimated with full information, maximum likelihood.

In "total equations", own-price elasticities for total long- (short-) haul calls and minutes were -0.134 (-0.140) and -1.833 (-0.974). In each "total equation", coefficients on deflated GDP were always significantly positive. In all equations except long-haul minutes, first-differences in the dependent variables were significantly negative.

In "call share equations", own-price elasticities for long- (short-) haul DD, SS, and PP call shares with respect to P_{DD}, P_{OA}, and S were -1.62, -3.00, -0.67 (-1.94, -2.69, -0.68). Coefficients on lagged dependent variables were significantly positive, while coefficients on the number of DD subscribers were insignificant. Though not always significant, cross-price elasticities were generally positive, suggesting strong substitution effects.

The authors then combined price elasticities in their call, minute, and share equations to obtain a composite estimate of how setup and minute prices affect both call numbers and minutes. The price elasticities of long- (short-) haul calls with respect to P_{DD}, P_{OA}, and S were -0.01, -0.36, and -0.10 (-0.01, -0.37, and -0.09). Price elasticities of long- (short-) haul minutes with respect to P_{DD} and P_{OA} were -1.02 and -1.47 (-1.34 and -1.14). The total number of calls then is not very elastic with respect to any price instrument, while usage minutes generally are.

Appelbe et al.

Appelbe, et al. (1988) derived econometric equations for outgoing billed minutes for customer dialed calls from each of six Canadian provinces to each of four U.S. regions. Separate regressions were estimated for full-rate (8 am to 6 pm, Monday to Saturday) and discount periods for both short-haul (0-800 miles) and long-haul traffic routes. Independent variables in each equation were own-price index (CPI deflated), number of outgoing access lines (residence, business, or total), return traffic, economic activity (provincial employment, retail sales, or exports), seasonality, and special events. Data were pooled quarterly time-series/cross-sectional over unspecified years. A log-log format was used with pooled, generalized 3SLS.

Each cross-section had a distinct intercept and slope coefficients on access lines and economic activity; the estimated coefficients on economic variables and number of access lines were always significantly positive. By contrast, coefficients on own-price (designated A_1) and return traffic (A_2) did not vary by cross-section. Estimated values of A_1 were significantly negative: -0.35 (full rate, short-haul), -0.43 (discount, short-haul), -0.38 (full rate, long-haul), and -0.45 (discount, long-haul). Corresponding estimated values of A_2 were 0.42, 0.24, 0.47, and 0.40 and confirmed significant complementarities in international traffic. Assuming identical values of A_2 on the return traffic U.S.-Canada equation (which was not estimated), the total price elasticity for Canadian callers was $E_1 = A_1/[1 - A_2^2]$. Respective values of E_1 were -0.43, -0.45, -0.49, and -0.53.

Acton and Vogelsang

Acton and Vogelsang (1992) derived econometric equations to explain two-way billed minutes between the U.S. and each of seventeen European countries. Price variables included in reduced equations were charges in the daytime tail block (deflated and U.S.-converted) for both originating and terminating correspondents, and telex prices. Also included were originating access lines, deflated GDP (separately represented for U.S. and foreign nations), volume of bilateral trade, and sector employments for agriculture, restaurants/hotels, banking, manufacturing, and transportation.

Data were pooled annual time-series, cross sectional data from 1979-86. The authors used a log-log format with dummy intercepts for each country. They adjusted for heteroscedasticity and first-order autocorrelation.

Estimated own-price demand elasticities for U.S. and foreign callers were -0.36 and -0.49 and significantly negative. Estimated elasticities for return-prices were insignificant. Coefficients on U.S. outgoing telex prices were significantly positive, confirming some complementarity. Coefficients on originating access lines and real GDPs were significantly positive, while trade volume was insignificant. Each sector employment had a positive significant coefficient except transportation (insignificantly negative).

Hackl and Westlund

Hackl and Westlund (1995) derived econometric equations to explain outgoing traffic minutes from Sweden to each of six foreign correspondents (Germany, U.K., U.S., Denmark,

Norway, and Finland). Explanatory variables were deflated own-price, bilateral trade volume, Swedish industrial production index (IPI), correspondent IPI, and seasonal dummies. Data were pooled monthly time-series, cross-section from 1976-90. The structural form was log-log, which was close to optimal among Box-Cox transforms.

Coefficients on IPI and trade volume variables were significantly positive; the former variable was lagged for up to six months. More important in this abbreviated model was the authors' use of locally weighted curve fitting (Cleveland et al., 1988) to allow own-price-elasticities to vary over time.[12] Except for U.S. traffic, these elasticities continually increased during the data period and were uniformly near or above unity in 1990. By contrast, the demand elasticity for U.S. traffic diminished over the interval and was near zero in 1990, contradicting Taylor's (1980) conclusion that elasticity increases with travel distance. The authors conjectured that elasticities may have changed due to new technologies (e.g., fax), changes in consumer awareness, and temporal shifts between business and residential calling.

Sandbach

Sandbach (1996) used econometric equations to explain two-way billed traffic minutes between each of seven European countries and each of twenty other nations (including one another).[13] Data were 1995 annual cross-sectional, and the estimation technique was OLS.

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[12]A more detailed discussion appears in Hackl and Westlund (1992).

[13]The initial seven were U.K., France, Germany, Italy, Netherlands, Sweden, and Switzerland. The latter twenty included these seven, U.S., Ireland, Spain, Australia, Canada,

The author included three price variables: own-price, price difference (own minus reverse price) , and a truncated price difference which kicked in only when it exceeded a "best fit" threshold ($0.90/minute). Both differentials were included to capture the effects of straight arbitrage. Other variables included originating and terminating lines, per capita real GDP, common language dummy, number of time zone differences, geographic distance (inverted), and a dummy for Germany-Turkey. For unexplained reasons, only minutes, access lines, and GDP were "logged", while the remaining variables were "leveled".

The coefficient on price level was significantly negative. The coefficient on the first price difference was correctly negative and almost significant (at 5%). The coefficient on the second price difference was insignificant. Coefficients on originating and terminating access lines, per capita deflated GDP, common language dummies, the Germany-Turkey dummy were significantly positive. Coefficients on time zone differences and geographic distance were significantly negative.

Garin Munoz and Perez Amaral

Garin Munoz and Perez Amaral (1996) estimated econometric equations to explain aggregate outgoing total international traffic from each of fifty provinces in Spain. Data were pooled annual time-series, cross-section from 1985-89. The structural form was log-log.

The authors used two alternative dependent variables -- per line deflated expenditure and

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Belgium, Denmark, Greece, Japan, Norway, Austria, Turkey, and Portugal.

traffic minutes. Explanatory variables included deflated (CPI) own-price index, national gross value added, number of stayovers in hotel establishments by foreign tourists, number of foreign residents, and number of Spanish emigrants going abroad. Respective estimated own-price (value added) elasticities in the two respective equations were -0.77 (0.63) and -0.57 (0.47). These price and value added elasticities greatly exceeded comparable results that one author (Perez Amaral, 1995) derived for interprovincial domestic traffic within Spain (-0.13 and 0.46). Elasticities for tourism and foreign residents were significantly positive.

6. **Conclusion**

I regard the following points to be most important regarding the literature under review:

1. Hakim and Lu suffers from the assumption that arbitrage is perfect and that calls originate always in the low-cost country. However, the possibility of some arbitrage may provide incentives for carriers to ratchet prices upward in order to avoid higher origination costs. Their paper makes a contribution by suggesting some implications.

2. Carter and Wright attempt to disprove an allegation that carrier collusion increases international rates. The paper suffers from the assumption that individual carriers may unilaterally set terminating charges. If carriers instead negotiate with one another, lower settlement rates would be expected. This could reverse the conclusion.

3. Cave and Donnelly correctly represent the settlements process as a two-stage game where bargaining carriers set accounting rates in first-round negotiations and then unilaterally choose collection rates. This basic framework is seminal. The authors establish that marginal

cost pricing can be expected under negotiation if and only if carriers are equally sized. This conclusion suggests that ongoing regulation may be necessary.

4. Yun, Choi, and Ahn establish that developing and developed nations have differing interests and that domestic competition can lead to higher settled accounting rates for international calls This further supports an ongoing role for an interventionist regulator.

5. Galbi identifies the disparate interests of small and large carriers and provides a series of testable assumptions regarding their relative traffic outflow. His conclusion that correspodents will differ over the desirability of cost-based interconnection is interesting and supports regulatory interventionism. It is interesting that the country with positive net international settlements payments might not support cost-based settlements.

6. O'Brien's paper is theoretically elegant and points out the potential danger of the FCC's uniform settlements policy.. I wonder how robust the results are to the underlying modeling assumptions about negotiating sequences and costs. Since outgoing U.S. traffic exceeds incoming, O'Brien would predict that U.S. carriers would disfavor USP. This is a questionable prediction.

7. Bewley and Fiebig is the only surveyed econometric paper that recognizes that setup and usage minutes are two components of a call that have two distinct prices. They appropriately model customer demand for each. The paper is unique in estimating share equations for calls and minutes across respective calling categories. The econometrics are firm, while the list of explanatory variables is meager.

8. Appelbe et al. is the only paper that includes return traffic as an explanatory variable for outgoing volume. They confirm that complementarities exist in international markets.

However, the authors also demonstrate that domestic complementarities in Canada are larger.

9. If a nation's incoming and outgoing calls are possibly related, it is unclear why economic activity in a correspondent country should affect a nation's outgoing call volume while return-prices should not, as in Acton and Vogelsang. I suspect that the included telex prices may have provided some multicollinearity and therefore increased the variance of the measured price coefficient.

10. The Hackl-Westlund piece is seminal for time-series researchers. There is no reason to believe that demand elasticities are constant over time. These may change due to modified technology (e.g., fax), sectorial mix (business vs. residence), consumer tastes, or economic integration.

11. Sandbach uses out many intriguing variables that affect calling correspondence. Unfortunately, he uses OLS and his functional form is strange, combining logs, levels, and inverses. The included price variables suggest multicollinearity; the arbitrage term $[P_{ji} - P_{ij}]$ would probably be significant if the threshold terms were eliminated.

12. Garin Munoz and Perez Amaral pay special attention to tourism and immigration. This seems worthwhile, particularly for a popular international destination such as Spain.

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