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ON THE IMPACT OF "CALL-BACK" COMPETITION ON INTERNATIONAL TELEPHONY *

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Abstract

In this paper we build a simple three-country model to evaluate the impact of "call-back" on international telephony. The effects on both accounting rates and collection prices are studied. Call-back firms exploit arbitrage opportunities in collection prices among countries, rerouteing calls that originate in countries with high prices for international phone calls via countries with low prices. Contrary to what it is commonly perceived, we show that call-back tends to magnify the distortions associated with the current accounting rate regime. In particular call-back puts upward pressure both on low price countries foreign accounting rates and collection charges. Call-back companies are assumed to enjoy a price discount on each rerouted call; we show that the larger the price discount offered to call-back companies, the higher the prices for international calls in the country hosting call-back.

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Key Words: telecommunications, call-back, access, accounting rate, collection charge, international telephony.

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1 Introduction.

The aim of this paper is to analyse and evaluate the impact of "call-back" on international telecommunications. Call-back is an alternative way of placing international calls (alternative calling procedure[1] in the industry jargon) that new technologies have made available to customers for international voice communications. Until recent market liberalisation decisions by many national governments are effectively put in place, ACPs, and call-back in particular, are one of the main challenge to national carriers monopolistic power.[2]

Call-back is based on a very simple idea: suppose a customer in Italy wants to speak with a friend in a different country (the US). If the price of a call from the US to Italy is lower than the price of a call in the opposite direction, then it may be cheaper for the Italian resident to be called rather than to call the friend located in the US. He will then compensate the friend for the cost of the call. Instead, he can use a public call-back service and get a computer to do the call-rerouteing.

In the typical call-back call, first a customer in one country places a free call to the call-back operator equipment (usually just an automated system) in a second country. The operator, which detects the caller's identity without answering the call, calls the customer back at a predesignated number providing the customer a dial tone in the second country and connects the customer to a number in the second or third country. The original call is now "rerouted" via the country where the call-back firm operates.

Most call-back enterprises are located in the US where lower prices for international phone calls provide wide margins for arbitrage opportunities. Industry estimates have shown that there were up to 600 million minutes of call-back traffic in 1995, equivalent to 1% of total telephone traffic or 4% of US international traffic.[3] In terms of revenue, estimates put the market size at $15 billion in 1994. The figures are more impressive when one thinks that the market for call-back didn't exist until few years ago and it has increased tenfold between 1993-1995.

Despite its growth, call-back is still a very controversial phenomenon. On the one hand the FCC, the US regulatory authority that provides the licences to US-based call-back firms, and international organisations such us the OECD and, more recently, the ITU (International Telecommunications Union) have argued in favour of call-back.[4] Accordingly, call-back should be encouraged because it would engineer downward pressure on prices for international phone calls. On the other hand, 60 countries around the world, mainly developing countries, have so far declared call-back illegal in their territories[5] and are putting pressure on the FCC to stop licencing of new call-back operators. These countries perceive call-back as a problem because it deprives the local operator of revenues from the international telecommunications sector.[6] This controversy has been, and still is, a source of strong debate among operators.

[1] ACP hereafter.

[2] An exhaustive description of the ACPs is provided in OECD (1995) . The most common practices of ACPs are: reverse charge calling, credit card calls, country direct service, country and beyond service, call-back, international free-phone service, international leased lines and refile (hubbing).

[3] See ITU (1996) and ITU (1999). Call-back traffic is included in the "pure-resale" category in the FCC statistics. In 1997, pure-resale accounted for 15% of the whole outgoing US traffic. See Lande and Blake (1997).

[4] After more than two years of legal disputes, the FCC gave its final assent to the provision of call-back services in 1995 (10 FCC Rcd 95-40). See Propp (1996) for a discussion of the legal issues related to the FCC decision to authorize call-back operators in the US. But note that not all types of call-back are allowed: the so called "call-bombardment" and "answer suppression" are fraudulent since they interfere with the billing mechanism of the national operators.

[5] The list of these countries is kept up-to-date in the ITU web-site (`http://www.itu.int/`).

[6] Arguments for and against call-back are summarised in Kelly (1996).

The surprising growth and development of this particular form of competition has been made possible by the way in which international telecommunications are organised. The typical method of governing interactions among national telecom operators is the accounting rate system. Consider, for example, a call from Italy to France: the Italian carrier keeps the revenue for this call but, for this call to be terminated (i.e. received by a user in France), it must pay an access fee to the French operator for the use of its network. The same fee applies to each call that goes from France to Italy; this fee (called the accounting rate or the interconnection charge) is arranged in bilateral negotiations between the two operators.

As suggested by Frieden (1997), under this regime, carriers have failed to negotiate adequate interconnection charges. Even if accounting rates are falling over time, they are still well above the cost of providing interconnection.[7] This distortion in the access charges has kept prices for international phone calls at a artificially high level preventing them from reflecting the dramatic costs reduction implied by the development of new technologies.

Call-back advocates, such as the OECD, argue that this form of competition between international operators creates downward pressure both on retail prices and accounting rates. According to Frieden (1997), the more nations authorizing call-back, the more accounting rates and collection charges decrease consequently.

In a recent paper, Choi *et. al.* (1999) provide a formal treatment of the callback phenomenon. Interestingly, they show that one of the main reasons for the exisiting of callback services is the inefficiency of the accounting rate system. Nonetheless, in their paper, the inefficiency is not fully explained; in addition, the authors use a two country model, while most callback operators reroute calls between two high price countries and are located in a third country with low international rates. By using a three country model, we make endogenous the choice of the accounting rates in order to highlight the consequences of call-back both on accounting and retail charges; we show that with call-back, accounting rates and collection prices on different routes, otherwise uncorrelated, become interconnected. As a consequence, the distortive effects of the accounting rate regime are no longer restricted to few specific routes, but rather are extended to the interconnection agreements between the countries involved in the calls rerouteing.

This paper demonstrates that call-back puts upward pressure on the accounting rates between "high price" countries (called *target* countries) which in turn pushes up collection prices. In addition, it is shown that the impact of call-back on the prices charged by the low price carrier (called the *host* carrier) depends upon the price discount offered to call-back firms. Quite surpsisingly, it is found that the larger the discount, the higher the host carrier mark-up.

Although in a different context, these results confirm similar arguments presented in Alleman (1998) and are the consequence of the accounting rate regime. Indeed, instead of undermining it, call-back exacerbates the distortions that this regime has on prices: when call-back firms are in the market, carriers in target countries may find it optimal to raise the reciprocal interconnection fee in order to enjoy higher payments from the country hosting the call-back firms.

The paper is organised as follows. In Section 2 we present the model. Section 3 evaluates and discusses the solution of the game and Section 4 concludes the paper.

[7] Data about accounting rates are confidential and, apart from the US and the UK, they are not published; estimates of the accounting rates can be found in OECD (1997).

2 The model.

We model a world with three countries **A**, **B** and **C**. For sake of simplicity, we assume that in each country, telecommunications are provided by only one operator (carrier). This assumption may appear rather unrealistic, especially in relation to the country hosting the CB firms. In the real world, price differences occur mainly because in some countries telecommunications are opened to competition. Nonetheless, as it will become clear later, the main arguments of the paper are not affected by this assumption. In this stylized world only international telephone services are provided. That is, calls originating in one country and terminating (i.e. received by a user) in another country. We make the following assumptions:

- National carriers in countries **A** and **B** have the same cost conditions. We denominate with c the cost incurred by these operators in collecting a call on their local network and sending it to the "half-way point".[8] Instead, carrier **C** (**C** for cheaper) is more efficient: it incurs a lower cost per outgoing call: $c_c < c$. Given its superior technology, carrier **C** can set lower prices for calls directed to countries **A** and **B**: prices for international calls differ according to the direction of the call (i.e. a call from **C** to **A** costs less then a call in the opposite direction).

- Each call directed to a country must transit on that country's network in order to reach the final user. The transmitting carrier pays for each call an access fee to the receiving carrier for the use of its network. This fee, called the "accounting rate", is reciprocal (i.e. the same access charge for a call from **A** to **B** applies to a call from **B** to **A**) and is negotiated between the carriers involved in the call transmission. The accounting rate is determined according to a Nash-bargaining process.

- The cost of providing access (the cost of delivering other carriers' calls) is c_o and is the same across countries.

- Call-back firms (CB hereafter) are located in country **C**. The CB sector is characterised by price competition with free-entry. CB enterprises exploit arbitrage opportunities based on calls rerouteing: a CB firm located in **C**, the *cheap* country, can reroute a call from **A** to **B** (or viceversa) transforming it into two outgoing calls from **C**. For these reasons, we denominate **A** and **B** *target* countries and **C** *host* country.

This symmetric framework is a simplification since asymmetries between countries both at the demand and at the cost level often occur. Nonetheless we must start somewhere and we believe that this stylized enviroment, beside contributing in keeping the model at a reasonable level of complextity, it is a good starting point for our purposes.

2.1 The demand for international telecommunications.

Our main purpose is to investigate the impact of CB on high price countries reciprocal accounting rates and tariffs. For this reason we assume that CB services are provided only on the main route **A-B**. We rule out the possibility that CB firms offer to reverse calls from **A** or **B** to **C**. This is a simplification because, usually, once the customer located in the target country (for example **A**), is connected with the CB terminal equipment, he can then place a call either in the host country **C** or to a foreign destination (**B**).[9]

[8] This is called the imaginary point of interconnection between national networks.

[9] However, if markets are separated and there are no economies of scale, the introduction of CB even between target and host countries would not affect our results. For an analysis of CB between target and host countries, see Choi *et al.* (1999).

CB firms act symmetrically with respect to the target carriers: each CB firm offers to reroute both calls from **A** to **B** and from **B** to **A**. This is what happens in practice in the CB market: unless a country has banned CB, then CB firms provide connection in both the directions of the call.

There are n CB firms, indexed by $h = 1, \ldots, n$, all located in the host country **C**. They have two main effects: on the one hand they compete with networks **A** and **B** by lowering the amount of calls that they place each other and, on the other hand, they increase the number of calls originating in **C**.

Each customer located in a target country can place calls to individuals located in the other target country either via his country's national carrier or through a CB company. We model standard calls and CB calls as imperfect substitutes: the demand for CB services increases with the price for standard calls.

Formally, denoting by Q_i^j the demand for standard calls from i to j, by Y_i^j the demand for CB services on the same route, and by p_i^j and v_i^j the prices for these calls, the following assumption is made:

Assumption 1

$$a) \quad \frac{\partial Q_i^j(p_i^j, v_i^j)}{\partial p_i^j} < 0 \quad \frac{\partial Y_i^j(v_i^j, p_i^j)}{\partial v_i^j} < 0 \quad \frac{\partial Y_i^j(v_i^j, p_i^j)}{\partial p_i^j} > 0 \quad i, j = \boldsymbol{A}, \boldsymbol{B} \quad \textit{and} \quad i \neq j$$

b) The demand for standard calls and the demand for call-back calls are the same across countries and have costant price elasticities, denoted by η and ε respectively:

$$\eta = -\frac{\partial Q_i^j}{\partial p_i^j}\frac{p_i^j}{Q_i^j} \qquad i, j = \mathbf{A},\mathbf{B},\mathbf{C} \quad \textit{and} \quad i \neq j$$

$$\varepsilon = -\frac{\partial Y_i^j}{\partial v_i^j}\frac{v_i^j}{Y_i^j} \qquad i, j = \mathbf{A},\mathbf{B} \quad \textit{and} \quad i \neq j$$

c) $\varepsilon > \eta > 1$.

The assumption of imperfect substitutability ($1a$) is taken on practical ground: on the one hand, although CB is becoming a very popular telecommunication service, its use is still confined to a restricted share of well informed customers. In addition, calls placed via CB are often of a lower quality when compared to standard calls (delays in the conversation, echoes, noise etc.): quality considerations may reduce the attractiveness of these services affecting customers' demand. According to these observations, it is even natural to assume that the demand for CB calls is more reactive to change in prices then the demand for standard calls (assumption $1c$): although we cannot empirically support this assumption, we believe it is reasonable to think of CB users more concerned of changes in prices than the customers of standard calls.[10]

2.1.1 Traffic flows.

CB rerouteing affects the traffic flows between countries. For each call that is rerouted from the main line **A-B** via **C**, two outgoing calls from **C** are placed.

The following graphical representation will help to understand the traffic flows

[10] The condition $\eta > 1$ is necessary to guarantee positive equilibrium prices and is supported by some studies of elasticity of demand for international calling. See OECD (1997) or Lande and Blake (1997).

[Figure 1 here]

The amount of calls delivered on carrier i's network directed to country j is the combination between the amount of standard calls Q_i^j and CB rerouteing Y_i^j. In particular, the traffic flow between target carrier **A** and **B** is given by

$$\begin{array}{ccccc} \text{Traffic Flow} & & \textit{standard calls} & & \textit{call-back rerouteing} \\ TF_i^j(\cdot) & = & Q_i^j(p_i^j, v_i^j) & - & Y_i^j(v_i^j, p_i^j) \end{array}$$

while the flow of calls from country **C** to country i is

$$TF_c^i(\cdot) = Q_c^i(p_c^i) + Y_i^j(v_i^j, p_i^j) + Y_j^i(v_j^i, p_j^i)$$

with $i = \mathbf{A}, \mathbf{B}$ and $i \neq j$.

According to our simplification, CB firms reverse calls only on the route **A-B**. This implies that the traffic of calls from countries **A** and **B** to country **C** is not affected by CB.

2.2 Fundamentals of the reciprocal accounting rate regime.

The current system of multilateral collaboration in the transmission of international calls is the accounting rate regime. According to this regime, the transmitting carrier pays for each call sent to the foreign carrier an access fee (the accounting rate) for the use of its network and receives an equal payment for each incoming call from this operator. The accounting rate is negotiated at bilateral meetings between telecom carriers.

We assume that these negotiations take the form of a Nash-bargaining process in which the contracting parties have the same bargaining power.[11] Formally, the accounting rate between country i and j ($ar_{i,j}$) is given by

$$ar_{i,j} = argmax\left[\pi_i^{1/2}\pi_j^{1/2}\right] \tag{1}$$

where π_i is the carrier i's profit function. We denominate a the accounting rate between target carriers (**A** and **B**) and t_i the accounting rate between carrier **C** and carrier i.

The following table summarizes the adopted notation.

[Tab 1 here]

The analysis of the current accounting rate regime is beyond the scope of this work. Nonetheless, as it will become clear later, since CB is intrinsically related to the process through which collection charges are determined, it is important to recall briefly how this regime works; in particular two main effects are worth noting:[12]

[11] This is realistic in this framework in which international telecommunications are supplied by monopolies but it applies even when competion is considered. In this case we can think to a regulatory policy that assigns to a representative carrier a monopoly equivalent bargaining power.

[12] For a formal treatment, we refer to an earlier version of this paper; there we study the consequences of demand and cost asymmetries on bargained accounting rates (paper available on request).

- when carriers face the same demand and cost conditions (perfect symmetry), traffic flows between countries are balanced (outgoing traffic = incoming traffic) and the bargained access price is set equal to the cost of providing access. In our case, since carriers **A** and **B** are identical, then $a = c_o$;

- when there is asymmetry between countries either at the demand or at the cost level, traffic is no longer balanced and the bargained access price is shown to be above the cost of providing access. In this model, due to the technological asymmetry, traffic flows between host and target countries are unbalanced; this implies that $t_i > c_o$.

Perfect symmetry is a very special situation. In more general cases traffic flows among countries are unbalanced. That is, due to the reciprocity of the accounting rate regime, the carrier that terminates more calls than it originates receives for interconnection to its network more than it pays to the foreign carrier.[13]

When the traffic is unbalanced, carriers fail to set the reciprocal access charge at the cost level. This is considered one of the reasons why international calls charges are higher when compared to national long distance calls. The accounting rate is de facto an additional cost per call that each carrier must pay to have its calls delivered. The higher the accounting rate, the higher the cost per call and the higher are collection prices.[14]

2.3 Firms' profits.

2.3.1 Call-Back firm's profit.

CB firms are assumed to be identical and, as stated above, they are established in country **C**. For each rerouted call from one target country to the other, they must pay the hosting carrier for the price of two outgoing calls. In practice, CB firms enjoy lower prices than residential customers since they fully exploit the volume discounts offered by the host carrier: assuming that CB firms do not face additional costs for each call, the CB cost per call is equal to a discounted sum of two outgoing calls from **C**. We denote the price charged to CB companies by p_{cb}, with $p_{cb} = \theta(p_c^a + p_c^b)$, where $\theta \in [0, 1]$ represents the discount rate. For the moment, let us assume that θ is exogenous. Note that p_{cb} is independent of the direction of the rerouted call.

Since each CB firm reroutes calls both from **A** to **B** and from **B** to **A**, the profit function for the h CB firm is then

$$\pi_{CB}^h = \sum_{i,j=\mathbf{A},\mathbf{B}} [v_{i,h}^j - p_{cb}] Y_{i,h}^j(\cdot) \quad h = 1, \ldots, n \quad \text{and} \quad i \neq j \tag{2}$$

where $v_{i,h}^j$ is the price for calling from i to j charged by the h CB operator and $Y_{i,h}^j$ is the demand it faces.

2.3.2 Carriers' profits.

The profit functions for each established carrier are given by

[13] The growing imbalances in traffic flows between countries have produced large deficits in countries like the US, Sweden or Australia and large surpluses in other countries such as Mexico or Germany. Data on traffic flows settlement payments are in ITU (1999).

[14] For these reasons many governments and organisations are promoting the introduction of new interconnection arrangements. See De Fraja and Valbonesi (1998) for a discussion of the proposed reforms of the accounting rate regime.

$$\begin{aligned}\pi_i &= \left[p_i^j - c - a\right]Q_i^j(\cdot) + (a - c_o)Q_j^i(\cdot) + \left[p_i^c - c - t_i\right]Q_i^c(\cdot) + \\ &\quad + (t_i - c_o)\left[Q_c^i(\cdot) + Y_i^j(\cdot) + Y_j^i(\cdot)\right] \qquad i,j = \mathbf{A},\mathbf{B} \quad \text{and} \quad i \neq j \end{aligned} \tag{3}$$

$$\pi_c = \left[p_{cb} - 2c_c - t_a - t_b\right]\left(Y_a^b(\cdot) + Y_b^a(\cdot)\right) + \sum_{i,j=\mathbf{A},\mathbf{B}} \left[p_c^i - c_c - t_i\right]Q_c^i(\cdot) + (t_i - c_o)Q_i^c(\cdot) \tag{4}$$

where p_i^j is the price for a call between target countries via established carriers ($i,j = \mathbf{A}$, $\mathbf{B}$), while p_c^i and p_i^c are the prices for $\mathbf{C}$'s outgoing and incoming calls respectively. a and t_i are the bargained accounting rates between target countries and between the host country and country i respectively. In (4), the first term represents the profit from selling calls to CB operators. Each rerouted call implies two outgoing calls from $\mathbf{C}$; each pair of calls is charged p_{cb} and costs $(2c_c - t_a - t_b)$ to the host carrier.

Using the definitions of traffic flows and rearranging, it is useful to rewrite carriers $\mathbf{A}$ and $\mathbf{B}$ profit as follows:

$$\begin{aligned}\pi_i &= \left[p_i^j - (c + c_o)\right]Q_i^j + (a - c_o)\left[Q_j^i - Q_i^j\right] + \\ &\quad + \left[p_i^c - (c + c_o)\right]Q_i^c + (t_i - c_o)\left[TF_c^i - Q_i^c\right]\end{aligned}$$

This expression shows that if the access charge exceeds the marginal cost of giving access c_o, then the carrier makes money on access (accounting revenues) only if it terminates more calls than it originates. When volumes of incoming and outgoing traffics are unbalanced, then the operator which generates more traffic pays for the difference to compensate the terminating carrier (the so called "settlement payment"). For example, if $a > c_o$ then carrier $\mathbf{A}$ receives from $\mathbf{B}$ a positive settlement payment if $Q_b^a - Q_a^b > 0$. The reciprocal accounting rate regime implies that part of the "high traffic" carrier's profit is "stolen" by the "low traffic" firm through the bargaining process.

It is therefore clear how this system reduces the incentives for a firm to cut its prices: lower prices imply more outgoing calls and, as a consequence, a lower (even negative) settlement payment.

2.4 The timing.

We model CB competition as a four stage game: see Figure 2.

[Figure 2 here]

In the first stage, each monopolist negotiates the reciprocal accounting rates with each of the other carriers. At this stage a, t_a and t_b are determined.

Given these values, collection prices are defined in the second stage. This sequence of events is justified on practical ground: accounting rates are negotiated during periodical meetings between telecom operators. Retail prices are then adjusted accordingly. In the third stage CB competition occurs. CB firms exploit arbitrage opportunities between carriers prices. This means that CB firms observe the retail prices for international phone calls charged by carriers and then compete in the market for CB calls. In the last stage, firms' profits are realised.

3 The impact of Call-Back competition.

CB is a textbook example of a market with no cost of entry. Indeed, to set up a CB firm and to start competing, only switched equipment terminals are required. For this reason, in the last few years there has been a proliferation of CB companies, especially in the US.[15] Accordingly, we analyse CB assuming price competition with free entry.

3.1 t=2: Call-Back competition.

Starting from the last stage of the game, we solve the model by backward induction. At date $t = 2$, CB competition occurs: CB firms observe the collection prices charged by the carriers at $t = 1$ and then compete in the market for rerouted calls.

CB firms compete on prices: given the collection prices set by domestic carriers, each company sets its prices $v^j_{i,h}$, with $h = 1, \cdots, n$. The profit function for the h CB firm is given in (2). Note that at this stage of the game, carriers' collection prices are determined: $Y^j_{i,h}(\cdot)$ is now function only of the prices charged by CB firms.

Since the CB industry is characterised by price competition, then CB calls are priced at marginal cost. The cost for each rerouted call is a discounted sum of the prices of two outgoing calls from **C**; this implies that at the equilibrium:

$$v = v^j_{i,h} = \theta(p^b_c + p^a_c) \qquad i, j = \mathbf{A}, \mathbf{B} \quad and \quad h = 1, \cdots, n \tag{5}$$

We note that: *i*) the equilibrium price for a CB call is independent on the direction of the call, and *ii*) since p^i_c is a component of the marginal cost of the CB firms, then an increase in **C**'s outgoing prices implies, for given θ, a reduction in CB rerouteing:

$$\frac{\partial Y^j_i}{\partial p^i_c} = \frac{\partial Y^j_i}{\partial v}\frac{dv}{dp^i_c} < 0.$$

3.2 t=1: Second stage collection charges.

At date $t = 1$ carriers set their prices given the reciprocal access charges a and t_i that they have bilaterally negotiated at $t = 0$. The following proposition presents the second period mark-ups at the symmetric equilibrium.

Proposition 1 *At the symmetric equilibrium* $p = p^b_a = p^a_b$, $p_c = p^a_c = p^b_c$, $p^c = p^c_a = p^c_b$ *and* $t = t_a = t_b$*; the equilibrium mark-ups are*

$$\frac{p - (c + a)}{p} = \frac{1}{\eta}\left[1 + \frac{t - c_o}{p}\rho\frac{Y}{Q}\right] \tag{6}$$

$$\frac{p^c - (c + t)}{p^c} = \frac{1}{\eta} \tag{7}$$

$$\frac{p_c - (c_c + t)}{p_c} = \frac{1}{\eta}\left[\frac{1 + 2\frac{Y}{Q_c}\left(\theta + \varepsilon(1 - \theta)\right)}{1 + 2\frac{\varepsilon}{\eta}\frac{Y}{Q_c}}\right] \tag{8}$$

[15] An update list of the currently operating CB providers is on the WEB site `http://telworld.com/callbackworld/`.

where ρ is the cross elasticity of the demand for CB calls to target carriers prices.[16] Since for customers located in target countries CB calls and standard calls are substitutes, then $\rho > 0$.

Proof See the Appendix. ■

Note that without CB ($Y = 0$) these mark-ups all reduce to

$$\frac{p_i^j - (c_i + ar_{i,j})}{p_j^j} = \frac{1}{\eta} \qquad c_i = c, c_c \tag{9}$$

that represents the standard monopoly's pricing formula where the marginal cost per call is the sum between the collection cost and the accounting rate. Without CB, telecom operators act as monopolies that price accordingly to the inverse of the elasticity rule.[17]

Observing the results given in Proposition 1, it is clear that the presence of CB firms makes collection charges and accounting rates for calls on the different routes more correlated. This is an important result. In particular note that optimal second stage prices for calls on the route **A-B** given in expression (6) depend, not only on the amount of calls rerouted by CB on each route (Y), but even on the accounting charge t between target carriers and the host carrier **C**. Without CB, the traffic on each route is independent of the traffic on any other route. With CB part of the traffic flows on one route is moved to a different route; this fact puts in relation prices and quantities of calls that are otherwise uncorrelated.

Nevertheless, since at date $t = 1$ retail prices are defined as functions of the negotiated accounting rates, in order to analyse the impact of CB services on carriers collection prices it is necessary to characterize the behaviour of the interconnection charges between networks. This analysis is conducted in the following section.

3.3 t=0: Accounting rates.

3.3.1 The accounting rate between target countries.

Interconnection charges (or accounting rates) are defined at date $t = 0$ according to a Nash-bargaining process. We assume that firms have equal bargaining power. The following proposition presents our main result:

Proposition 2 *When call-back firms reroute calls between target countries, the interconnection charge between these countries increases with respect the solution without call-back:*

$$a > c_o$$

Proof. Using second stage prices provided in Proposition 1, carriers' profits can be expressed in terms of the access charges only. Therefore, according to expression (1) the accounting rate between carriers **A** and **B** is given by

$$a = argmax\left\{ \left[\log \pi_a \left(p_a^b(a), p_b^a(a), a \right) + \log \pi_b \left(p_a^b(a), p_b^a(a), a \right) \right] \right\}$$

[16] $\rho = \frac{\partial Y_i^j}{\partial p_i^j} \frac{p_i^j}{Y_i^j}$.

[17] Nevertheless note the peculiarity of the international telecommunications industry with respect to a standard monopoly case. Each monopolist produces an input (the access) that is necessary to the production of the foreign monopoly and viceversa. This is called "symbiotic production" (Carter and Wright (1994)). In addition, since each carrier is restricted to operate in its own country, customers cannot choose which operator to use. For an analysis of competition among networks, see Laffont et al. (1998a and b).

Differentiating the argument of the above expression and using the fact that, by the envelope theorem, $\partial \pi_i / \partial p_i = 0$, the bargained accounting rate solves the equation

$$\left[\frac{\partial \pi_a}{\partial p_b^a} \frac{dp_b^a}{da} + \frac{\partial \pi_a}{\partial a} \right] \pi_b + \left[\frac{\partial \pi_b}{\partial p_a^b} \frac{dp_a^b}{da} + \frac{\partial \pi_b}{\partial a} \right] \pi_a = 0$$

In our symmetric environment, this expression reduces to

$$(a - c_o) \frac{\partial Q}{\partial p} + (t - c_o) \frac{\partial Y}{\partial p} = 0 \tag{10}$$

rearranging

$$a - c_o = (t - c_o) \frac{\rho}{\eta} \frac{Y}{Q} \tag{11}$$

Where t is the interconnection charge between host and target countries.[18] By construction, the traffic flow between the host country **C** and target country i is unbalanced. Then, as we saw before, the negotiated accounting rate between the host carrier **C** and the target carrier i is set above the cost of interconnection: $t > c_o$; given Assumption 1 ($\rho > 0$), it follows from expression (11) that $a > c_o$.

Without CB, $Y = 0$ and therefore $a = c_o$. This proves the Proposition.[19] ■

This is a surprising result: the presence of CB enterprises located in **C** pushes up the access price between **A** and **B**. Proposition 2 has a clear explanation. Consider first the solution without CB. This situation is close to the analysis of "symbiotic production" reported in Carter and Wright (1994). In this case, perfect symmetry between operators **A** and **B** occurs; these carriers have identical demand and cost conditions which implies that, at the equilibrium, traffic on the route **A-B** is perfectly balanced ($Q_a^b = Q_b^a$). As a consequence, the access is not an issue for the carriers: with reciprocal access price, the interconnection payment that one monopolist pays to the other is exactly the same it receives for delivering the other carrier's calls.

Nonetheless the interconnection rate a matters since, according to expression (9), it affects collection prices. Without CB firms **A** and **B** set it equal to the cost of providing access ($a = c_o$); doing so each carrier enjoys the highest level of profit (monopolistic level) charging the monopolistic price

$$p^M = (c + c_o) \frac{\eta}{\eta - 1}$$

As explained in Carter and Wright (1994), collusion over the access price lowers collection charges: both the firms increase their profit lowering the access price. The cost of providing interconnection c_o represents the lower bound below which it is not optimal for both the carriers to set the accounting rate.[20]

[18] Recall that, given the symmetry of the game, at the solution $t_a = t_b$.

[19] To guarantee the existence of an internal equilibrium ($Y > 0$), we implicitly assume that CB firms enjoy a price discount θ, such that there is always room for CB services. In reality the presence of competition in the host country, which we do not model here, justifies this assumption. Competition has two effects: on the one hand it implies lower prices for standard calls in the host country thus providing bigger arbitrage opportunities; on the other hand, it induces another form of competition among carriers in country **C** to attract rerouted traffic. This additional form of competition drives down the price charged to CB companies, hence reducing their marginal cost.

[20] The collusive nature of the accounting rate regime emerges only when traffic flows are balanced. If not, carriers interests diverge and collusion can no longer be sustained.

Consider now the solution with CB. Since CB acts symmetrically towards target carriers, the relationship between networks **A** and **B** is still symmetric: traffic flow is perfectly balanced and there is no settlement payment; the accounting rate is still a mean of collusion. Nevertheless now target carriers deal with the new CB effect: the higher the price they charge for a call on the route **A-B**, the more the calls rerouted via call-back and the higher the settlement payment that they receive from carrier **C**.

In other words, since $t > c_o$, rerouted calls are attractive because they increase the target countries settlement payments. Target carriers may agree upon a higher interconnection charge and, as a consequence, a higher collection price thus stimulating CB and increasing their access revenues. Moreover, (11) implies that, other things being equal, the accounting rate between countries **A** and **B** increases the more calls are rerouted via callback.

This result gives evidence on how CB rerouteing exacerbates the distortive effects of the current accounting rate regime: CB puts upward pressure on accounting rates that, otherwise, would have been set at the cost level.

3.3.2 The accounting rate between host and target countries.

The characterization of the impact of call-back on the interconnection charge between **A** (or **B**) and **C** is much more complex and cannot be unambiguously defined.

Given the asymmetry between host and target countries, we know from the previous analysis that the reciprocal interconnection charges t_a and t_b are set above the cost of providing access; at the symmetric equilibrium $t_a = t_b = t$ and $t > c_o$.

Nevertheless the interactions between prices, accounting rates and profits are very complex. The presence of CB affects both the prices between target countries and between target and host countries making the overall impact of Y on t undetermined.[21]

3.4 The impact of Call-Back on collection prices.

Applying the results of the previous section to the second stage prices given in 3.2, we now discuss the impact of CB on retail prices. Starting from the price for a call between **A** and **B**, the following corollary holds:

Corollary 1 *The collection price for a call between target countries is increased by call-back:*

$$p = (c + c_o)\frac{\eta}{\eta - 1} + (t - c_o)\rho\frac{Y}{Q}\frac{\eta + 1}{\eta - 1} > p^M . \tag{12}$$

Proof See the Appendix. ■

On the one hand, with CB, both the interconnection charges a and t put upward pressure on **A** and **B** collection prices. As stated in Proposition 2, the access charge between **A** and **B** is higher when CB firms are in the market: the cost per call incurred by each target carrier is increased with respect the equilibrium without CB firms thus making pressure on retail prices.

[21] In a extended version of this paper, we show that, under very mild conditions, the accounting rate increases with the asymmetry in the demand's size faced by the countries involved in the bargaining process. This argument is confirmed in Wright (1999) where it is shown that the accounting rate between two countries is higher the more the two countries differ in per capita income: other things being equal, higher differences in income imply higher traffic inbalances which translate into higher accounting rates. According to this argument, since CB rerouteing increases the asymmetry in demand's size between host and target countries, then the bargained accounting rate should be fixed at a higher level when CB firms are in the market.

In addition, now, even the interconnection charge between target and host countries enters in the determination of the equilibrium price: all the other things equal, the higher t, the higher the price for a call from **A** to **B** (or viceversa). On the other hand, CB reduces the demand faced by target carriers thus pushing down collection prices; this effect is more than compensated by the effect of t on both accounting and collection charges and the equilibrium price increases with respect the solution without CB. These arguments are strengthened by the presence of the term Y/Q in expressions (11) and (12). The term Y/Q represents the ratio between the amount of CB calls and the amount of standard calls on the route **A-B**. Ceteris paribus, the larger this ratio the higher the accounting rate and collection charges.

Together with Proposition 2, this result is the central message of the paper. CB does not put downward pressure on the accounting rate between target countries and it does not put pressure on foreign collection prices either. Instead of undermining the accounting rate regime, the presence of CB tends to expand the distortions intrinsically associated with it. Our conclusion provides a formal support to the intuition presented in Alleman (1998); in his paper, Alleman raises many concerns about the widespread view of CB as a device to induce a reduction in foreign collection rates and accounting charges. The author claims that foreign countries should welcome CB, not make it illegal because it can improve foreign monopolists revenue and profit.

Let us now consider the impact of CB on the price for calls from host to target countries; although we don't know the exact impact of CB on the bargained accounting rates between host and target countries, t_i, we can still say something relevant on the impact of CB on carrier's **C** mark-up.

Corollary 2 *For a given accounting rate between target and host country, the mark-up for calls that originate in **C** and terminate in **A** or **B** tends to decrease with the price discount offered to CB firms; in particular:*
i) with full price discount, $\theta = 0$, CB competition increses the mark-up;
ii) without any price discount, $\theta = 1$, CB competition reduces the mark-up.

Proof When $\theta = 0$, (8) becomes:

$$\frac{p_c - c_c - t}{p_c} = \frac{1}{\eta}\frac{1 + 2\varepsilon\frac{Y}{Q_c}}{1 + \frac{\varepsilon}{\eta}\frac{Y}{Q_c}} \tag{13}$$

Without CB, the monopolist sets the standard mark-up $1/\eta$, which is clearly smaller than (13). For $\theta = 1$, (8) becomes:

$$\frac{p_c - c_c - t}{p_c} = \frac{1}{\eta}\frac{1 + 2\frac{Y}{Q_c}}{1 + \frac{\varepsilon}{\eta}\frac{Y}{Q_c}} \tag{14}$$

which, for $\varepsilon > \eta$, is always lower than the mark-up without CB. ■

By offering a large price discount to CB companies, the contribution of CB to carrier **C** total profit is modest. At the same time, a large discount implies that more calls between **A** and **B** are rerouted via **C** by CB companies. This entails an increase in the traffic unbalance between **C** and foreign countries and, as a consequence, a higher settlement deficit for the host carrier. By incresing p_c, the carrier limits the number of outgoing calls; this reduces the traffic unbalance and the payment due to foreign carriers for interconnection. On the contrary, with little or no price discount, CB becomes profitable for carrier **C** which now fully exploits the increased demand by reducing the price for a call.[22]

[22] For sake of completeness, the endogenous choice of θ by the host carrier is

$$\theta^* = \frac{\varepsilon}{\varepsilon - 1}\frac{1 + 2\varepsilon\frac{Y}{Q_c}}{\eta + 4\varepsilon\frac{Y}{Q_c}\frac{Y}{Q_c}}$$

These observations might become useful in a competitive environment. As mentioned, in some countries, and in the US in particular, prices are lower because of the pressure of competitive forces. This creates the humus for callback to proliferate. Our main conclusions, namely the impact of CB on foreign accounting and retail charges are not affected by the introduction of competition in country **C**. What could become relevant in a competitive context, is the relationship between the price charged by the host country carrier and the discount offerd to CB companies. Competition in the country **C** has two main effects. Firstly, it lowers the host country collection prices which furtherly accentuates the traffic unbalance between host and target coutries. Secondly, as discussed in Choi *et al.* (1999), competition increases the price discount offered to CB companies: rival firms compete not only for standard market shares but even to attract CB traffic: competition reduces θ.[23] According to our discussion, larger discounts translate into higher equilibrium prices; this might prevent competition from achieving its goal, namely driving prices down to costs.

4 Conclusions.

The primary motivation of this paper was to conduct an analysis of the impact of call-back on international telecommunications prices and accounting rates. To achieve this purpose, we employed a stylized three-country model of international telephony. In one country prices for international calls are lower and arbitrage opportunities based on calls rerouteing via the cheap country may be exploited. Call-back is an alternative calling procedure that is often claimed as a method to induce a reduction both in accounting rates and in collection charges. Call-back firms reroute calls between high collection price countries via low price countries.

We analyse how CB firms interact with established carriers and their impact on the process of definition of the reciprocal accounting rates between national networks. The main effect of calls rerouteing is to put in relation traffic and tariffs on different routes that, otherwise, are uncorrelated. As a consequence, call-back expands the distortions induced by the current accounting rate regime to those routes where access charges would have been set at the cost level.

We show that calls rerouteing puts upward pressure both on target countries accounting rates and collection prices. Because of the reciprocal accounting rate, incoming calls are attractive since they imply a higher settlement payment. With rising retail prices, target carriers may increase their access revenues stimulating traffic rerouteing.

The effects on prices charged by the carrier of the country where CB firms are located depend upon the price discount offered to CB firms. The larger the discount, the higher the mark-up for calls directed to high price countries; again this is due to the reciprocal accounting rate regime. By offering a large price discount to CB companies, the carrier stimulates CB rerouteing; in this case, the low price operator tends to increases its tariffs to lower the amount of outgoing traffic and the associated payment to foreign carriers.

It is easy to see that $\theta^* > 0$. For sufficiently high levels of the elasticity of demand for CB services, ε, a corner solution occurs, $\theta = 1$.

[23] We must note that competition does not necessarily affect the bargaining process over the interconnection terms. In the US the market for incoming traffic is divided up in proportion to the US carrier's own share of outgoing traffic with the corresponding country. This follows the FCC's rules called proportional return rules. These rules were introduced to prevent US carriers competing against each other for calls termination, when dealing with a monopoly foreign carrier. Such competition could decrease the bargaining power of the US carriers and it could also lead the incumbent US carrier to reach an exclusive deal with the foreign carrier, to prevent entry of other carriers into the US market (*wipsawing*). As discussed in Wright (1999), these rules imply that US carriers act jointly in the bargaining over the accounting rate; equivalently, a representative host country operator can be assigned with a monopolistic bargaining power thus keeping the process identical to the monopolistic case.

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Appendix.

Proof of Proposition 1.
Let us first consider the prices on the route **A-B**. From the definition of π_i the first order condition with respect to p_i^j is

$$\frac{d\pi_i}{dp_i^j} = Q_i^j + (p_i^j - c - a)\frac{dQ_i^j}{dp_i^j} + (t_i - c_o)\frac{dY_i^j}{dp_i^j} = 0$$

Due to the symmetry of the game,[24] we can rewrite this expression as follows

$$[p - (c + a)]\frac{dQ}{dp} = -Q - (t - c_o)\frac{dY}{dp}$$

recalling the definition of the cross-elasticity ρ and rearranging

$$\frac{p - (c + a)}{p} = \frac{1}{\eta} + \frac{t - c_o}{p}\frac{\rho}{\eta}\frac{Y}{Q}$$

and expression (6) follows immediately.
The collection price for calls form **A** (or **B**) to **C** solves the following *f.o.c.*

$$\frac{d\pi_i}{dp_i^c} = Q_i^c + [p_i^c - (c + t_i)]\frac{dQ_i^c}{dp_i^c} = 0$$

This is a standard monopoly's profit maximising condition. Given the symmetry it is easy to derive expression (7).
Finally let us consider the price for an outgoing call from country **C**; using the fact that $p_{cb} = \theta(p_c^i + p_c^j)$ and rearranging, (4) becomes:

$$\pi_c = \Big[\theta(p_c^i + p_c^j) - 2c_c - t_i - t_j\Big]\left(Y_i^j(\cdot) + Y_j^i(\cdot)\right) + \sum_{i,j=\mathbf{A},\mathbf{B}}\Big[p_c^i - c_c - t_i\Big]Q_c^i(\cdot) + (t_i - c_o)Q_i^c(\cdot)$$

differentiating, the first order condition is:

$$\frac{d\pi_c}{dp_c} = \left[\theta(p_c^i + p_c^j) - 2c_c - t_i - t_j\right]\left(\frac{\partial Y_i^j}{\partial v_i^j}\frac{dv_i^j}{dp_c^i} + \frac{\partial Y_j^i}{\partial v_j^i}\frac{dv_j^i}{dp_c^i}\right) + \theta(Y_i^j + Y_j^i) + Q_c^i + (p_c^i - c_c - t_i)\frac{dQ_c^i}{dp_c^i} = 0$$

since $dv_i^j/dp_c^i = dv_j^i/dp_c^i = \theta$, and given that, at the symmetric equilibrium, $\frac{\partial Y_i^j}{\partial v_i^j}\frac{dv_i^j}{dp_c^i} = \frac{\partial Y_j^i}{\partial v_j^i}\frac{dv_j^i}{dp_c^i} = 2\theta\frac{\partial Y}{\partial v}$ and that $v = 2\theta p_c$, this expression reduces to

$$\frac{d\pi_c}{dp_c} = Q_c + [p_c - (c_c + t)]\frac{dQ_c}{dp_c} + 2\theta Y + 4\theta^2 p_c\frac{\partial Y}{\partial v} - 4\theta p_c\frac{\partial Y}{\partial v} + [p_c - (c_c + t)]4\theta\frac{\partial Y}{\partial v} = 0$$

rearranging:

$$\frac{p_c - (c_c + t)}{p_c}\left[1 + 2\frac{\varepsilon}{\eta}\frac{Y}{Q_c}\right] = \frac{1}{\eta} + 2\frac{\theta}{\eta}\frac{Y}{Q_c} + 2\frac{\varepsilon}{\eta}(1 - \theta)\frac{Y}{Q_c}$$

and expression (8) is obtained.
Second order conditions are assumed to hold. ■

[24] At the symmetric equilibrium $p_i^j = p_j^i = p$, $p_c^i = p_c^j = p_c$ and $v_i^j = v_j^i = v$. These conditions imply that $Q_i^j = Q_j^i = Q$, $Q_c^i = Q_c^j = Q_c$ and $\phi_i^j = \phi_j^i = \phi$.

Proof of Corollary 1.
Without CB, the price for a call between **A** and **B** is the monopolistic price p^M. Instead, from expression (6), the price for the same call when CB firms are in the market is

$$p = \left[c + c_o + (a - c_o) + (t - c_o)\rho \frac{Y}{Q} \right] \frac{\eta}{\eta - 1}$$

using expression (11), then $p > p^M$ if

$$(t - c_o)\rho \frac{Y}{Q} \frac{\eta + 1}{\eta - 1} > 0$$

which is always satisfied for $t - c_o > 0$. ■

Tab 1

Name	Description $(i, j =$ **A**,**B** and $i \neq j$,$h = 1, \ldots, n)$
a	accounting rate between **A** and **B**
t_a	accounting rate between **C** and **A**
t_b	accounting rate between **C** and **B**
p_i^j	price for a call from country i to country j via domestic carrier
p_c^i	price for a call from the host country **C** to country i
$v_{i,h}^j$	price for a call-back call from country i to country j via operator h
$Q_i^j(\cdot)$	demand for standard calls from target country i to target country j
$Q_c^i(\cdot)$	demand for standard calls from country **C** to target country j
$Y_{i,h}^j(\cdot)$	demand for call-back calls from country i to country j via operator h
TF_i^j	Traffic flow from country i to country j

Figure 1: Traffic flows

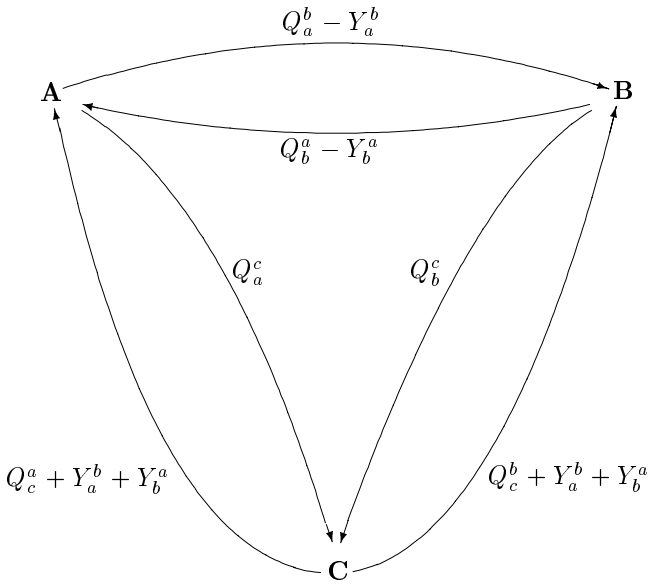

Figure 2: The timing