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Notes on the Economics of Termination Charges

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Bruno Jullien[1]

Patrick Rey[2]

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[1] Toulouse School of Economics (IDEI&GREMAQ)
[2] Toulouse School of Economics (IDEI&GREMAQ)

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I Introduction

This report follows up on a previous report (Jullien and Rey (2006)) on the economics of telecommunications. The first report mostly focused on two concerns that had emerged in the context of mobile to mobile termination: the risk that high termination rates be used by operators as a cooperative device (see also Jullien and Rey (2004)), and the risk that high termination rates be used to exclude small operators from the market. In this follow up, we shall first summarize the content of the previous note and then update it. Based on this we shall try to draw some insights that we hope may be useful in the debate on the regulation of termination rates.

The European mobile markets have been very dynamic over the last decades and are expected to stabilize in most western European countries. Penetration rates as well as volumes are high. The market has been driven by voice telephony until now and it is expected that the development of data services (including TV and high-speed wireless Internet) will generate growth in the near future.

One main characteristic of the European markets compared to some other markets such as US or Hong Kong, is that customers are not charged for receiving calls (caller pays principle or CPP). In the context of CPP, termination revenues, in particular from fixed networks to mobile networks (FTM) have always been considered as an important source of revenue for the mobile operator.[3] However a striking feature is the rapid decline of termination rates over the last decade, mostly driven by national regulators. As an illustration, in France, the (regulated) termination rates of the two main mobile operators (France Telecom and SFR) has declined steadily from 20.12 cts/mn in 2002 to 6.5 cts/mn in 2008 (the rate of the third operator declined from 27.49 cts/mn to 8.5 cts/mn).[4] This evolution has induced a

[3] See our discussion of this point in the conclusion.
[4] Source: ARCEP

decline in the share of termination in the revenue of mobile operators. A similar pattern can be found in most European countries.

Apart from this reduction in termination rates, the industry has undergone a permanent evolution. The most noticeable evolution is the development of 3G and the large investments it requires. This puts the industry at a critical stage where the outcome is very sensitive to regulatory decisions. In particular it is important to avoid that current regulatory decisions aimed at reducing prices be perceived as bad signals for the future of 3G mobile telephony, or the future of the fibber to the home market.

In terms of regulation, the situation has evolved in a contrasted way. On one hand, the new European framework for the regulation of electronic communication has clarified the regulatory process, and helped regulation to focus on the wholesale market. On the other hand there has been pressure by political authorities and regulators to reduce prices. Moreover the roaming regulation introduced in 2007 is a shift in the policy of the European Commission from rule making to direct regulation as it imposes price-caps on both retail prices and wholesale prices for international calls. More recently the proposal of the "draft Commission Recommendation on the regulatory treatment of fixed and mobile termination rates in the EU" shows a shift toward more harmonization and centralisation of regulation.

The development of the 3G market is concomitant to the convergence of various IT technologies, including telecommunications, internet, TV. In France for instance this has resulted in a wave of consolidation between ISP, fixed and mobile operators.

Another noticeable evolution is the emergence of new competitors and in particular the development of mobile virtual networks (MVNOs). Although the speed of development of MVNOs varies from one country to the other, this puts increasing competitive pressure on the industry and should generate some commercial innovation in the future.

Finally let us mention that while the market has been traditionally dominated by post-paid and pre-pay contracts based on a price per minute of call, along with subscription fees, there is been recently a trend toward unlimited offers and increased differentiation between

on-net and off-net calls. Because of this evolution in tariffs, what was valid a few years ago may not apply anymore, and conventional wisdom may have to be reconsidered.[5]

Thus the industry has undergone several important changes during the past few years. Our approach in the note is conditioned by these changes as we try to highlight what we believe are important contributions of the literature for the understanding of the role of termination charges for the industry in its current stage.

The economic literature has also evolved mostly due to the emergence of the literature on two-sided markets.[6] The concept of two-sided market, which refers to the fact that the value of the service derives from the interactions between actors on different side of the market, is now well established. The determination of termination rates is recognized to be an issue of two-sided market, along the lines initiated by Laffont, Rey and Tirole (1997, 1998) and Armstrong (1998). Better understanding of the economics of two-sided markets should bring better understanding of the issues involved in the current evolution of the market.

II FTM vs MTM

While the first report focused on MTM (Mobile to Mobile) termination, we should emphasize the fact that FTM (Fixed To Mobile) and MTM termination rates have been the object of different treatments.

FTM termination has been treated as a one-way access problem, in which outside users pay the operators to access their customers. This is mostly motivated by the fact that until recently, fixed line telephony was not competing with mobile telephony. In this context, it is well understood (see the survey by Armstrong (2005) for instance) that unless termination rates are regulated, mobile operators will unilaterally set excessively high termination rates. The most debated question is whether the termination revenue so generated is captured by the operators earning larger profits, or passed-on to consumers through lower retail prices on the

[5] As will appear later on, the outcome of the market competition is dastrically affected by the nature of contractual agreements between operators and their clients.
[6] See Rochet and Tirole (2006) for a recent exposition.

mobile market. The latter possibility is referred to as the "waterbed effect" and we shall discuss it at more length in the present report.

The waterbed effect refers to the fact that termination revenues are at least partly competed away on the retail market, as the result of more aggressive pricing by competing operators. The reasoning is simple. Incoming termination revenue accrues to the operator once the receiver has subscribed, independently of the amount of calls placed by this subscriber; it thus constitutes a fixed revenue per subscriber, which reduces the net fixed cost (the opportunity cost) of servicing a customer. A rational operator then reacts to the reduction in fixed costs per subscriber by lowering subscription prices (or, given subscribers' inertia and the possibility of mid-term contracts, by rising advertising spending or offering handset subsidies). That is, increasing termination rates and revenues results in lower acquisition costs (or even transforms them into net acquisition revenues). But it also intensifies competition *for* subscribers and results in lower net subscription prices and enhanced participation.

Thus the profits generated by termination revenues are shared between the firms and their customers. Depending on the magnitude of the waterbed effect, one may argue that the termination revenue has been used to finance the infrastructure fixed cost, or that it has been used to boost market expansion with lower prices. We shall discus this point at more length in the update section.

MTM termination has been treated instead as a two-way access problem, in which competing operators pay termination revenue to each other. Unlike FTM termination, MTM termination cannot be a source of profit for the mobile industry as a whole, since it only involves transfers that are internal to that industry. Termination rates may however affect the manner in which firms compete, the prices, the distribution of consumers and thus the profits as well as the efficiency of the market for mobile telecommunications.

The effect on equilibrium price can be understood as follows. The termination net revenue can be decomposed between revenue from termination of incoming calls and the cost of termination on other network. The effect of the revenue from termination of incoming calls is similar to the effect of FTM termination, and generates a waterbed effect of the same nature. On the one hand, the outgoing termination expenses increase on average the unit cost of calls, since the cost of these calls includes the cost of terminating on other networks, which is variable with the calls of the clients. Thus increasing the termination rate increases the

variable cost of calls placed by subscribers, while it reduces the acquisition cost of subscribers. That is, increasing termination rates and revenues results in higher prices for placing calls and thus lower usage; by reducing acquisition costs, it also intensifies competition *for* subscribers and results in lower net subscription prices. The overall effect then depends on factors such as whether access is one-way or two-ways, or the pass-trough rate of costs to prices.

It is well understood that letting the operators unilaterally set their own termination rates, without any coordination or regulation, would again result in excessively high rates.[7] The reason is a combination of two factors. First, the incentive to generate revenue through high prices identified for FTM termination is also present if an operator considers only the calls terminating on its network. Second, high termination rates may put a competitor at a disadvantage and thus constitutes a form of "raising rivals' costs" strategy.[8] These concerns can however be addressed by imposing reciprocity or by forcing firms into bilateral or multilateral negotiations.

But even under reciprocity, firms will understand that the termination rates affect the market outcome and set these rates at the levels that are the most profitable, which may not coincide with the socially optimal levels.

Two main concerns have been expressed by both practitioners and academics concerning MTM termination. The first is that excessive termination rates may be used as a cooperative device, helping the operator to support high retail prices. The second is that large firms may use termination charges to exclude smaller firms from the market.

III MTM termination rates

The previous report examined the lessons from the economic literature on the need to regulate MTM termination rates, as well as the nature of such regulation, focusing on issues of excessive cooperation and of exclusion.

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[7] See Armstrong (2002) and Behringer (2004, 2006).

[8] The general idea that it may be profitable to act in a manner that raises the costs of rivals was introduced by Salop and Scheffman (1983).

III.1 Risk of excessive cooperation

Our reading of the literature does not support the idea that the European context is conducive to the risk that large termination rates help sustain high prices and profits. Laffont, Rey and Tirole (1998a) and Armstrong (1998) started the debate by pointing to the fact that high termination charges raise the cost and thus the price of communications. In the case where contracts are reduced to a single constant unit usage price per minute, this translates into high retail prices and profits, despite the fact that termination payments globally cancel out. But as soon as one departs from the assumption that operators compete only in usage prices, the reasoning loses its substance because high termination charges and revenues will intensify the competition in the other dimensions of the offers made to consumers. These other dimensions can take many forms, such as handset subsidy or lower prices for non voice services, but the literature has focused mostly on two-part tariffs. Already in the same article, Laffont, Rey and Tirole point to the fact that the previous conclusion does not hold anymore if firms offer two-part tariffs. Indeed, they propose a model where the profit turns out to be independent of the termination rate. This conclusion has been extended in various ways by subsequent contributors.[9] Of course the result that profits are neutral to the termination charges relies on specific assumptions of the models that are unlikely to hold in practice, but it points to the fact that there is no clear relationship between the level of termination charges and the final level of profits. The subsequent literature has relaxed the modelling assumptions, and the general conclusion that emerges is that in an industry where firms are not too asymmetric, firms would rather opt for a low termination rates, even below cost, than for a high termination rate. This conclusion was reached for instance by Dessein (2003), accounting for demand expansion effects, or by Berger (2004), accounting for the utility of receiving calls. Laffont, Rey and Tirole (1998b), Gans and King (2001) and Calzada and Valletti (2005) reach the same conclusion by allowing for off-net / on-net price discrimination. They emphasize the fact that on-net / off-net price discrimination creates tariff mediated network effects since above-cost termination charges translate into higher prices for off-net calls, making it cheaper to call within the same network than across networks, and these network effects intensify competition.

[9] Dessein (2003) or Hahn (2004) for instance.

III.2 Risk of insufficient cooperation

Concerning the risk that the large firms raise termination rates in an attempt to exclude smaller firms, the conclusions are less clear-cut.

Consider first the case where networks that do not charge different price on-net and off-net face a symmetric termination charge. The key point to emphasize is that whether a high termination charge favours such or such network is not directly related to the size of a network but rather to the access deficit or surplus that each operator generates per customer. This access deficit or surplus depends on the usage prices and the type of consumers serviced by the network. For instance a small network with consumers generating large termination surplus, because they receive more calls than they send, would benefit from increasing termination rates.

Thus if there is a risk of eviction of small networks there must be some reason why size somehow generates a traffic imbalance in favour of large networks. This is far from obvious. For instance Carter and Wright (2003) argue that in the absence of on-net / off-net price discrimination, large networks tend to charge lower usage prices than small networks if the termination charge is above cost. This is because they have relatively more on-net calls and thus lower average cost per minute of call. For this reason, large networks face an access deficit and would therefore benefit from lowering the termination charge.

However, if larger market shares are the sign of larger market power, and larger market power allows having larger mark-ups of costs, then large networks may charge larger prices than small networks. If the mark-up differential results in lower usage prices for the small network, then the small network may incur an access deficit (Laffont-Rey-Tirole (1998a)).

Things are somewhat different when operators charge different prices for off-net calls than for on-net calls. In this case a termination charge above cost induces a higher price for off-net calls. As mentioned above this creates network externalities, as consumers then try to join the same network as those they will call, in order to benefit from the lower on-net prices. With network externalities, size matters. In this case a large network becomes relatively more attractive when the termination charge is large, since it is more likely that calls will end up on this network than on a small network (Laffont, Rey and Tirole (1998b)). Hoernig (2007)

extends the argument by accounting for the fact that users also benefit from receiving calls. Subscribing to a small network is then costly when off-net prices are high, as this means receiving fewer calls. In these circumstances a high termination rate may favour the large network and prevent a small operator from entering. However, it may also help entry if the new entrant adopts a marketing strategy that attracts customers generating an access surplus.

III.3 The Receiver Pays Principle

To conclude this part, let us note that the contributions discussed so far analyze competition under the caller pays principle, which requires that only the callers pay for the termination, while receivers are not charged. Most of these conclusions do not hold under the so-called receiver pays principle (RPP), where mobile operators charge customers (possibly different) prices for placing and receiving calls. In this case the termination charge does not affect the total price of a call, but it does affect the repartition of this total charge between callers and receivers. Typically, an increase in the termination charge leads to an increase in the price for calling and a decrease in the price for receiving calls. For the moment there is scarce literature analysing competition in the mobile industry under RPP.[10] The main conclusion is that moving to RPP would eliminate the risk that high termination charges lead to a cooperative outcome even when only linear prices are charged by the networks. Termination charges in this set-up should be used to balance the incentives of callers and receivers to respectively place and accept a call, and their optimal level should reflect the benefits that each side derives from calls. The problem is then a two-sided problem.[11]

IV Update

The current situation presents the following paradox. On the one hand, the literature on the joint termination agreements points to a tendency to set low MTM termination rates under the circumstances encountered in most European countries, in particular when the caller pays principle is combined with non-linear tariffs, multi-product competition and some on-net

[10] The most noticeable contributions are focused on the internet communication market, see Laffont, Marcus, Rey and Tirole (2003), Jeon, Laffont and Tirole (2004), and Hermalin and Katz (2004) and (2005).
[11] See Rochet and Tirole (2006).

/ off-net price differentiation. Yet, in practice European mobile operators have shown little sign of a willingness to reduce MTM termination rates. There is thus a discrepancy between the models and reality that one should explain. Possible explanations can be found in some contributions but they are not very convincing.

First one could argue that reality is in between the cases of linear and two-part tariffs. But almost no contract involves a unique pure linear price and the cooperative argument derived for uniform price depends critically on this assumption. Moreover in some countries such as France or UK, post-pay contracts are largely prevalent and still MTM charges are not small.

Another explanation could be the desire of large incumbent operators to impose barriers to entry to newcomers. We will discuss this in the section on exclusion, but we should notice that for a long time many markets have been protected from entry by spectrum regulation anyway, and yet they had MTM charges comparable with others. So this cannot explain a general pattern.

In what follows we shall develop two potential explanations. The first explanation of this puzzle is proposed by Armstrong and Wright and is based on the idea that arbitrage between the fixed and the mobile termination has prevented operators from setting low MTM rates, because of the risk that it affects FTM termination. The second explanation, currently developed by Jullien, Rey and Sand, is based on the idea that high MTM rates are a mean of maintaining the incentives of the operators to develop the market in the presence of network effects, by raising the profitability of small users.

Before we turn to that, let us discuss the notion of waterbed effect and clarify its nature.

IV.1 Waterbed effect, distribution and efficiency

As mentioned in section II, the waterbed effect refers to the fact that raising termination revenues amounts to reducing the net acquisition cost of subscribers, and that at least part of this termination will be redistributed to consumers though lower prices. From above, we conclude that the waterbed effect is to be assimilated with the impact of a fixed cost per customer on the subscription price. There has been a consistent disbelief from

regulators that the waterbed effect is effective and needs to be accounted for. This is surprising because this amounts to a disbelief that costs matter for prices. Or to put it in another way, neglecting the waterbed effect amounts to postulating that the only driving force of competition on the mobile telephony market is the unit cost of calls, and that fixed subscription costs do not matter (this would include handset subsidy, advertising, fixed origination and termination costs…). Yet, even for a monopoly, costs drive prices.

a) The intensity of the waterbed effect

One piece of explanation for this disbelief is that while there have been extensive theoretical analyses of the waterbed effect, its intensity in practice has not been the object of sufficient attention so far. If one has to take the waterbed effect seriously, the main question is empirical. How large is the effect? Does it really matters for retail prices? The work by Genakos and Valletti (2007) goes into that direction. They provide evidence on international data that the waterbed effect exists, but their data does not allow to obtain a precise measure of its level.

The answer to the question of the intensity of the effect is closely related to a simpler question which is the pass-through rate of costs into prices, i.e. the change in retail prices induced by a reduction in the cost per subscriber. This in turn depends on the degree of competition on the market. If the mobile industry were perfectly competitive, there would be a one-to-one pass-through of costs to retail prices and a 100% waterbed effect on subscription (all termination profits would be competed away). Due to the large costs of developing a mobile network, the industry is only imperfectly competitive. In an imperfectly competitive there is not a 100% pass-through of costs into prices, but the deviation can go either way. To see that notice that the price can be decomposed between the cost and the mark-up, $p=c+m$. The mark-up depends on many factors that affect the intensity of competition such as the cost itself, the elasticity of demand, the substitutability between products, capacity constraints, dynamic considerations, and so forth. It is thus a complex notion that varies across industries.[12] The change Δp in price is then the sum of the change in the cost and the change in the mark-up, given by the relation $\Delta p=\Delta c+\Delta m$. As a result the price reacts less than one-to-

[12] A recent general discussion of this is Weyl (2008), see also Genakos and Valletti (2007).

one to a reduction in the cost when the mark-up decreases as the cost increases. We should point here that while it is reasonable to assume that the mark-up indeed decreases when the cost increases, this is not necessarily the case.[13] For instance a proportional mark-up, $m = x.c$, implies more than 100% pass-through since a reduction in cost of 1 unit reduces the price by $1+x$ units.

The profit neutrality results obtained in Laffont-Rey-Tirole (1998) and many of the subsequent work are the consequence of assumptions in these models that imply that the equilibrium mark-up is independent of the cost. This corresponds to a 100% waterbed effect in level,[14] and this is due to the fact that these models consider "full participation" of subscribers and therefore assume that the aggregate demand for subscription is fixed. Relying on these models had the advantage of pointing to the key mechanisms at work and the lack of robustness of the reasoning based on unit cost of calls, but probably led to some confusion on the role of participation and the waterbed effect. Indeed the estimates of Genakos and Valletti (2007) suggest that the waterbed effect is significant but less than 100%. Thus a reduction in FTM termination rates would result both in an increase in subscription prices and a reduction in profits.

[13] This is tantamount to saying that the equilibrium profit decreases with the cost, which holds unless the price elasticity of demand decreases strongly with the price.

[14] 1 Euro reduction of the acquisition cost results in 1 Euros reduction in the subscription price, in the representation based on the so-called Hotelling model.

An example with a waterbed effect for a monopoly

Consider an operator that serves a population of potential subscribers of mass 1, among which half are willing to pay 7 and half are willing to pay 10 to subscribe. We ignore here any variable costs and usage to focus on subscriptions. Suppose the cost of subscription is 6 per subscriber and that, for each subscriber the operator receives T as FTM termination revenue. The net cost of a subscriber is therefore 6 – T. In this context the operator either focuses on half of the subscribers that have a high valuation and charges a price of 10, which generates a profit (10 – 6 + T)/2, or attracts all subscribers at a price of 7, which generates a profit 7 – 6 + T. Suppose that the termination revenue is initially equal to 1. In that case the operator will favour the first option, since (10 – 6 + 1)/2 = 5/2 is higher than 7 – 6 + 1 = 2. If the termination revenue T rises to 5, the operator will instead favour the second option, since (10 – 6 + 5)/2 = 9/2 is lower than 7 – 6 + 5 = 6. Therefore, an increase by 4 in the termination revenue, from 1 to 5, triggers a reduction by 3 in the retail price, from 10 to 7: the waterbed effect is less than one to one.

Suppose now that, while half of the subscribers are still willing to pay 7, the other half is willing to pay 12. The operator then charges a price 12 if (12 – 6 + T)/2 > 7 – 6 + T, that is, when T is less than 4. Doing the same exercise, an increase in T from 1 to 5 yields a reduction of price from 12 to 7, and the waterbed effect is therefore larger than 100%.

We see that to assess the waterbed effect we need to have a measure of the demand.

b) Extending the waterbed effect: complementary services

Another dimension that has not been explored so far is the impact of termination charges on the complementary services offered by the operator. Typically mobile telephony is a composite offer, which includes national calls, international calls, international roaming, call reception, SMS, MMS, internet access….. The handset also includes various ad-on such as agenda, games, and mp3 music or address book. Thus one should view the mobile telephony as a platform that is shared by several services that may be substitutable (SMS may partly substitute to voice) or complement (MMS can complement voice by sending pictures).

When the termination rates are changed, the revenue per customer is affected and this is likely to affect all prices. The reason is that additional services, such as data for instance, are part of the commercial strategy that mobile operators develop to attract customers and thus to generate termination revenues. Unlike the cost of calls, the cost of these additional services is not affected by a change in the termination rates for voice telephony but changes in subscription and the terms offered for voice services will affect demand for all services.

Of course, the prices of these services is affected only when they are ad-on or shared services, rather than sold as independent services. For instance, in France wireless data services are mostly ad-on to voice services, while in the UK there is a significant independent demand for these services.

How a change in the termination rates will affect the prices of the other services is an open question on which little is known.

In a first attempt to gain some insight on this issue, we develop a very simple and stylized model to analyze the effect of termination revenue on the price of other services. We present in the technical appendix the model of a monopoly that offers two services, one basic voice subscription service and an option for data services. This monopoly faces two categories of consumers: consumers for voice only, and consumers for voice and data services. Both types of consumers generate termination revenue. We then derive the monopoly prices for subscription and for data services. Because data services are only sold as a complement for voice services, there are in fact only two relevant total prices for consumers: the price for voice subscription and the total price for voice with data services. The price for data services is then the difference between the latter and the former prices. Since both prices (voice alone, voice plus data) are subject to a waterbed effect, the effect of the level termination revenue on the difference between these prices depends on the relative intensities of these waterbed effects. We show that the level of termination revenue affects not only the price for subscription but also the price for data services, except for very specific shapes of the demand functions for voice. The model used is highly specific in that it does not allow for a transition from voice only to voice plus data when prices are adjusted as a reaction to changing termination rates. But even in this context, the effect of termination revenue on the price of data services depends on complex factors and in particular on the elasticity of the demand for voice and the elasticity of the demand for voice plus data.

The conclusion is that while the prices of complementary services are indeed affected by a change in the level of the termination rates, the direction of this effect cannot be predicted based on theoretical considerations only.

IV.2 A synthesis: FTM with MTM termination

A good synthesis of the implications of the waterbed effect can be found in the recent work by Armstrong and Wright (2007). They propose a synthesis of the literature on FTM and MTM termination charges by considering a model involving both dimensions and two-part tariffs. If one could set FTM and MTM termination rates separately, operators would favour a positive margin on FTM termination (the industry profit increases when costs decrease, due to market expansion). On the other hand they would favour a small MTM termination charges, in line with the conclusion of many theoretical models. Armstrong and Wright argue that the two rates cannot be independent because different rates would lead to arbitrage, whereby fixed operators would transform FTM calls into MTM calls. This is a well known phenomenon in the telecommunication industry. For instance during the end of the period where mobile operators in France were under bill and keep agreements, there has been an increase in the practice of transforming FTM calls into MTM calls (this was known to as "hedgehogs"). With arbitrage there cannot be too much discrepancy between FTM and MTM rates. Another motive for maintaining high MTM when FTM rates are regulated is that any attempt to reduce MTM terminations charges could backfire into lower regulated FTM rates, as the regulator would take it as a signal that firms are able to accommodate low rates.

Armstrong and Wright (2007) then analyze the choice of a common rate for FTM and MTM termination. The profit maximizing level depends then on the relative magnitude of the FTM and MTM traffic and the intensity of retail competition. Their conclusion is that when the FTM market is large enough, the operators have an incentive to set the joint FTM-MTM rate too high compared to the efficient levels, hence the need of a regulation.

They also conclude that the socially optimal FTM and MTM rates are above the marginal cost of termination. The reason is that leaving some termination profit to the operators leads to a market expansion that generates positive network effects.

The analysis of Armstrong and Wright provides an explanation of the discrepancy between casual observation of market practices and the predictions of the theoretical model. Although we will propose an alternative/complementary explanation below, we view this as convincing argument that explains part of the determination of the current rates, being regulated or not.

To conclude this discussion, it is worth noticing that the balance of incentives between FTM and MTM is changing over time. While FTM termination may have dominated in the past, now that markets have reached a high level of development, the relative size of the fixed line market is smaller compared to the mobile telephony market. Thus incentives should be more balanced in the future and the industry may prefer lower rates. But it is hard to predict when and how such a shift in incentives should occur.

IV.3 Market segmentation, penetration and heterogeneous usage

One dimension that has not been the object of sufficient attention to our view is the heterogeneity of consumers in the mobile market. This heterogeneity is the source of complex and multiple contracts. First, contracts can be distinguished according to whether they are pre-paid (or pay as you go) contracts or post paid contracts. Second, post-paid contracts are complex and do not reduce to simple two-part tariffs. For instance, most of these contracts include the choice of a fixed allowance and a unit price above it, as well as various options concerning SMS, MMS, or roaming. The literature has shown that the traffic imbalances that emerge when consumers are heterogeneous may alter the effect of termination charges. But the general view is that it does not alter the conclusions in a well identified way. Indeed Dessein (2003) extended the profit neutrality result of Laffont, Rey and Tirole (1998) to the case of consumer heterogeneity by allowing the firm to use non-linear contract to screen different types of consumers. As Dessein pointed out, departing from his assumptions and in particular allowing for demand expansion effects would invalidate the neutrality result but it could go either way. The view seems thus to be that consumer heterogeneity is not the key factor explaining high rates.[15] This is formally true if one allow for any type of heterogeneity. But the market presents some general patterns that may give hints on the type of heterogeneity that matters.

We contend then that understanding the implication specific patterns of observed heterogeneity may help explaining why we observe the current level of MTM termination rates. Moreover this would clarify the welfare implication of reducing these rates.

[15] An exception is Poletti and Wright (2004) who obtain a positive profit maximizing termination rate by adding some participation constraints for consumers.

In a contemporary study, Jullien, Rey and Sand (2008) examine the issue of price discrimination in such a context. We model a situation involving two mobile operators of similar efficiency competing in two-part tariffs on the retail market, with heterogeneous consumers. We distinguish between consumers mostly interested in calling, and consumers who are mostly interested in the ability to be called. In a nutshell the former would correspond best to post-pay consumers, while the latter would rather opt for cheap pre-pay contracts with few calls.[16] A critical assumption in the analysis is that "small users" have a demand that is more elastic than "large users", which seems quite plausible as the former represents the margin of the market (those most likely to renounce on mobile telecommunications if prices raise).

Networks discriminate between the two categories of users by offering different two-part tariffs. In equilibrium there is no global traffic imbalance between networks but there is a traffic imbalance between small and large users. As a result, increasing the termination rate raises the profitability of small users, for which there is a net inflow if calls. This intensifies the competition for small users, resulting in lower prices for them and enhanced participation.

The situation involves network externalities (at the industry level) similar to those studied in the literature on two-sided markets.[17] Enhanced participation of small users raises the value of the network for large users, which may be beneficial both for profit and for welfare.

A first conclusion is that firms favour a termination rate above the marginal cost. A second conclusion is that the welfare maximizing termination rate is also above the marginal cost. Both conclusions derive from the fact that marginal consumers exert a positive network externality on other users, and that increasing the termination rate raises participation. From a profit perspective, this allows firms to raise the revenue from large users, while from a welfare perspective this raises the surplus of both types of users.

While the work is still very preliminary, it suggests that in the case of MTM termination revenue from fixed networks, the optimal termination rate may be above cost when the consumers the most reactive to prices are also the less active on usage.

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[16] Most pre-pay contracts allow receiving calls long after the minutes of communication have been exhausted.

[17] See Rochet and Tirole (2006).

We view the situation as a good representation of the current mobile business model of large operators. This provides a rationale for the reluctance of operators to reduce MTM termination rates, which is complementary to the explanation based on the link with FTM termination revenues (Armstrong and Wright 2007). While for FTM termination the profit maximizing margin may be positive or negative, depending on the waterbed effect and network effects, the MTM model with heterogeneous consumers described above points to a positive termination margin.

IV.4 Exclusion revisited

As already mentioned, one of the traditional concerns is that cooperation among operators might be insufficient, particularly in markets where large incumbent operators face competition from smaller rivals, and may be tempted to charge prohibitively high termination rates in order to foreclose the market. One argument echoed by small operators and regulators to motivate this concern, and on which we will focus here,[18] is related to the already noted network effects generated by termination-based price discrimination. Termination charges above cost induce higher prices for off-net calls and, as a result, customers prefer to join larger networks, for which a higher proportion of calls remain on-net. Some European NRAs have relied on this argument to call for asymmetric MTM termination rates. For example, in its Decision of October 2007, the French national regulator stressed the presence of network effects due to off-net/on-net tariff differentials that impede smaller networks to compete effectively.[19] Similarly, in September 2006, the Spanish national regulator argued that network effects can place smaller networks at a disadvantage, and that higher termination rates can increase the size of such network effects.[20]

To explore this issue, Lopez and Rey (2008) analyze the competition between two asymmetric networks, an incumbent and a new entrant. Consumers are initially attached to the incumbent network and incur switching costs if moving to the other network. Thus, to build market share the entrant must bid more aggressively for customers than the incumbent, which therefore enjoys greater market power. In particular, the incumbent can keep monopolizing

[18] The discussion here is based on Lopez and Rey (2008).
[19] See section 4.2.2 of ARCEP Decision 2007-0810 of October 4 2007.
[20] Decisions AEM 2006/724, AEM 2006/725 and AEM 2006/726 adopted by the Spanish NRA (CMT) on 28 September 2006.

the market when switching costs are large enough; as we will see when switching costs are not that large, departing from cost-based termination charges can help the incumbent maintaining its monopoly position and protect its profit.

They first consider the case where networks compete both in subscription fees and in usage prices, which can moreover differ for on-net and off-net calls. This termination-based discrimination creates network externalities, which are amplified by the level of the termination charge. As a result, the incumbent can keep the entrant out of the market and still charge monopoly prices by setting a large enough mark-up on the termination rate. Indeed, if the incumbent benefits from consumer inertia,[21] then it has an incentive to insist on the highest possible (even if reciprocal) access mark-up.

Lopez and Rey also study competition for levels of switching costs and termination mark-ups that are moderate enough to allow the operators to share the market. They show in particular that a high termination charge that results in a possibly small but positive market share for the entrant gives the incumbent a lower profit than cost-based termination rates.

The analysis thus supports the conventional wisdom that high termination rates may help well-established networks to exclude small competitors; however, high termination charges are profitable only when it allows the incumbent to keep the entrant entirely out of the market, while they are unprofitable at any positive market of the entrant. This appears to limit the foreclosure concern to markets in which potential entrants have been unable to develop any customer base.

Indeed, in the line with our previous discussion of MTM termination rates and results obtained by Gans and King (2001) for symmetric networks, they show that when the market is shared, lowering the termination rate below cost would raise both networks' equilibrium profits. However, networks may fail to coordinate on the more profitable equilibrium.

Finally, Lopez and Rey (2008) consider the impact of the termination rate on competition in the absence of on-net / off-net price differentiation or under the receiver pays principle regime. In the latter case, termination rates can no longer foreclose competition

[21] Since on-net pricing generates club effects, consumers face coordination problems and there may exist multiple consumer responses to a given set of prices. "Consumer inertia" refers to the situation where consumers adopt the response the most favourable to the incumbent.

because all usage prices (even on-net ones) are then always set at the off-net cost. In the former case, neither the incumbent nor the entrant finds it profitable to foreclose competition through termination rates. Network externalities are thus the key ingredient that allows established networks to foreclose competition. Network interconnection should in principle eliminate them, but they are restored when the competing operators can charge different prices for off-net and on-net calls.

The analysis clarifies the circumstances under which an exclusionary effect of termination rates may be a concern, although we should point that it does so in the context of a homogenous population of consumers. As already mentioned in section III.2, and along the lines of section IV.4, a new entrant may adopt a strategy of differentiation when tastes vary within the population. Indeed market segmentation is a natural outcome when the population is heterogeneous and firms differ in cost and quality.[22] When the small operator can design its commercial strategy so as to target particular types of clients, it may be more difficult to use termination rates for exclusion.

V Conclusions

What do we retain from theses developments? To summarize the main conclusions concerning the difficulties that could arise if firms were left free to negotiate reciprocal rates, we found that the risk of excessive cooperation may have received too much attention, while there may be instances with insufficient cooperation. Insufficient cooperation seems to be associated with on-net/off-net differentiation and tariff mediated network effects. On this latter point, we must stress that most of the contributions associate excessive rates with full exclusion of the competitor, and that a large operator may not benefit from increasing termination rates if this only hurts the small competitor without eliminating it. Thus one may not be too concerned about the "raising rivals costs" issues discussed for the case of unilateral determination of the termination rates.

[22] In France for example, in 2006, the smallest operator Bouygues Telecom has a higher ARPU and a higher share of post-paid contracts than the other two operators Orange and SFR (the average monthly ARPUs (euros) are 33.7, 37.9, 42 for Orange, SFR and Bouygues resp., while the proportion of post-paid subscribers are resp. 63%, 65% and 72%, Source: Merrill Lynch).

Concerning the FTM termination charges, it is often argued that the FTM termination revenue has constituted some hidden form of subsidy to the mobile operators that helped them to finance the infrastructure. As discussed above, the so-called waterbed effect however implies that some benefits are passed-on to customers through lower prices. Thus one could also argue that these revenues were rather used to boost market expansions. Which claim is valid depends on the intensity of the waterbed effect. On this we need more studies and returns from experiences.

But more importantly, these claims may not address the right question. The key question of the debate on termination rates is "What is the optimal level of termination rates?".

The complexity of deriving optimal rules suggests that the answer may vary from one case to the other. It also suggests that the discussion should be based mainly on the evaluation of the impact of the termination rates on the retail prices, both in terms of level and structure, rather than on ad-hoc principles.

A first obvious point is that termination is part of the services offered by mobile telecommunication operators. In the presence of the large fixed costs required to develop a mobile telecommunication network, we know from the work of Laffont and Tirole (2000) on access that it is optimal that all services contribute to the financing, including retail and wholesale services; this needs however to be tailored to the specificities of the networks. From the literature on network externalities and on two-sided markets, we know that a cost orientation is not necessarily optimal with two-sided network effects. The literature highlights the fact that one should think of termination rates as inducing changes in the price structure faced by consumers rather than a change in the level of prices (which is moreover hard to define and much more difficult to predict).

A change in price structure has two types of consequences for welfare. First it modifies the behaviour of the users. Since the same instrument affects the prices faced by the two parties involved in the call, choice has to be made on which side it is more efficient to incentivize.[23] In addition, it may affect participation as well as usage by those who do join the

[23] One insight from the literature on two-sided market is that the price should be somewhat biased in favour of the party that generates the highest surplus to the other side. Thus if the receiving parties enjoy little utility while the calling parties are the most interested in the call,

network. For example, increasing the termination charge is likely to translate into higher usage prices and lower subscription fees, thereby favouring participation over usage.

Second changing the price structure generates some implicit redistribution between different categories of consumers (fixed line and mobile lines subscribers, large and small users, rich and poor….). This redistribution is a key effect of the regulation of wholesale access tariffs in telecommunication network and is most of the time overlooked. Likewise, it would be important to evaluate the redistributive implication of a major change in termination rates.

Policy discussions, at least in the European Union have focussed on a cap on termination rates. If indeed there remain competitive issues in the mobile industry, there exist other policies that could present more efficient ways to alleviate them. For instance, while a cap on termination-based discrimination may reduce the risk of foreclosure, it would be useful to evaluate alternative approaches such as a shift toward the receiver pays principle and, if found useful, what policy might be appropriate to promote it.

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Notes on the Economics of Termination Rates Technical Appendix: Termination Rates and Complementary Services

Bruno Jullien and Patrick Rey
IDEI.

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Abstract

In this appendix, we develop a simple model that highlights the potential implications of termination rates on the prices of services that are offered as complements of voice telephony by mobile operators, such as data services. By considering a monopoly operator that offers two services, one basic subscription and an option for data services, we show that the impact on the termination revenue on the price of data, depends on complex factors and in particular on the relative elasticities of the demand for voice and the demand for voice plus data.

1 The model

To simplify matters, consider a monopolistic operator that offers two services: a base service at price p, and an optional extra service at price r. In the case of mobile telephony, we can interpret the base service as voice and the optional service as data.[1] To simplify the analysis, we suppose that usage is inelastic (all users are willing to use a given amount of each service, and thus interpret p and r as subscription prices for each service; we denote by $q = p + r$ the total price for accessing both services. Notice that we do not allow to offer data only, which fits the current situation. Allowing such an offer would complicate the analysis but not alter the conclusions.

Suppose that there are two distinct populations:

- Population 1 is interested in the base subscription only and has a demand $D(p)$;
- Population 2 is interested in both the base subscription and data. Moreover all members are willing to pay at most $\hat{v}$ for the data services. This

[1] This fits also the case of fixed line broadband services, where data could be tought as TV and base service as internet access.

means that they all attach the value $\hat{v}$ to data. Their demand for the subscription alone is $Q(p)$ while their demand for the combined data-voice services is $Q(p-\hat{v})$.

Assume that the per-subscriber cost of base service is c while the additional cost for data is $\hat{c} < \hat{v}$. In addition, each subscriber generates a net revenue T from termination (from fixed line users, say).

2 General case

The profit of the platform is then

$$\Pi = (p - c + T) D(p) + (q - c - \hat{c} + T) Q(q - \hat{v}) \ \ when \ q \leq p + \hat{v}$$

and

$$\Pi = (p - c + T) D(p) + (p - c + T) Q(p) \ \ when \ q > p + \hat{v}$$

since at $q > \hat{p} + \hat{v}$ no consumer buys the data service. Thus we have that the data service is delivered if

$$\max_{p,q \leq p+\hat{v}} (p - c + T) D(p) + (q - c - \hat{c} + T) Q(q - \hat{v})$$

is larger than

$$\max_{p} (p - c + T) D(p) + (p - c + T) Q(p).$$

This is always the case because at equal price p and $q = p + \hat{v}$ we have

$$(p - c + T) D(p) + (p + \hat{v} - c - \hat{c} + T) Q(p) > (p - c + T) D(p) + (p - c + T) Q(p)$$

since $\hat{v} > \hat{c}$.

Define $p^*(T)$ and $q^*(c)$ as the monopoly prices for voice services and for combined services under perfect discrimination

$$\begin{aligned} p^*(T) &= \arg\max_{p} (p - c + T) D(p) \\ q^*(c) &= \arg\max_{q} (q - c - \hat{c} + T) Q(q - \hat{v}) \end{aligned}$$

We then have $p = p^*(T)$ and $q = q^*(T)$ if $q^*(T) \leq p^*(T) + \hat{v}$.

When this is not the case, assuming quasi-concavity we have

$$p = \hat{p}(T) \ \text{ and } q = \hat{p}(T) + \hat{v}$$

$$\hat{p}(T) = \arg\max_{p} (p - c + T) D(p) + (p + \hat{v} - c - \hat{c} + T) Q(p)$$

Remind that the price for data is defined as $r = q - p$. We then have

Proposition 1 *The price for data is* $r(T) = \min(q^*(T) - p^*(T), \hat{v})$

Proof. Immediate. ■

Thus when the self-selection constraint is binding the price for data is unaffected by the termination revenue. This is the consequence of the assumption that all potential buyers of data have the same valuation $\hat{v}$ and would not hold with heterogenous demand for data services.

The more interesting case is when the constraint is not binding. Then we have $r(T) = q^*(T) - p^*(T)$. Notice that $q^*(T) - \hat{v}$ is the monopoly price that would be charged by the operator on the second population if the following 3 conditions were met:

i) Third-degree price discrimination is possible;

ii) There is no data service

iii) the cost is $c - \hat{v} + \hat{c}$

Now define $p^m(C)$ and $q^m(C)$ as monopoly prices for voice services only on each population for a cost and no termination revenue. Then we have

$$\begin{aligned} p^*(T) &= p^m(c - T) \\ q^*(T) &= q^m(c - \hat{v} + \hat{c} - T) + \hat{v} \\ r^*(T) &= q^m(c - \hat{v} + \hat{c} - T) - p^m(c - T) + \hat{v} \end{aligned}$$

Thus the effect of the termination revenue on the price of data depends on the comparison between the impact of the termination charge on the monopoly price for each population but evaluated at different (opportunity) costs. >From this we see that the answer to the sign of this effect is complex and ambiguous from a theoretical perspective.

3 Examples

3.1 Proportional demands

Assume that the demands for voice services are proportional. This is the case when $Q(p) = \theta D(p)$. In this case we have

$$q^*(T) = \arg\max_q (q - c - \hat{c} + T)\theta D(q - \hat{v})$$

Now given that $q^m(C) = p^m(C)$ for proportional demands:

$$q^*(T) = p^*(T + \hat{v} - \hat{c}) + \hat{v}.$$

The first result in this case is that because p^* decreases with T and $T + \hat{v} - \hat{c} > T$, it is the case that $q^*(T) < p^*(T) + \hat{v}$ for all T. We then obtain that

$$r^*(T) = p^*(T + \hat{v} - \hat{c}) - p^*(T) + \hat{v}$$

We can thus conclude that

Proposition 2 *When demands for voice services are proportional, the price of data $r^*(T)$ decreases with the termination revenue T if $p^*(T)$ is concave, i.e. if the monopoly price is concave with the cost.*

Proof. We have

$$\frac{dr^*(T)}{dT} < 0 \; if \; \frac{dp^*(T+\hat{v}-\hat{c})}{dT} < \frac{dp^*(T)}{dT}$$

or if $\frac{d^2p^*(T)}{dT^2} < 0$ since $\hat{v} > \hat{c}$. ■

As an illustration in the cases where the demand is linear, and where the demand is iso-elastic, the price $p^*(T)$ is linear and thus the price of data is not affected by the termination revenue.

Consider the case a quadratic demand $D(p) = D_0 - p + \sigma p^2$ for $\sigma \neq 0$. Then

$$p^*(T) = \frac{1}{3\sigma}\left(1 - T\sigma + c\sigma - \sqrt{T\sigma - c\sigma - 3\sigma D_0 - 2Tc\sigma^2 + T^2\sigma^2 + c^2\sigma^2 + 1}\right)$$

and

$$\begin{aligned}
\frac{dp^*(T)}{dT} &= \frac{1}{3}\left(-1 - \frac{1 + 2T\sigma - 2c\sigma}{2\sqrt{T\sigma - c\sigma - 3\sigma D_0 - 2Tc\sigma^2 + T^2\sigma^2 + c^2\sigma^2 + 1}}\right) \\
\frac{d^2p^*(T)}{dT^2} &= \frac{\sigma}{4}\left(\frac{4\sigma D_0 - 1}{\left(T\sigma - c\sigma - 3\sigma D_0 - 2Tc\sigma^2 + T^2\sigma^2 + c^2\sigma^2 + 1\right)^{\frac{3}{2}}}\right)
\end{aligned}$$

For σ small, we see that the price of data decreases when T increases if σ is positive, hence if demand is convex.

3.2 Iso-elastic demands

Suppose that both demand are iso-elastic then

$$\begin{aligned}
p^m(C) &= (1+m)C \\
q^m(C) &= (1+\mu)C
\end{aligned}$$

where $\mu > m$ if the demand of population 2 is less elastic than the demand from population 1.

We have

$$\begin{aligned}
p^*(T) &= (1+m)(c-T) \\
q^*(T) &= (1+\mu)(c-\hat{v}+\hat{c}-T) + \hat{v}
\end{aligned}$$

$$r^*(T) = (\mu - m)c + (1+\mu)\hat{c} - \mu\hat{v} + (m-\mu)T$$

The conclusion is that $r^*(T)$ decreases if $\mu > m$.