Regulating prices in two-sided markets: the waterbed experience in mobile telephony[1]

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Abstract

The distinguishing feature of two-sided markets is that the pricing structure, i.e., the relative prices charged to each side, matters. Regulators need to understand and account for the interdependence of prices in both sides. Some interventions that lower the prices on one side can result in higher prices on the other side of such markets. We review the recent literature analyzing this "waterbed" phenomenon in mobile telephony and draw some more general lessons for policy interventions in two-sided markets.

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1. Introduction

A consumer in a mall is buying the latest version of Windows 7 using his Mastercard, while talking on his mobile to a friend about an article he read in the International Herald Tribune on the latest effort of European regulators to reduce mobile roaming charges across Europe. Surprisingly enough, there is a common thread linking these everyday activities and products: the mall, the software, the newspaper, the credit card and the mobile phone are all examples of what economists call two-sided markets. A large theoretical literature during the last decade has generated new economic insights on how competition and prices evolve in these markets, with significant implications for regulatory and anti-trust authorities alike.

At a general level, a two-sided market is simply a meeting place for two sets of agents who interact through an intermediary (or a platform). So, a mall is a platform such that consumers can find their favorite shops, the same way we can think of Windows as a meeting place for PC users and application developers. Credit cards are payment platforms composed of cardholders and merchants. A newspaper brings together advertisers and readers, much like a mobile phone network helps people who want to receive calls get together with people who want to make those calls. Two-sided markets are all around us. What is unique about them, compared to the traditional single-side markets, is that the decisions of each set of agents affect the outcomes on the other side of the market. Put it differently, each side of the platform exerts an externality on the other side. As a consumer I want to go to the mall that has the "right" shops or the wider variety of brands, I will use the credit card that most retailers accept, I will buy the operating system with the best applications, or I will subscribe to the mobile network with the largest customer base. Managing this externality and getting both sides on board is fundamental for the development and success of each platform and to our understanding of the pricing strategies followed by market participants.

In considering the platform pricing strategies, the economics literature has demonstrated that the characteristic that distinguishes two-sided markets is that the pricing structure, i.e., the relative prices charged to each side, matters. For example, there are many platforms in which one side pays nothing, or even receives inducements, to take the service: shoppers in a mall, application developers, (some) credit card customers, free newspapers. More generally, each platform provider will

try to balance prices in order to encourage take-up on both sides, which means that the prices charged to each side are jointly determined.

The fact that two-sided markets are based on these externalities and that the structure of prices matters, as much as their level, has important consequences for regulation. First, we should not expect to find a direct relationship between the price charged on one side and the incremental cost of serving that side. Traditional price regulation involved complex calculations trying to measure marginal cost and demand in an attempt to determine optimal prices. In two-sided markets, it should additionally be recognized that individual prices for each side might differ from the individual side costs, no matter how strong competition is. Moreover, the prices that maximize consumer welfare will often depart from the cost-reflective ones.

Second, any change imposed to the price on one side will also change the price on the other side of the platform, as one should expect when setting the prices of products that are essentially complements. Moreover, lowering the price on one side and raising it on the other by the same amount, such that the total level of prices is the same but the price structure has changed, will not be neutral but will affect the output of a platform. For example, if a shopping mall decided to lower rents and introduce an equivalent entry fee for shoppers, most likely that would affect the overall attractiveness of the mall to both shoppers and retailers. Similarly, a mobile network is a two-sided market because the allocation of prices between the mobile subscriber and the people who call them affects both the number of subscribers who join and the volume of calls on the network.

While theory has sharpened our thinking and raised some important considerations regarding how regulators should analyze two-sided markets and the best way to intervene, empirical evidence on these phenomena is still thin but growing. In this paper, we summarize some recent research on price regulation in a prototypical two-sided market, mobile telephony, which provides regulators with some stark lessons. Pushing down prices through regulation on only one side of this market results in a re-balancing of prices on the other side, much like a waterbed would react if you were to push down one side of it. Understanding and quantifying this "waterbed" phenomenon has important consequences for designing and implementing effective regulatory interventions not only for mobile telephony but for any two-sided market.

The paper is organized as follows. Section 2 provides a short review on the theory behind the waterbed effect. Section 3 discusses some empirical issues and data

considerations. Section 4 reviews the empirical evidence so far, whereas Section 5 provides policy lessons and points to open research questions.

2. The theory of two-way access charges and the waterbed effect

Competition in mobile telephony is usually characterized by the presence of a fairly small number of operators (typically, two to four physical networks of different sizes). Barriers to entry are mainly due to a limited number of spectrum licenses granted by national authorities. Furthermore, networks sell wholesale interconnection services to each other and often compete in tariffs which endogenously create network effects at the network operator level (rather than at the industry level). Customers are not directly aware of interconnection payments, but these can be considerable and have significant effects on retail prices. The most important of these interconnection services is "call termination". This allows a subscriber on one network to call a subscriber on another network.

To understand how termination rates work, it is useful to distinguish between interconnection with the fixed network, as opposed to interconnection between mobile networks. Starting with fixed-to-mobile (F2M) calls, competition does not help to keep the corresponding rates low. This situation has been called one of "competitive bottlenecks": Mobile operators have the ability and incentives to set monopoly prices in the market for F2M calls (as the price there is paid by callers on the fixed line, not by own mobile customers), but the rents thus obtained might be exhausted via cheaper prices to mobile customers in case competition among mobile operators is vigorous.[4]

The intuition for the monopoly pricing result for F2M calls is simple: Imagine F2M termination rates were set at cost; then one mobile operator, by raising its F2M termination rate, would be able to generate additional profits that it could use to lower subscription charges and attract more customers. What is crucial here is that the fixed network, most of the times, is heavily regulated in the sense that it is forced to

[4] This result is typical of models of two-sided markets where one of the two sides "single homes", while the other side "multi homes". For instance, in media markets, viewers/readers subscribe only to one broadcaster/newspaper, while advertisers want their ads to be seen by all readers/viewers. Advertisers are then typically charged monopoly ads rates, and these profits can be used to provide free (or cheaper) TV/newspapers (see, e.g., Anderson and Coate, 2005). In the case of models of F2M calls, mobile customers subscribe to only one mobile operators (and hence single home), while fixed users would like to make calls to all mobile users (and hence multi home). It is the latter that are eventually charged monopoly prices. This is a first-order result common to all "competitive bottlenecks" model, which may be diluted, or reinforced, by additional industry-specific features (e.g., audiences may dislike advertising in media markets, while mobile consumers might enjoy receiving calls).

interconnect with mobile networks and must charge a termination rate for its incoming calls (i.e., mobile-to-fixed calls) at cost-oriented rates an order of magnitude below current mobile termination rates. This implies that mobile networks have all the bargaining power in setting their termination rates for F2M calls.[5] That is why competition between mobile networks for subscribers will not at all lower F2M termination rates (see Gans and King, 2000; Mason and Valletti, 2001; Wright, 2002).

The situation for mobile-to-mobile (M2M) calls is potentially rather different. First of all, there is a termination service in both directions, so that two rates have to be determined. Secondly, and precisely because of this mutual dependence, there is potentially a fear that termination rates might be set in such a way as to relax competition in the retail market, i.e., that termination rates could be used as an instrument of "tacit" collusion. Here the results from the theory are more nuanced and puzzling when contrasted with market reality.

The literature, initiated by the seminal works of Armstrong (1998) and Laffont et al. (1998), has shown how the impact of M2M termination rates on retail prices and profits is subtle, as it depends on the type of contracts that operators can offer to their customers. Since unilaterally set termination rates would suffer from double mark-up problems, the literature has concentrated on the more interesting setting where reciprocal and identical rates have to be negotiated by operators. Typically, high (reciprocal) M2M termination deals can have a "collusive" effect of sustaining high retail prices and profits when operators compete in linear prices. This result collapses, and can actually be reversed, when competition is in two-part tariffs, and operators set differential charges according to whether the call is destined to consumers of the same operator ("on-net" calls), or belonging to rivals ("off-net" calls). This is in fact the puzzle: Gans and King (2001) show that networks would actually want to set a termination rate *below* cost in order to reduce the competitive intensity maintained by on-/off-net differentials and the resulting tariff-mediated network effects.

Although we cannot do justice here to the large body of theoretical literature on reciprocal two-way termination charges that has emerged in the last decade (see the surveys of Armstrong, 2002; Vogelsang, 2003; Peitz et al., 2004, Harbord and Pagnozzi, 2010; Hoernig and Valletti, 2011), it is fair to say that, overall, the theory

[5] For a dissenting view, see Binmore and Harbord (2005). Indeed, the fixed network is also typically a large operator who should be able to affect the termination rate it pays to terminate calls, despite having to be subject to some regulatory oversight. This problem of bargaining over termination rates between two large operators, and in the "shadow of regulation", still has to be studied in full.

would predict that mobile firms always have an incentive to set unregulated "high" F2M termination charges, while, under some circumstances, they would set profit-maximising "low" reciprocal M2M termination charges. If that was the case, then a regulation that capped termination rates for calls to mobile phones generically would most likely be binding only for F2M charges. However, keeping different termination rates is unsustainable. Either because, in practice, both M2M and F2M termination rates are forced by regulation to be set at the same level, or because "arbitrage" possibilities force them to be so, as discussed in Armstrong and Wright (2009).

Most regulators around the world, and certainly in the EU, are concerned that termination rates are too high, rather than too low, and have intervened to cut them considerably. This is consistent with the theoretical results for F2M calls, but less with the "collusive" concern arising from M2M calls. Possibly our theoretical understanding of the theory behind the strategic setting of M2M rates is still incomplete.[6] Nonetheless, there are predictions that one could safely make from the theory that we detail below.

If the mobile sector is relatively small compared to the fixed sector (as it certainly was more than a decade ago when regulators started intervening), the main effect would arise from F2M calls. Hence, a cut in mobile termination rates would be predicted, ceteris paribus, to:

a) Decrease prices to fixed users, but increase mobile prices,
b) Decrease the profitability of mobile operators (unless these were perfectly competitive, in which case their profits would always be kept at the normal level),
c) Decrease the diffusion of mobile services.

These three predictions are obviously all related to each other, but we distinguished between them as there have been attempts to test these aspects separately. In particular, the negative relationship between termination rates and prices to mobile consumers describes what is known as the "waterbed" or "seesaw" effect. This is a rather strong theoretical prediction that holds under many assumptions about the details of competition among mobile operators (Hoernig, 2010).

As the mobile markets, however, grow bigger relative to a rather static fixed sector, the effects for M2M calls will also be observed alongside the pure waterbed

[6] Recent advances include Hoernig et al. (2010), Hurkens and Lopez (2010), and Jullien et al. (2010).

effect mentioned above. The precise details depend on various factors, such as the relevance of call externalities, calling circles, and especially the strategic form taken by the tariff paid by the customers. The theory, in particular, says that there are conditions (limited uninternalized call externalities, and competition in linear prices) such that high M2M termination charges could be instrumental to lessen competition among mobile operators. A cut in these rates, therefore, could lead to lower retail prices (all else equal) in all those instances where mobile operators would compete more strongly as a result of lower termination rates, creating a downward pressure on retail prices resulting from this "competition effect" potentially sufficient to outweigh the price increase that would otherwise be prompted by the reduced revenues from incoming F2M calls. This would also decrease profits, but increase penetration (over and above any concomitant effect arising from F2M calls). By contrast, in cases where the regulation of a single rate for termination of both F2M and M2M calls, brings it more in line with a level that relaxes the intensity of competition among operators, the reverse would happen. In such cases, the reduction in termination rates would reinforce the waterbed effect on mobile retail prices, which would therefore increase, and lead to a reduction in penetration, but would also tend to increase profitability.

3. Uncovering the waterbed effect

Given the strong case for regulatory intervention over F2M rates, it is not a surprise that many countries have decided to intervene to cut these rates. Indeed, all EU member states, as well as several other countries, have done so, to the benefit of consumers calling mobile phones from fixed lines. However, reducing the level of termination rates can potentially increase the level of prices for mobile subscribers.

Over the last decade, there has been considerable variation in the toughness of regulatory intervention both across various countries and, within countries, over time and among different operators (typically, entrants have been treated in a more lenient way compared to incumbents, at least in the earlier days). This has provided interesting data to test various aspects of the theories that gave intellectual support to the case for regulatory intervention. The empirical literature so far has examined three sets of predictions related to the waterbed effect. First, reducing the level of termination rates can potentially increase the level of prices for mobile subscribers.

Particularly interesting here is to also examine both the direct effect stemming from the F2M termination rates, but also the indirect impact from M2M termination rates. Second, a reduction of termination rates will have no impact on profits, if the market is perfectly competitive. Otherwise, if firms have some degree of market power, the waterbed effect is less than complete and profits should be negatively affected. Third, the waterbed prediction that high termination rates should lead to lower mobile prices, also means that we should also observe faster diffusion in these markets as a result of the lower prices.

The data requirements to test these predictions naturally vary. In reverse order, the necessary data to examine mobile diffusion patterns is cross-country penetration rates. Veronese and Pesendorfer (2009), Cunninghamn et al. (2010) and Dewenter and Kruse (2011) use mobile subscriptions taken from the ITU World Telecommunications Indicators as their primary data source. In contrast, evaluation of the termination rates regulation on profits requires firm level data from various countries. The usual proxy for mobile operators' profits is the earnings margin before interest, taxes, depreciation and amortization (EBITDA), which is what both Genakos and Valletti (2011a) and Andersson and Hansen (2009) used from the Global Wireless Matrix of the investment bank Merrill Lynch and Ovum and Wireless Intelligence respectively.[7]

Finally, to test the direct effect of termination regulation on mobile subscription prices, data on the total bills paid by consumers across operators and countries is needed. Measuring and comparing prices across mobile operators and countries is not a trivial task in this market. Mobile operators offer a huge variety of products that are essentially bundles of various characteristics (e.g., inclusive minutes, messages and data, on-net and off-net tariffs, handset subsidies, etc.). Genakos and Valletti (2011a; 2011b) use the Teligen dataset as their main source, which collects and compares all available tariffs of the two largest mobile operators by subscribers' share for thirty OECD countries.[8] Teligen basically constructs three different hypothetical consumer

[7] The EBITDA margin is calculated by dividing total EBITDA by total revenues. It is important to note that this variable includes non-price elements such as advertising, and handset subsidies.

[8] An alternative proxy used for prices is revenues per minute derived from the Merrill Lynch dataset (Growitsch et al., 2010; Veronese and Pesendorfer, 2009). It contains aggregate information on total voice service-based revenues for all the operators in a country. However, there are two problems with this data. First, and more fundamentally, the revenue data includes also the revenues from termination rates – hence this is a measure more of overall profitability than prices to mobile customers. Second, the total revenue is an aggregate measure of "real world" behaviour and it does not allow like-to-like comparison of tariffs (as we cannot distinguish things like inclusive minutes, quantity discounts, etc.).

usage profiles (heavy, medium and low) based on a number of characteristics (number of calls and messages, average call length, time and type of call, etc), which are then held fixed when looking across countries and time. It then reports information on the cheapest overall tariff for each profile, which could be either pay-as-you-go (pre-paid) or monthly subscription (post-paid) contracts. The Teligen dataset does not contain information about handset subsidies.

The Teligen dataset has two main advantages. First, by fixing the calling profiles of customers, it provides us with information on the best choices of these customers across countries and time. Second, the total bills reported in this dataset include much of the relevant information for this industry, such as inclusive minutes, quantity discounts, etc. However, this richness of information comes at the cost of having data for only the two biggest operators of every country at each point in time (although they cover 80% of the market in terms of subscriber share on average during the sample considered, e.g., by Genakos and Valletti, 2011a). Also an important limitation is that these are not actual end user bills, but hypothetical baskets based on a number of assumptions. However, the very fact that it is a hypothetical basket based on a number of characteristics (number and length of calls, etc.) that are fixed *a priori* is also its strength, because it allows a meaningful comparison across time and countries.

The empirical methods used also vary across these papers. Two are the key problems faced by researchers. The first one is omitted variables or unobserved heterogeneity. Whether is the effect of termination regulation on diffusion, profits or prices, the empirical specifications used need to include all potentially significant variables that might affect the relationship in question. For example, Cunningham et al. (2010) examining the effect of termination rates on mobile diffusion across countries include as explanatory variables not just measures of the market in question such as the cost of termination, number of mobile operators and the size of networks, but also various demographic and institutional controls, such as GDP per capita, average age of the population, linguistic fractionalization and press repression. However, by far the most common method to alleviate these questions is to use panel data estimation techniques that control for unobserved heterogeneity across countries

These two problems pose some serious identification and endogeneity issues which renders the use of this data in examining the waterbed phenomenon problematic.

and operators using fixed effects (see, Andersson and Hansen, 2009; Genakos and Valletti, 2011a; 2011b).

The second important empirical consideration is the endogeneity of the explanatory variables used and, most importantly, of the introduction of termination rates regulation itself. There are three related concerns here. The first one is that it was due to the high retail prices, that termination rates are regulated (reverse causality). For example, it could have been the case that countries and operators, which have experienced slower decrease in prices than comparable countries, were the more likely candidate for regulation. The second concern could be that regulatory intervention is the outcome of a bargaining (or lobbying) process between firms and the relevant authority, where affected firms will try to minimize the reduction of their termination rates and therefore the impact of regulation on prices and their profits. And the third concern could be that some time-varying aspects of the political and regulatory environment across countries might be correlated with the timing of the introduction of regulation.

Researchers have tried to confront endogeneity concerns using three different approaches. Andersson and Hansen (2009) used lagged values of the endogenous variables as instruments in a GMM framework to resolve this issue. Their identification argument relied on the assumption that only current, and not lagged, termination rates should affect profits. On the contrary, Dewenter and Kruse (2011) used as instruments for the decision to regulate various political and institutional factors, such as an index of democracy, but also some features concerning the exercise of authority, such as a measure on the regulation of recruitment requirements, executive constraints or political competition, etc., from the Polity IV Project. Their idea relies on the work on telecommunication deregulation of Duso (2001) and Duso and Roller (2003) who have pointed out that both political and institutional factors systematically influence the decisions to deregulate. Finally, Genakos and Valletti (2011a) examined the impact of termination rates on prices and profits by using regulation as an instrument. Due to the inclusion of various fixed effects, their identification argument basically looks at how prices (or profits) in countries that introduced regulation (treatment group) evolve compare to non-reforming countries (control group). Moreover, they also explicitly account for the possibility that regulatory intervention is the outcome of a bargaining (or lobbying) process between operators and the relevant authority by distinguishing between countries that

introduced substantial cuts in termination rates and countries that regulated them but only mildly.

4. The empirical evidence so far

Regarding the effect of termination rates regulation on prices, Genakos and Valletti (2011a) were the first to document empirically the existence and magnitude of the waterbed phenomenon using a quarterly panel of mobile operators' prices across more than twenty countries over six years. Figure 1 plots the average (time and usage-country-operator demeaned) prices in countries that have experienced a change in regulation at a certain time T, six quarters before and after the introduction of regulation. Notice first that compared to prices in the rest of the world, average mobile retail prices in countries that experienced a change in regulation at time T were actually lower before the introduction of regulation.[9] Most importantly, in line with the waterbed prediction, the introduction of regulation at time T has a clear positive impact on retail prices and their trend as regulation becomes progressively more binding.

[Insert Figure 1 around here]

In the full empirical specification, using fixed effects panel data techniques, Genakos and Valletti (2011a) were able to control for country-specific differences (as, say, the UK has special features different from Italy), for operator-specific differences (for example, differences in spectrum access or other factors that affect costs across different operators), time-specific differences (as technological progress varies over time, as well as controlling for seasonality effects), as well as consumer-specific differences (different usage profiles). After controlling for all these differences, Genakos and Valletti (2011a) test for whether reductions to termination rates, as a result of regulation, had an *additional* effect on retail prices set by mobile operators and on their profits. The underlying assumption is that regulation affects retail prices indirectly via reducing termination rates, while regulators do not intervene in any other direct manner in relation to customer prices. Their results suggest that, although regulation reduced termination rates by about 10% to the benefit of callers to mobile

[9] This is important because it refutes the argument that regulation was introduced as a result of high retail prices (reverse causality).

phones from fixed lines, this also led to a 5% increase[10] (varying between 2%-15% depending on the estimate) in mobile retail prices. This roughly translates to a 25 euros increase on the yearly bill per subscriber, or some 750 million euros extra in total in their sample. Their analysis also reveal that the waterbed effect is stronger the more intense competition is in markets with high levels of market penetration and high termination rates.

In follow-up work, Genakos and Valletti (2011b) also look more closely on the impact that regulation of mobile termination rates should have on mobile customers' bills, distinguishing between the pure (or direct) waterbed effect from F2M calls and the indirect effect of regulation through its impact on the price of M2M calls, whereby termination rates could be instrumental to *lessen* competition among mobile operators, because of a "raise-each-other's costs" effect. In synthesizing the literature on two-way access charges that we also briefly covered in Section 2, they derive two testable implications. They find that the waterbed effect is stronger for non-linear monthly (post-paid) than for pre-paid contracts and in particular it shows up on the fixed, rather than the variable, component of the contract. This highlights the importance of these direct and indirect channels, and of taking into consideration the structure of tariffs when examining the waterbed phenomenon in mobile telephony (see Hoernig, 2010).

Genakos and Valletti (2011b) run the empirical analysis twice, once allowing consumers to choose without constraints between pre-pay and post-pay contracts, and a second time allowing consumers to choose only within one type of contract (i.e., they were not allowed to switch between pre-pay and post-pay). In fact, there are important reasons to believe that distinguishing sharply between pre-pay and post-pay customers is important. Customers on long-term contracts may be looking only at similar long-term deals, and may not be interested in a temporary pre-pay subscription, even if this turned out to be cheaper for a while. Switching among mobile operators takes time and for a business user this might not be a very realistic option, even in the presence of mobile number portability. Conversely, pre-pay customers may have budget constraints and do not want to commit to long-term post-pay contracts where they would have to pay a fixed monthly fee for one or more

[10] This does not imply that the waterbed is 50% as, in order to conclude what the impact on revenues is, one would need to know the total termination revenues as well as revenues from retail voice (calls and subscriptions). The data required for this assessment was not available in Genakos and Valletti (2011a).

years. Again, these customers may want to look only at pre-pay offers. Genakos and Valletti (2011b) find a difference in the impact of the waterbed effect between the pre-pay and post-pay segments in both sets of results, and in particular when each type of user is limited in their choices exclusively within the same type of contracts. They conclude that the waterbed effect is much stronger for post-pay contracts, and diluted for pre-pay consumers (in the "constrained" version, the waterbed effect for pre-pay customers is even not significantly different from zero). This may indicate that the pure waterbed effect is exactly compensated by the more competitive environment for pre-pay customers, due to lower termination rates and thus a reduced role for "raise-each-other's-costs" effects.

The different behaviour between pre-pay and post-pay consumers could also be related to other factors Genakos and Valletti (2011b) cannot directly test because of data limitations. To the extent that pre-pay users receive fewer calls, termination rents from receiving calls would be less relevant for mobile operators and therefore the waterbed effect would play a much reduced role in determining their retail prices. However, casual evidence seems to suggest the opposite, in that, compared to post-pay consumers, pre-pay consumers do get a high volume of incoming calls (relative to their outgoing calls), and therefore MTR regulation should induce a strong waterbed effect, but arguably much diluted by their reduced competition-dampening role.

Given that the termination rate regulation is relatively recent, more research is needed to focus on aspects that could be considered limitations of the current research. First, more data information on a larger number of mobile operators within countries, would allow for a more detailed investigation of the regulation's impact. Second, a longer time series since the regulation's introduction would allow us to better distinguish its short vs. long run effects. Third, customer level information at a country level would allow us to model more satisfactorily the effect of competition and market penetration on the waterbed effect. Such a structural model would also enable us to quantify the effects of various regulatory interventions and their welfare implications.

Considering the impact of termination rates regulation on mobile operators' profits, existing research seems contradictory. On the one hand, Andersson and Hansen (2009) test the impact on the overall profitability of changes in mobile termination rates across twenty-six mobile operators in nine north-western European countries. They find that mobile operators' profits do not seem to vary statistically with changes

in these termination rates, consistent with a hypothesis of a "full" (one-for-one) waterbed effect. On the other hand, Genakos and Valletti (2011a) using panel data on all mobile operators in forty-six countries worldwide show that the profitability of mobile firms was negatively affected by regulation. Figure 2 plots the average (time and country-operator demeaned) profits in countries that experienced a change in regulation, six quarters before and after the introduction of regulation. As we can see, compared to the rest of the world, profits of mobile operators in countries that experienced a change in regulation were higher before the introduction of regulation and were severely hit following its introduction. Genakos and Valletti (2011a) interpret this as evidence that the industry is oligopolistic and does not pass one-for-one termination rents to their customers. We must remark, however, that the negative effect of regulation on profit margins was often not statistically significant even in Genakos and Valletti (2011a), but the authors view that more as a data problem (considerably noisier) than indication of a perfectly competitive industry.

Given the contradictory evidence, the impact of regulation on profits is also a fruitful area for future research. Again, longer time series than the above mentioned papers and perhaps collecting alternative proxies for the profitability of mobile operators across countries would definitely add to the evidence so far. Moreover, even conducting a stock market event study based on mobile operators' share prices and its reaction around the introduction of regulation would provide useful information regarding its impact on firms' profitability.

[Insert Figure 2 around here]

Finally, looking at the impact of mobile termination rates on diffusion, researchers unanimously agree on a positive relationship. Cunningham et al. (2010) find evidence that mobile termination rates are positive and significantly related to mobile phone adoption in a cross-section of countries. Their result is robust to the inclusion of a variety of other structural, institutional, demographic, and income controls. This is also the conclusion of Dewenter and Kruse (2011), who used panel data techniques on a much larger dataset of seventy-seven countries over a span of twenty-three years. In a similar vein, Veronese and Pesendorfer (2009) examining the take up of mobile services, measured as the number of SIM cards per capita, in thirty-nine OECD

countries also provide evidence of a consistently positive relationship with termination rates.[11]

5. Conclusions and policy lessons

In two-sided markets there are obviously are two different viewpoints emphasized by the parties involved in a competition or regulation case. Firms with the features of a two-sided market are correct to stress the fact that these are "special" markets, which policy-makers consequently need to be very careful with. Regulatory interventions typical of one-sided markets will potentially be fallacious and possibly bring unintended consequences. We agree with this point and always advocate a full and appropriate economic analysis of these markets. However, it is also useful to recall the other view that, even if a two-sided market is assumed to be perfectly competitive, then this market would not work well. This is in stark contrast with standard one-sided markets: when these markets are competitive, they are also efficient and no regulator should interfere with their working. In two-sided markets, on the other hand, privately chosen prices, even when ideally set by competing firms, will differ from socially-optimal prices, because of externalities. Two-sided markets should therefore be subject to more, rather than less regulatory oversight.

Both views are right, as is the Keynesian adage that it is better to be imprecisely right than precisely wrong. A correct intervention can increase consumer and social welfare in a two-sided market. But, if inappropriate, it can worsen things.

The mobile telephony market is a fitting example. The market for subscription and outgoing services is closely interlinked to the market for termination of incoming calls. Over the last decade, regulating one side of this market (mobile termination charges) has become increasingly prevalent around the world (e.g., every single country in the EU has adopted regulation of mobile termination rates). However, the "two-sidedness" of this market meant that while regulators were pushing prices down

[11] A related strand of literature has focused on measuring the impact of calling party pays (CPP) compared to a Bill & Keep (B&K) system that is associated with a retail regime with mobile reception charges. The CPP regime is usually characterized by significantly higher termination rates relative to the B&K. Examining the diffusion patterns under these two regimes would also provide us with indirect information on the effect of termination rates on mobile take up. Both Jang et al. (2005) and Veronese and Pesendorfer (2009) report consistent evidence that the CPP regime is associated with greater diffusion of mobile services across OECD countries, whereas Dewenter and Kruse (2011) find an insignificant positive effect. Hence overall, this literature also points in the direction that termination rates and mobile diffusion have moved in parallel.

on one side (reducing the level of termination charges), prices were pumping up on the other side (increase in the level of prices for mobile subscribers) leading to what is known as the "waterbed" effect.

The waterbed effect points to a trade-off between cheaper prices to those calling mobile phones and increased charge levels to mobile subscribers. The empirical literature is quite strong in finding this effect, but still falls short of computing, from the data, what the optimal level of intervention should be, possibly because of the nature of these studies (cross-country comparisons, rather than empirical structural models at a single-country level with more detailed information especially about demand parameters). If the "marginal" subscriber would not give up his mobile phone even after the waterbed effect, the increase in calling volumes following a cut in termination rates should be the prevailing effect, thereby increasing social welfare. Similarly, if this marginal subscriber was a holder of several SIM cards and, say, would drop one them due to the waterbed, there would not be a loss in network externalities as he would still be reachable, and regulatory cuts would still be fully justifiable. On the contrary, if the waterbed effect led the marginal customer to abandon mobile subscription altogether, and at the same time destroy the possible contacts that other people would have otherwise made to him, then social welfare could possibly worsen due to intervention. It is this type of more precise estimates that represent a fruitful area for future empirical research, as they will inform regulators and policy makers whether and how to intervene.

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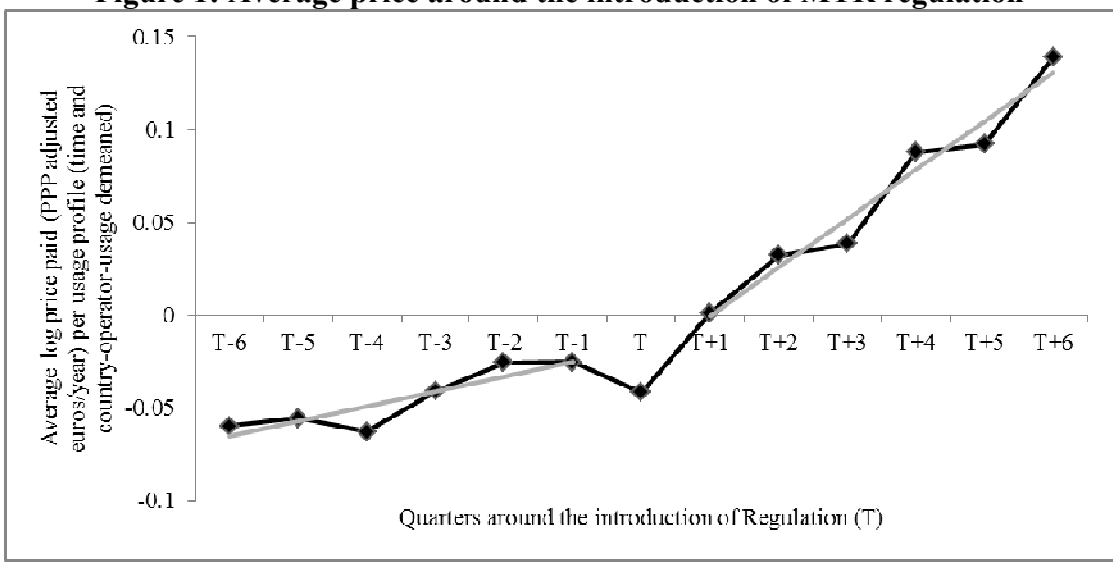
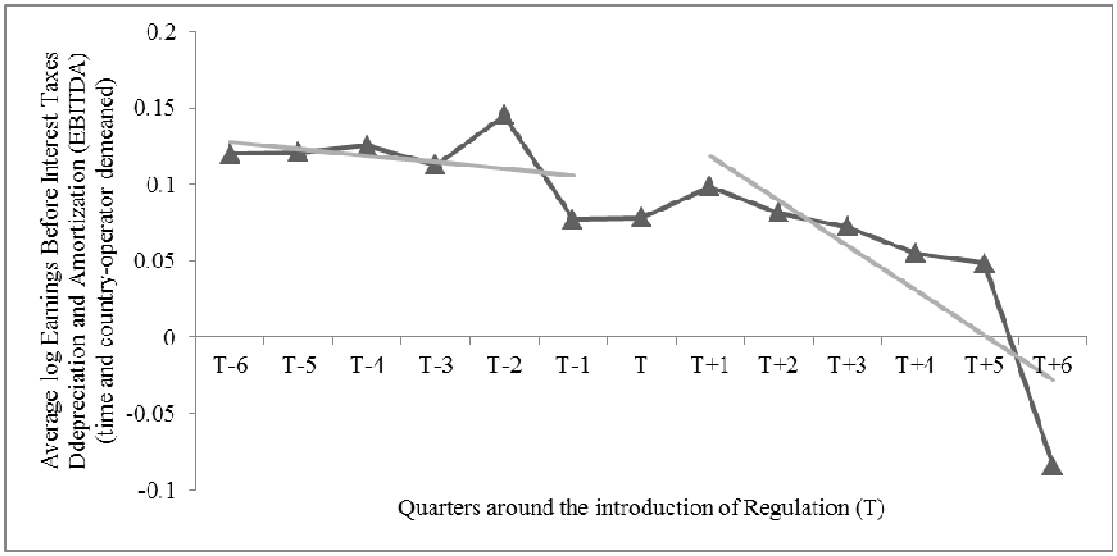
Figure 1: Average price around the introduction of MTR regulation



Notes: MTR = Mobile Termination Rate. Data from Teligen. Figure 1 plots the average (time and country-operator-usage demeaned) logarithm of the PPP adjusted price paid per usage profile in countries that have experienced a change in regulation, six quarters before and after the introduction of MTR regulation. The two continuous grey lines indicate the linear trend before and after the introduction of regulation. Regulation takes the form of "glide paths", in which termination charges are allowed to fall gradually towards a target over the period.

Figure 2: Average profits around the introduction of MTR regulation



Notes: MTR = Mobile Termination Rate. Data from Merrill Lynch. Figure 2 plots the average (time and country-operator demeaned) logarithm of the EBITDA in countries that experienced a change in regulation, six quarters before and after the introduction of MTR regulation. The two continuous grey lines indicate the linear trend before and after the introduction of regulation. Regulation takes the form of "glide paths", in which termination charges are allowed to fall gradually towards a target over the period.