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APPENDIX B - ADDITIONAL RESULTS

In this Appendix we discuss some theoretical extensions and provide a number of additional empirical results and that complement our analysis in the main text. We first show our benchmark waterbed effect results using a simpler difference-in-difference specification. We then analyze in detail the effect of regulation on pre- and post-paid contracts. Next, we provide an explicit theoretical analysis on mobile-to-mobile calls and their expected effect on the structure of tariffs. The following section presents empirical results using ARPU as an alternative proxy for profits. The last section presents alternative estimates on the effect of market structure using the HHI as a proxy for competition.

B.1 Difference-in-Difference specification

An alternative empirical specification to that of model (4) and (4a) in the main text (Section 3) could be as follows:

$$(B1) \quad \ln P_{ujct} = \alpha_{ujc} + \alpha_t + \beta_1 \text{Regulation}_{jct} + \varepsilon_{ujct}$$

$$(B1a) \quad \ln \Pi_{jct} = \alpha_{jc} + \alpha_t + \beta_1 \text{Regulation}_{jct} + \varepsilon_{jct}$$

The dependent variable in (B1) is the logarithm of retail prices ($\ln P_{ujct}$) for the usage profile $u = \{\text{low, medium, high}\}$ of operator j in country c in quarter t . The dependent variable in (B1a) is the logarithm of earnings before interest, taxes, depreciation and amortization (EBITDA), which is defined as the sum of operating income and depreciation and is our proxy for profits ($\ln \Pi_{jct}$). Time fixed effects (α_t) and usage-operator-country (α_{ujc}) or operator-country (α_{jc}) fixed effects control for time-invariant global trends and (usage-)operator-country characteristics respectively. The main variable of interest, Regulation_{jct} , is a binary indicator variable that takes the value one in the quarters when mobile termination rates are regulated.

Both regressions constitute a difference-in-difference model, where countries that introduced the regulation are the “treated” group, while non-reforming countries (always regulated or always unregulated) are the “control” group. Due to the inclusion of (usage-)country-operator and time fixed effects, the impact of regulation on prices

(or profits) is identified from countries that introduced this regulation and measures the effect of regulation in reforming countries compared to the general evolution of prices or profits in non-reforming countries. The “waterbed” prediction is that, *ceteris paribus*, the coefficient on regulation should have a positive sign in (B1), and a negative or zero effect in (B1a) depending on whether the effect is full or not.

In other words, a difference-in-difference model rests on very similar assumptions, but empirically is much less demanding than the two step IV specification. In Tables B1 and B2 we provide the results from a diff-in-diff specification for prices and profits respectively. The first three columns in Table B1 correspond to the same columns in Table 1, whereas the last two columns correspond to columns 3 and 4 in Table 2. Similarly, the first three columns in Table B2 correspond to the last three columns in Table 1, whereas the last two columns correspond to last two columns in Table 2. Finally, note that magnitude of the waterbed effect is exactly the same, as the impact of regulation on prices, for instance, can be decomposed as $\frac{\partial P}{\partial \text{Regulation}} = \frac{\partial P / \partial \text{MTR}}{\partial \text{MTR} / \partial \text{Regulation}}$, where the denominator and the numerator are obtained from the 1st and 2nd stage respectively in the IV regression.

TABLE B1 – ESTIMATING THE “WATERBED” EFFECT (TELIGEN)

	(1)	(2)	(3)	(4)	(5)
Estimation method	OLS	OLS	OLS	OLS	OLS
Dependent variable	$\ln P_{ujct}$	$\ln P_{ujct}$	$\ln P_{ujct}$	$\ln P_{ujct}$	$\ln P_{ujct}$
<i>Waterbed effect</i>	13.3%	4.7%	1.9%	15.2%	5.1%
Regulation _{jct}	0.133*** (0.033)			0.152*** (0.033)	
MaxMTR index _{jct}		0.290*** (0.068)			0.316*** (0.066)
UnregulatedMTR index _{jct}			0.127** (0.051)		
Pre-paid _{jct}	-0.045 (0.040)	-0.051 (0.041)	-0.127*** (0.044)	-0.052 (0.039)	-0.056 (0.040)
Observations	1734	1734	450	1734	1734
Country-Operator-Usage	150	150	36	150	150
Within-R ²	0.220	0.234	0.367	0.252	0.267

Source: Author’s calculations based on the Teligen data corresponding to the best deals available at every quarter and the matched MTRs.

Notes: The dependent variable is the logarithm of the PPP adjusted total bill paid by consumers with different usage at every quarter. All equations include country-operator-usage and a full set of time binary indicators (first three columns) or a full set of region-time binary indicators (last two columns). All countries in the sample were divided into three macro regions: Western Europe, Eastern Europe and Rest of the World (RoW); see text for more details. Standard errors clustered (i.e. robust to heteroskedasticity and autocorrelation of unknown form) either at the country-operator-usage level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.

TABLE B2 – ESTIMATING THE “WATERBED” EFFECT (MERRILL LYNCH)

Estimation method	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS
Dependent variable	$\ln\text{EBITDA}_{\text{jct}}$	$\ln\text{EBITDA}_{\text{jct}}$	$\ln\text{EBITDA}_{\text{jct}}$	$\ln\text{EBITDA}_{\text{jct}}$	$\ln\text{EBITDA}_{\text{jct}}$
<i>Waterbed Effect</i>	-12.5%	-0.3%	-1.3%	-13.8%	-0.6%
Regulation _{jct}	-0.125* (0.070)			-0.138* (0.076)	
MaxMTR index _{jct}		-0.024 (0.133)			-0.054 (0.139)
UnregulatedMTR index _{jct}			-0.148 (0.236)		
Observations	1135	1135	319	1135	1135
Country-Operator	67	67	16	67	67
Within-R ²	0.209	0.203	0.281	0.215	0.209

Source: Author's calculations based on the Merrill Lynch dataset and the matched MTRs.

Notes: The dependent variable is the logarithm of the EBITDA for each operator in a given country at every quarter. All equations include country-operator-usage and a full set of time binary indicators (first three columns) or a full set of region-time binary indicators (last two columns). All countries in the sample were divided into three macro regions: Western Europe, Eastern Europe and Rest of the World (RoW); see text for more details. Standard errors clustered (i.e. robust to heteroskedasticity and autocorrelation of unknown form) either at the country-operator level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.

B.2 Pre- and post-paid contracts

In Tables 1-3 using the Teligen data, we assumed that a customer could ideally choose the best available contracts at any given point in time, given her/his usage profile. The results are therefore valid if indeed customers behave in this frictionless way. The introduction of mobile number portability¹ certainly makes this possibility all the more realistic. However, as many market analysts advocate, there are good reasons to believe that distinguishing between pre-paid (pay-as-you-go) and post-paid (long-term contract) customers is still important.

Using our benchmark IV specification (4), we now investigate whether there is a difference in the waterbed effect between pre-paid and post-paid users, when each type of user is limited in her/his choices within the same type of contracts. Table B3 provides some summary statistics of the key variables. Tables B4 and B5 report the results for pre-paid and monthly (post-paid) contracts respectively. The procedure and interpretation is equivalent to that of Table 1 (columns 1-3) and Table 2 (columns 3 and 4). We find that pre-paid customers essentially are unaffected by regulation, whereas monthly subscribers bear the bulk of the price increases. As explained in the

¹ Mobile number portability is the ability of consumers to switch among mobile operators while keeping the same phone number.

main text, the reason for this may come from the ‘countervailing’ collusive effect of M2M rates. As an additional explanation, the difference between pre-paid and post-paid may also arise because firms have a more secure relationship with monthly contract subscribers (who tend to stay with the same operator for several years), and so have a greater expectation of receiving future incoming revenues as a result of competing on price for these customers. Post-pay customers also tend to receive more incoming calls, and so become more (less) profitable as termination rates rise (fall). On the contrary, pre-pay subscribers, who are typically very price sensitive, tend to change their number often, therefore it is less likely that their numbers are known by potential callers. Thus pre-pay users receive relatively few calls and a change in MTR has a much lower expected impact compared to post-pay customers.²

TABLE B3 – SUMMARY STATISTICS

Variable	Observations	Mean	Standard Deviation	Min	Max
Teligen (Pre-Paid)					
$\ln P_{ujct}$	1686	5.556	1.680	0.114	7.989
$\ln(MTR)_{jct}$	1686	1.883	1.574	-3.246	3.573
$Regulation_{jct}$	1686	0.603	0.489	0	1
$MaxMTR\ index_{jct}$	1686	0.167	0.239	0	1.127
$UnregulatedMTR\ index_{jct}$	450	0.150	0.291	-0.137	1.127
Teligen (Monthly subscriptions)					
$\ln P_{ujct}$	1734	5.292	1.695	0.107	7.728
$\ln(MTR)_{jct}$	1734	1.800	1.656	-3.246	3.573
$Regulation_{jct}$	1734	0.614	0.487	0	1
$MaxMTR\ index_{jct}$	1734	0.163	0.237	0	1.127
$UnregulatedMTR\ index_{jct}$	450	0.150	0.291	-0.137	1.127

Source: Author’s calculations based on the Teligen data corresponding to deals available to monthly subscribers only (first panel) and deals available to pre-paid customers only (second panel) and the matched MTRs.

Notes: The above table provides summary statistics on the key variables used in Table B3 and B4.

² Vodafone, for example, reports the following churn rates across its major European markets for the quarter to 30 September 2007 (Source: Vodafone):

Markets	Prepaid	Contract	Total
Germany	29.5%	13.5%	22.1%
Italy	22.4%	13.6%	21.7%
Spain	62.5%	13.4%	37.0%
UK	49.9%	18.8%	37.6%

TABLE B4 – WATERBED EFFECT THROUGH MTR (TELIGEN Pre-Paid)

	(1)	(2)	(3)	(4)	(5)
Estimation method	IV	IV	IV	IV	IV
Dependent variable	$\ln P_{ujct}$	$\ln P_{ujct}$	$\ln P_{ujct}$	$\ln P_{ujct}$	$\ln P_{ujct}$
<i>Waterbed Effect</i>	0.8%	2.6%	0.1%	1.4%	2.8%
$\ln(MTR)_{jct}$	-0.069 (0.501)	-0.489 (0.352)	-0.017 (0.260)	-0.137 (0.559)	-0.548 (0.365)
Region-Time FE	no	no	no	yes	yes
Time FE	yes	yes	yes	yes	yes
County-Operator-Usage FE	yes	yes	yes	yes	yes
Instrument	Regulation _{jct}	MaxMTR index _{jct}	UnregulatedMTR index _{jct}	Regulation _{jct}	MaxMTR index _{jct}
1 st Stage Coef.	-0.113*** (0.025)	-0.316*** (0.039)	-0.389*** (0.029)	-0.104*** (0.025)	-0.302*** (0.036)
1 st Stage R ²	0.049	0.138	0.532	0.043	0.133
1 st Stage F-test	20.37*** [0.000]	66.33*** [0.000]	175.40*** [0.000]	16.82*** [0.000]	69.71*** [0.000]
Observations	1686	1686	450	1686	1686
Clusters	147	147	36	147	147

Source: Author's calculations based on the Teligen data corresponding to the deals available to pre-paid customers only and the matched MTRs.

Notes: The dependent variable is the logarithm of the PPP adjusted total bill paid by consumers with different usage at every quarter. All equations include country-operator-usage and a full set of time binary indicators (first three columns) or a full set of region-time binary indicators (last two columns). All countries in the sample were divided into three macro regions: Western Europe, Eastern Europe and Rest of the World (RoW); see text for more details. The instrumental variable "Regulation" is a binary indicator that takes the value one in the quarters when mobile termination rates are regulated. The instrumental variable "MaxMTR" is an index that takes larger values the more regulated a mobile operator is compare to the operator that is regulated the least in the same country and quarter. The instrumental variable "UnregulatedMTR" is an index that takes larger values the more regulated a mobile operator is compare to the operator that is unregulated in the same country and quarter. The waterbed effect in row four is calculated as follows: 1st stage coeff. \times coeff. $\ln(MTR) \times$ mean value of instrumental variable. P-values for diagnostic tests are in brackets and italics. Standard errors clustered (i.e. robust to heteroskedasticity and autocorrelation of unknown form) either at the country-operator level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.

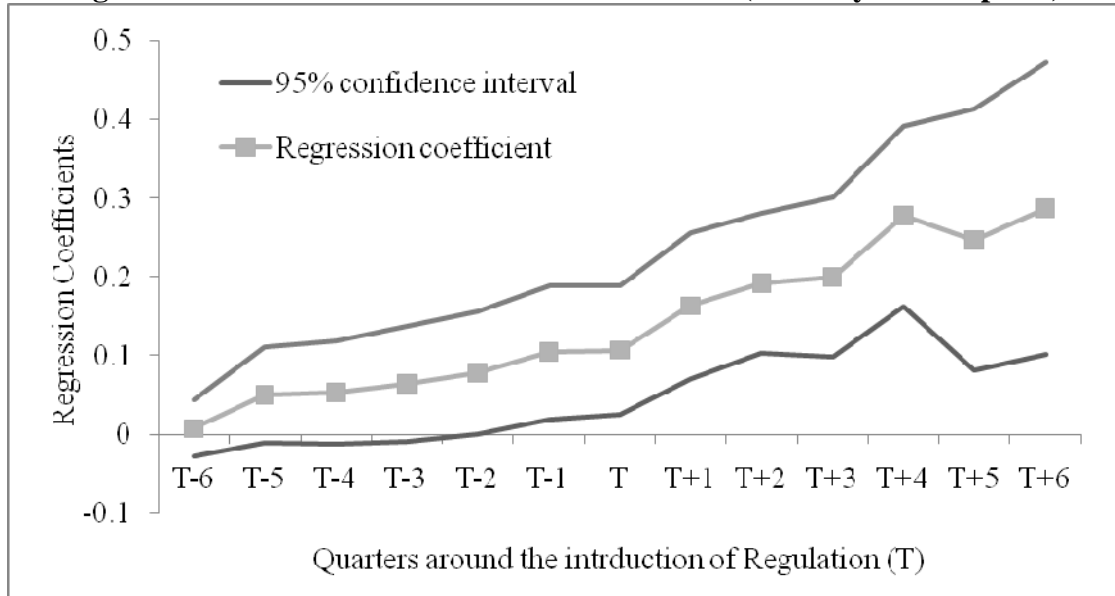
TABLE B5 – WATERBED EFFECT THROUGH MTR (TELIGEN Monthly Subscription)

	(1)	(2)	(3)	(4)	(5)
Estimation method	IV	IV	IV	IV	IV
Dependent variable	$\ln P_{ujct}$	$\ln P_{ujct}$	$\ln P_{ujct}$	$\ln P_{ujct}$	$\ln P_{ujct}$
<i>Waterbed Effect</i>	<i>13.7%</i>	<i>5.2%</i>	<i>2.3%</i>	<i>15.8%</i>	<i>5.6%</i>
$\ln(MTR)_{jct}$	-1.226*** (0.393)	-1.014*** (0.269)	-0.390*** (0.144)	-1.540*** (0.477)	-1.149*** (0.272)
Region-Time FE	no	no	no	yes	yes
Time FE	yes	yes	yes	yes	yes
County-Operator FE	yes	yes	yes	yes	yes
Instrument	Regulation _{jct}	<i>MaxMTR</i> index _{jct}	<i>UnregulatedMTR</i> index _{jct}	Regulation _{jct}	<i>MaxMTR</i> index _{jct}
1 st Stage Coef.	-0.112*** (0.025)	-0.313*** (0.037)	-0.389*** (0.029)	-0.102*** (0.025)	-0.298*** (0.034)
1 st Stage R ²	0.046	0.130	0.532	0.040	0.127
1 st Stage F-test	19.63*** [0.000]	72.24*** [0.000]	175.40*** [0.000]	16.110*** [0.000]	76.54*** [0.000]
Observations	1734	1734	450	1734	1734
Clusters	150	150	36	150	150

Source: Author's calculations based on the Teligen data corresponding to the deals available to monthly subscribers only and the matched MTRs. Notes: The dependent variable is the logarithm of the PPP adjusted total bill paid by consumers with different usage at every quarter. All equations include country-operator-usage and a full set of time binary indicators (first three columns) or a full set of region-time binary indicators (last two columns). All countries in the sample were divided into three macro regions: Western Europe, Eastern Europe and Rest of the World (RoW); see text for more details. The instrumental variable "Regulation" is a binary indicator that takes the value one in the quarters when mobile termination rates are regulated. The instrumental variable "MaxMTR" is an index that takes larger values the more regulated a mobile operator is compare to the operator that is regulated the least in the same country and quarter. The instrumental variable "UnregulatedMTR" is an index that takes larger values the more regulated a mobile operator is compare to the operator that is unregulated in the same country and quarter. The waterbed effect in row four is calculated as follows: 1st stage coeff. \times coeff. $\ln(MTR) \times$ mean value of instrumental variable. P-values for diagnostic tests are in brackets and italics. Standard errors clustered (i.e. robust to heteroskedasticity and autocorrelation of unknown form) either at the country-operator level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.

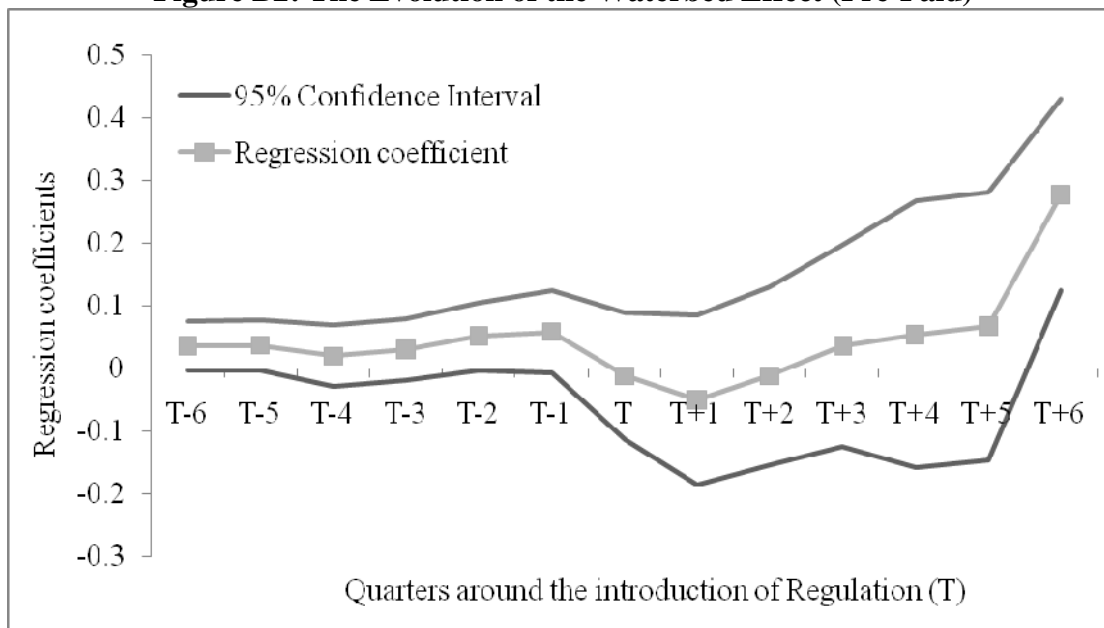
The relationship between regulation and prices might not be monotonic and for that reason we examine as in the main text the dynamics of the waterbed effect using our specification in (5) separately for pre- and post-paid deals. Figures B1 and B2 plot the regression coefficients on the thirteen binary indicators around the introduction of regulation together with their 95% confidence interval for post- and pre-paid contracts respectively.

Figure B1: The Evolution of the Waterbed Effect (Monthly Subscription)



Notes: Data from Teligen corresponding to the deals available at every quarter to monthly customers only. Figure B1 plots the regression coefficients from model (5) on binary variables six quarters before and after the introduction of regulation. The dependent variable is the logarithm of the PPP adjusted total bill paid by consumers with different usage at every quarter. All equations include country-operator-usage and a full set of time dummies. Confidence interval is based on standard errors clustered (i.e. robust to heteroskedasticity and autocorrelation of unknown form) at the country-operator-usage level.

Figure B2: The Evolution of the Waterbed Effect (Pre-Paid)



Notes: Data from Teligen corresponding to the deals available at every quarter to pre-paid customers only. Figure B2 plots the regression coefficients from model (5) on binary variables six quarters before and after the introduction of regulation. The dependent variable is the logarithm of the PPP adjusted total bill paid by consumers with different usage at every quarter. All equations include country-operator-usage and a full set of time dummies. Confidence interval is based on standard errors clustered (i.e. robust to heteroskedasticity and autocorrelation of unknown form) at the country-operator-usage level.

In line with our previous analysis, the anticipation of regulation has very little impact on either pre- or post-paid contracts up to two periods before regulation.

Monthly customers (Figure B1) then experience a change similar to that analysed with the general unconstrained results (contrast it with Figure 3 in the main text). On the contrary, the pattern for pre-paid contracts is more intriguing. As can be seen in Figure B2, the inaction before the introduction of regulation is followed by a short-lived (for periods T and T+1) non-significant decrease in prices and then a continuous non-significant increase in prices for the next four quarters (periods T+2, T+3, T+4 and T+5). There is, however, an overall positive and strongly significant long-run waterbed effect (coefficient on T+6, around 27%) on these prices too.

Notice also the massive increase in the variance associated with these coefficients after the introduction of regulation. Mobile operators seem to have reacted differentially regarding the pricing of these contracts shortly after the introduction of regulation. At the beginning, they seem on average to reduce the prices charged to these customers, possibly trying to lure customers into their networks (with the hope of them upgrading later to monthly subscribers) or potentially as a loss making, short term strategy against smaller firms that either remained unregulated or were not regulated at the same rates. In either case, the strong and positive long-run coefficient illustrates that mobile operators eventually were forced to abandon any such strategies and raise the prices even for the pre-paid customers, which is another manifestation of the power of the waterbed effect.

B.3 Mobile-to-mobile calls and the structure of tariffs

The call termination problem described in Section 2 of the main text is relevant when the market of callers from fixed networks is separate from the market of receivers on mobile networks. This has been the focus of the literature on MTRs and the main concern of regulatory authorities. However, mobile firms also interconnect with each other. There is therefore another termination rate, for mobile-to-mobile (M2M) calls, that we have to discuss. In this section we first analyze the impact of M2M termination rates on prices and profits, when considered completely in isolation from F2M termination rates that we dealt with in Section 2 of the main text. We then put these two sets of results together and derive empirical implications. Finally, we test these additional predictions with our data.

B.3.1 Mobile-to-mobile calls

Mobile operators compete for the same customer base that both originates and terminates mobile calls. As long as operators M1 and M2 command some market share, operator M1 needs interconnection with M2 to terminate the calls that M1's customers destine to M2's customers and vice versa. There is a sort of "double coincidence of wants" that potentially makes the interconnection problem less problematic. In a symmetric situation termination charges may even be thought to be irrelevant since M1 pays M2 the same amount it receives from M2. However, this reasoning is not entirely correct. When termination charges are negotiated jointly, two kinds of potential problems emerge: a) operators can agree to set access charges at a level that eliminates any effective competition among them; and b) termination-based discrimination creates forms of externalities that may be used to affect the intensity of competition.

As extensively analyzed by the literature on "two way" access charges initiated by the seminal works of Armstrong (1998) and Laffont et al. (1998), different results arise according to the type of tariffs offered by competing mobile firms. Take the following tariff structure as a reference point:

$$(B2) \quad P(F, p_{on}, p_{off}) = F + p_{on}q_{on} + p_{off}q_{off}$$

where P is the average total bill of a mobile customer for a given usage profile, F is the fixed fee of the customer's multi-part tariff, p_{on} is the on-net price for calls made to customers belonging to the same network, p_{off} is off-net price for calls made to customers belonging to other networks, q_{on} is the average on-net traffic, and q_{off} is the average off-net traffic.

When firms compete in simple *linear* prices (which are relevant for pay-as-you-go or pre-paid contracts), collusive retail prices can be sustained using high termination charges because of a "raise-each-other's cost" effect. To see this, imagine what happens when operators charge monopoly retail prices to customers. This can be an equilibrium only if no one has a unilateral incentive to deviate. If one firm deviates from the monopoly retail charges by undercutting the rival, it induces its subscribers to call more. Since part of the calls made are destined to the rival's network, the effect of a price cut is to send out more calls than it receives from the rival. The resulting net

outflow of calls has an associated deficit that is particularly burdensome if the termination charge is high. This will discourage under-pricing in the first place. If we call T^M the termination rate between mobile networks, in the case of competition in linear prices we have the following prediction of an increase of termination rates (starting, say, from termination rates set at cost as a benchmark):

$$(B3a) \quad \frac{dP}{dT^M} > 0,$$

and a similar positive effect on profits, while there is obviously no prediction on the fixed component F since we are dealing with linear tariffs.

This collusive result disappears when firms compete in *multi-part* tariffs (which are relevant particularly for post-pay contracts). When firms compete in uniform two-part tariffs (which do not distinguish between calls placed on-net and off-net), there is a profit neutrality result of termination charges on profits. It is still true that a high termination charge feeds into high retail call charges. However, all the profits generated from termination are used to lower the fixed component. Hence, in this case, the waterbed effect would be neutral on profits and on the total bill; however it would still be at work on the fixed component of the two-part tariff:

$$(B3b) \quad \frac{dP}{dT^M} = 0, \frac{dF}{dT^M} < 0, \frac{dp_{on}}{dT^M} = 0, \frac{dp_{off}}{dT^M} > 0.$$

Finally, when firms can discriminate between on-net and off-net calls, they reach higher profits by setting low (below cost) termination charges. This is because tariff-mediated externalities are generated, and firms would compete less aggressively *for* the market when termination charges are set below cost. Essentially, customers prefer to belong to small networks in this case, as they would place relatively more off-net calls, which are cheaper than on-net calls. When instead termination charges are set above cost, off-net prices increase but the competitive externality effect is particularly strong on the fixed fee and this is the prevailing effect:

$$(B3c) \quad \frac{dP}{dT^M} < 0, \frac{dF}{dT^M} \ll 0, \frac{dp_{on}}{dT^M} = 0, \frac{dp_{off}}{dT^M} > 0.$$

How does this discussion fit with the regulation of F2M termination rates described in Section 2 of our paper? In that case, our prediction was simply:

$$(B4) \quad \frac{dP}{dT^F} < 0,$$

where T^F is now the F2M termination rate. Since T^F affects only the price of F2M calls, there is no obvious effect on call prices, while most of the waterbed effect would arise from the fixed component paid by the mobile user, at least for those customers on a post-paid deal.

In many jurisdictions M2M rates are not regulated, apart from imposing reciprocity, and therefore cuts in F2M rates should not apply to other types of calls. However, in practice, F2M calls can be sometimes converted into M2M calls by some special equipment (there exists such a technical possibility, called GSM gateways). Then, if T^F is much higher than T^M , there can be arbitrage possibilities. Thus regulation, even if it formally regulates only T^F , may effectively set a price *also* for T^M . The ‘pure’ waterbed effect from F2M calls can be then confounded by the M2M effects we described above.

Thus imagine that F2M (regulated) charges constrain also M2M termination charges, because any difference would otherwise attract arbitrageurs to exploit the differential. The main waterbed prediction given by eq. (3) in the main text would then be additionally affected by the extra effects summarized by the various eq. (B3) in this section.

Let us start from the case of competition in linear prices. As far as M2M rates are concerned, this is when the theory predicts that firms collude by setting ‘high’ MTRs. Thus, reasonably assuming that the unregulated M2M rates would also have been pretty high, if regulation of F2M rates cuts indirectly also M2M rates, then firms can collude even ‘less’, and bills will go down from this side, which contrasts the pure waterbed effect.

Let us turn now to competition in two-part tariffs when there is no discrimination between on-net and off-net prices. The theory predicts that the higher MTR, the more expensive calls per minute, but the lower the fixed fee. Thus the effect on the fixed component of an increase of MTR is negative, which reinforces the waterbed effect

that would be already arising from F2M calls. The total bill and profits are instead unaffected as far as M2M calls are concerned (while there is still the pure waterbed effect arising from F2M calls).

Finally, consider when firms compete in multi-part discriminatory tariffs. If M2M termination is set equal to F2M termination, it will be set ‘high’ compared to the otherwise collusive one for M2M calls alone. Regulation of F2M calls, by cutting this rate, would therefore get *closer* to the otherwise optimal M2M charge. Therefore we have additional effects which reinforce the waterbed on the total bill, in particular via a big impact on the fixed fee of the multi-part tariff paid by the customer.

B.3.2 Additional empirical predictions

Table B6 below summarizes the above discussion. The column ‘F2M’ reports the standard ‘pure’ waterbed effect (our focus in Section 2 of the main text), when F2M calls are insulated from M2M calls. The column ‘Total effect’ reports the possible overall effect arising when a single termination rate effectively affects all types of calls, which may be empirically relevant. As it can be seen, the waterbed effect on the total bill is actually reinforced for contracts, and shows particularly via the impact on the fixed fee. On the contrary, there is a countervailing force for pre-paid deals.

In our data, we have price information divided into pre-pay and post-pay contracts. Within post-pay contracts, we also have a further split between the fixed amount and the variable amount spent on calls. Thus, by looking at the structure of tariffs, we may get a further idea on whether F2M regulation has also an additional impact via M2M prices. For contracts which can be approximated by a multi-part tariff, we can split the waterbed effect on the total bill and on the fixed component of the multi-part tariff. If M2M calls play *de facto* a role, then the waterbed effect should be even stronger on the fixed fee. When firms offer simple linear prices, proxied by pre-pay deals, instead, the waterbed effect is diluted by the collusive effect.

TABLE B6 – PREDICTIONS ON THE WATERBED EFFECT

	F2M calls (pure waterbed)	Possible additional effect from M2M calls	Total effect
(pre-pay)			
<i>Total bill</i>	-	+	Ambiguous
Profits	+	+	++
(contracts)			
No on-net/off-net discrimination			
<i>Total bill</i>	-	0	-
Fixed fee	-	-	--
Variable	0	+	Mildly +
Profits	+	0	Mildly +
On-net/off-net discrimination			
<i>Total bill</i>	-	-	--
Fixed fee	-	--	---
Variable	0	+	Mildly +
Profits	+	-	Ambiguous ³

In the empirical specification, it is not possible to know if the regulation of MTR is affecting only F2M calls or also M2M calls. However, this does not cause a problem, as we have just explained that predictions can be actually sharper if what is relevant is the overall effect. Also, in the data we can distinguish between prices for pre-paid and contracts, but we just have the overall level of profitability. Hence the refinement of our predictions applies only to the structure of prices, and not to overall profits.

To conclude, the waterbed predictions are quite robust, also when M2M calls are brought into the picture. The additional empirical predictions (*tariff structure*) on the waterbed effect that we bring to a test are on the type of contracts and on the structure of prices. We predict the following:

- The waterbed effect is stronger for contracts and weaker for pre-paid deals.
- Among contracts, the waterbed effect should prevail particularly via a change of the fixed component of the contract.

³ The effect which is termed ‘ambiguous’ is actually investigated by Armstrong and Wright (2009) in details. They show that, under reasonable circumstances, the total effect on profits is positive also overall, which explains why operators vehemently oppose reductions in MTRs.

B.3.3 Empirical analysis on the tariff structure and waterbed effect

We now present empirical results on the impact of the waterbed effect on tariff structure. Following the previous theoretical discussion, we examine now in detail the impact of MTR regulation on pre-paid (pay-as-you-go) and post-paid (long-term contract) deals. When the regulation of F2M rates also affects the setting of M2M rates, the waterbed is expected to be stronger for contracts, and weaker for pre-paid deals. Because we look at a much smaller subset of the data, we utilize the empirically less demanding difference-in-difference specification:

$$(B4) \quad \ln P_{ujct} = \alpha_{ujc} + \alpha_t + \beta_1 \text{Regulation}_{jct} + \varepsilon_{ujct}$$

which is estimated separately for pre-paid and post-paid users. For post-paid users, we also estimate a variant of (B4) where the dependent variable, instead of being the total bill P_{ujct} , is divided between the fixed fee Fixed_{ujct} and the variable component Voice_{ujct} of the multi-part tariff (where $P_{ujct} = \text{Fixed}_{ujct} + \text{Voice}_{ujct}$).

Table B7 provides summary statistics of the key variables used, whereas Table B8 presents the results. The first four columns report the results for the same set of observations corresponding to Table 1 in the main text, once they are split between pre- and post-paid. The difference in the sample size depends on the fact that, for monthly contracts, we look only at contracts that clearly have both a fixed and a variable component (voice), while we have excluded the contracts made of only a fixed component (e.g., contracts with unlimited or ‘all inclusive’ bundled offers) as the theory’s predictions only apply to pricing plans with a clear fixed and variable component. Columns 1, 2, and 3 refer to post-paid contracts. In line with the theory, the waterbed effect is strong, in particular on the fixed fee, while the variable component of making calls is negative but not significant. The waterbed effect is also stronger when compared to pre-paid deals in column 4.

However, as discussed in the main text there are important reasons to believe that distinguishing between pre-paid and post-paid customers is important. For that reason, in columns 5, 6, and 7 we analyze separately results for such ‘constrained’ post-paid deals, while column 8 deals with ‘constrained’ pre-paid users. The differences between the waterbed effect for monthly subscribers and pre-paid customers are now stark. Additionally, within monthly contracts, the increase of the bill following a cut

in MTRs is due to a change of the fixed rather than the variable component exactly as before.

TABLE B7 – SUMMARY STATISTICS

Variable	Observations	Mean	Standard Deviation	Min	Max
Teligen (Best Deals)					
$\ln P_{ujct}$	504	5.202	1.544	1.067	7.365
$\ln Fixed_{ujct}$	504	3.454	1.808	-1.538	6.496
$\ln Voice_{ujct}$	504	4.877	1.569	0.621	7.357
$\ln(MTR)_{jct}$	504	1.485	1.477	-3.246	3.405
$Regulation_{jct}$	504	0.679	0.467	0	1
$\ln P_{ujct}$	545	4.944	1.440	0.114	7.492
$\ln(MTR)_{jct}$	545	2.089	1.323	-2.978	3.573
$Regulation_{jct}$	545	0.563	0.496	0	1
Teligen (Monthly subscriptions)					
$\ln P_{ujct}$	792	5.142	1.540	0.888	7.551
$\ln Fixed_{ujct}$	792	3.487	1.735	-1.538	6.496
$\ln Voice_{ujct}$	792	4.802	1.579	0.258	7.357
$\ln(MTR)_{jct}$	792	1.618	1.440	-3.246	3.537
$Regulation_{jct}$	792	0.654	0.476	0	1
Teligen (Pre-Paid)					
$\ln P_{ujct}$	1670	5.554	1.688	0.114	7.989
$\ln(MTR)_{jct}$	1670	1.877	1.580	-3.246	3.573
$Regulation_{jct}$	1670	0.599	0.490	0	1

Source: Author's calculations based on the Teligen data corresponding to the best deals available at every quarter (first panel), deals available to monthly subscribers only (second panel) and deals available to pre-paid customers only (third panel) and the matched MTRs.

Notes: The first panel (Best Deals) provides summary statistics on the key variables used in Table B8 (columns 1-4), the second panel (Monthly subscriptions) provides similar information for the variables used in columns 5-7 and the third panel provides summary statistics on the variables used in column 8.

TABLE B8 – TARIFF STRUCTURE AND WATERBED EFFECT

Estimation method	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	lnP _{ujct}	lnFixed _{ujct}	lnVoice _{ujct}	lnP _{ujct}	lnP _{ujct}	lnFixed _{ujct}	lnVoice _{ujct}	lnP _{ujct}
	Best deals (Monthly subscriptions)			Best deals (Pre-paid)	Monthly subscriptions			Pre-paid
<i>Waterbed Effect</i>	13.4%			11.4%	15.9%			5.1%
Regulation _{ujct}	0.134** (0.064)	0.763*** (0.240)	-0.008 (0.085)	0.114*** (0.040)	0.159*** (0.052)	0.667*** (0.166)	0.066 (0.063)	0.051 (0.052)
Time FE	yes	yes	yes	yes	yes	yes	yes	yes
Country-Operator-Usage FE	yes	yes	yes	yes	yes	yes	yes	yes
Observations	504	504	504	545	792	792	792	1670
Clusters	68	68	68	78	88	88	88	147
Within-R ²	0.361	0.158	0.415	0.147	0.329	0.160	0.391	0.139

Source: Author's calculations based on the Teligen data corresponding to the best deals available at every quarter (columns 1-4), deals available to monthly subscribers only (columns 5-7) and deals available to pre-paid customers only (column 8) and the matched MTRs. In all cases the data has been restricted to monthly contracts that have both a variable and a fixed component and the variable component is larger than the fixed (for both pre-paid and monthly subscribers).

Notes: The dependent variable is either the logarithm of the PPP adjusted total bill paid by consumers with different usage at every quarter for monthly subscriptions (columns 1 and 5) or pre-paid contracts (columns 4 and 8) or the logarithm of the PPP adjusted fixed fee (columns 2 and 6) or variable component (columns 4 and 7) paid by consumers with different usage at every quarter for monthly subscriptions. All regressions include country-operator-usage and a full set of year binary indicators. Standard errors clustered (i.e. robust to heteroskedasticity and autocorrelation of unknown form) at the country-operator-usage level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.

B.4 Impact on ARPU

In the main text, we use EBITDA as our main proxy for profits. Alternatively, one can also use ARPU (recall that this measure also includes termination revenues, and therefore cannot be taken as a measure of customers' prices). Results are shown in Table B9. Results are not significant using the simple regulation indicator in column 1, but become positive and significant at the 10% level when using the other two indexes. However, the inclusion of the regional-time binary indicators although it barely changes its magnitude, it reduces its statistical significance. Therefore, in line with the results on EBITDA, we find that higher MTRs have a small positive effect on ARPU, though the results are marginally significant. Taken together with the results on EBITDA, we interpret this as evidence that firms are negatively affected post regulation indicating that the waterbed effect is not full.

TABLE B9 – WATERBED EFFECT THROUGH MTR (ARPU)

	(1)	(2)	(3)	(4)	(5)
Estimation method	IV	IV	IV	IV	IV
Dependent variable	$\ln\text{ARPU}_{\text{jct}}$	$\ln\text{ARPU}_{\text{jct}}$	$\ln\text{ARPU}_{\text{jct}}$	$\ln\text{ARPU}_{\text{jct}}$	$\ln\text{ARPU}_{\text{jct}}$
<i>Waterbed Effect</i>	-2.0%	0.9%	0.7%	-2.7%	0.7%
$\ln(\text{MTR})_{\text{jct}}$	0.161 (0.210)	-0.245* (0.143)	-0.315* (0.183)	0.240 (0.231)	-0.222 (0.164)
Region-Time FE	no	no	no	yes	yes
Time FE	yes	yes	yes	yes	yes
County-Operator FE	yes	yes	yes	yes	yes
Instrument	Regulation _{jct}	<i>MaxMTR</i> index _{jct}	<i>UnregulatedMTR</i> index _{jct}	Regulation _{jct}	<i>MaxMTR</i> index _{jct}
1 st Stage Coef.	-0.121*** (0.036)	-0.341*** (0.050)	-0.281*** (0.095)	-0.122*** (0.038)	-0.301*** (0.051)
1 st Stage R ²	0.053	0.110	0.166	0.051	0.098
1 st Stage F-test	11.14*** [0.001]	47.42*** [0.000]	8.69** [0.009]	8.67** [0.004]	35.02** [0.000]
Observations	1247	1247	357	1247	1247
Clusters	74	74	18	74	74

Source: Author's calculations based on the Merrill Lynch dataset and the matched MTRs.

Notes: The dependent variable is the logarithm of the PPP adjusted ARPU. All equations include country-operator and a full set of time binary indicators (first three columns) or a full set of region-time binary indicators (last two columns). All countries in the sample were divided into three macro regions: Western Europe, Eastern Europe and Rest of the World (RoW); see text for more details. The instrumental variable "Regulation" is a binary indicator that takes the value one in the quarters when mobile termination rates are regulated. The instrumental variable "MaxMTR" is an index that takes larger values the more regulated a mobile operator is compare to the operator that is regulated the least in the same country and quarter. The instrumental variable "UnregulatedMTR" is an index that takes larger values the more regulated a mobile operator is compare to the operator that is unregulated in the same country and quarter. The waterbed effect in row four is calculated as follows: 1st stage coeff. \times coeff. $\ln(\text{MTR}) \times$ mean value of instrumental variable. P-values for diagnostic tests are in brackets and italics. Standard errors clustered (i.e. robust to heteroskedasticity and autocorrelation of unknown form) either at the country-operator level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.

B.5 HHI as proxy for Competition

We provide alternative estimates for model (6) in the main text using the Herfindahl-Hirschman Index (HHI) of market concentration as a proxy for the intensity of competition in the market. Table B10 reports the results, whereas Table B11 the first-stage coefficients.

Results are very much in line with the ones from Table 3 in the main text. Most importantly, the coefficient on the triple interaction, δ , in column 5 is still significant and has the expected sign (now the coefficient is positive, as an increase in HHI means a lessening of competition). However, HHI clearly suffers from a more serious endogeneity problem than the number of competitors used in the main text. This highlights the limitations of our reduced-form methodology regarding the effect of market structure on the waterbed phenomenon. Future research using a structural approach and more detailed country-level data is required to further understand these mechanisms.

Finally, Table B12 reports the first-stage results from Table 3.

TABLE B10 – COMPETITION AND WATERBED EFFECT

	(1)	(2)	(3)	(4)	(5)
Estimation method	GMM	GMM	GMM	GMM	GMM
Dependent variable	$\ln P_{ujct}$	$\ln P_{ujct}$	$\ln P_{ujct}$	$\ln P_{ujct}$	$\ln P_{ujct}$
$\ln(MTR)_{jct}$	-1.137*** (0.325)	12.091** (5.440)	11.535** (5.769)	23.545*** (5.202)	28.008*** (7.483)
$\ln(HHI)_{ct}$	0.122 (0.609)	3.673** (1.620)	5.295*** (1.743)	8.038*** (1.745)	7.563*** (2.059)
$\ln(\text{penetration})_{ct}$	-0.760** (0.301)	-0.466 (0.366)	16.351** (7.188)	60.167*** (15.656)	81.523*** (25.825)
$\ln(MTR)_{jct} \times \ln(HHI)_{ct}$		-1.703** (0.692)	-1.422** (0.709)	-2.937*** (0.644)	-3.645*** (0.963)
$\ln(MTR)_{jct} \times \ln(\text{penetration})_{ct}$			0.445*** (0.144)	-15.912** (6.206)	-31.221*** (11.434)
$\ln(HHI)_{ct} \times \ln(\text{penetration})_{ct}$			-2.013** (0.851)	-7.240*** (1.882)	-9.791*** (3.091)
$\ln(MTR)_{jct} \times \ln(HHI)_{ct} \times \ln(\text{penetration})_{ct}$				1.957*** (0.752)	3.780*** (1.372)
$\Delta \ln P / \Delta \ln HHI$	0.122	0.593	2.989	3.215	1.360
$\Delta \ln P / \Delta \ln MTR$	-1.137	-1.882	-0.191	-0.570	-1.876
$\Delta \ln P / \Delta \ln \text{penetration}$	-0.760	-0.466	0.642	1.021	0.813
Observations	1371	1371	1371	1371	1371
Clusters	141	141	141	141	141
Sargan-Hansen test of overidentifying restrictions	13.737 <i>[0.003]</i>	8.397 <i>[0.015]</i>	13.904 <i>[0.008]</i>	9.434 <i>[0.093]</i>	10.336 <i>[0.066]</i>

Source: Author's calculations based on the combination of variables from the Merrill Lynch dataset and the Teligen data corresponding to the best deals available at every quarter and the matched MTRs.

Notes: The dependent variable in all regressions is the logarithm of the PPP adjusted total bill paid by consumers with different usage at every quarter. All equations include country-operator-usage and a full set of year binary indicators. The full list of instruments used together with the first stage estimates can be found in Table B7. P-values for diagnostic tests are in brackets and italics. Standard errors clustered (i.e. robust to heteroskedasticity and autocorrelation of unknown form) at the country-operator-usage level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.

TABLE B11 – COMPETITION AND WATERBED EFFECT-First Stage Results

	(1)	(2)	(3)	(4)	(5)
Dependent variable: $\ln(\text{MTR})_{\text{jet}}$					
Instruments					
Regulation _{jet}	-0.032 (0.024)	-0.032 (0.024)	-0.983*** (0.105)	-0.698*** (0.075)	-0.194*** (0.028)
$\ln(\text{competitors})_{\text{ct}}$	13.841** (6.608)	13.841** (6.608)	10.427* (5.427)	-0.318 (4.889)	3.166 (4.532)
$\text{Regulation}_{\text{jet}} \times \ln(\text{competitors})_{\text{ct}}$			0.769*** (0.073)	0.542*** (0.052)	0.024 (0.018)
$\text{Regulation}_{\text{jet}} \times \ln(\text{penetration})_{\text{ct}}$			-0.228*** (0.075)	0.009 (0.051)	0.199*** (0.056)
Number of products produced by firm			-0.004 (0.016)	-0.020* (0.011)	-0.021** (0.011)
$\text{MTRhat}_{\text{jet}} \times \ln(\text{competitors})_{\text{ct}}$	-0.124 (0.090)	-0.124 (0.090)	-0.078 (0.072)	-0.003 (0.075)	-0.033 (0.073)
$\text{MTRhat}_{\text{jet}} \times \ln(\text{penetration})_{\text{ct}}$			-0.045 (0.081)	0.530*** (0.095)	0.586*** (0.099)
$\text{MTRhat}_{\text{jet}} \times \ln(\text{competitors})_{\text{ct}} \times \ln(\text{penetration})_{\text{ct}}$				-0.262*** (0.084)	-0.270*** (0.089)
$\text{HHIhat} \times \ln(\text{competitors})_{\text{ct}}$	-1.701** (0.817)	-1.701** (0.817)	-1.375** (0.676)	0.024 (0.606)	-0.348 (0.566)
$\text{HHIhat} \times \ln(\text{penetration})_{\text{ct}}$	1.825*** (0.441)	1.825*** (0.441)	1.580*** (0.276)	4.801*** (0.624)	4.685*** (0.578)
$\text{HHIhat} \times \ln(\text{penetration})_{\text{ct}} \times \ln(\text{competitors})_{\text{ct}}$				0.494*** (0.042)	0.486*** (0.047)
1 st Stage R ²	0.107	0.107	0.163	0.341	0.355
1 st Stage F-test	7.73*** [0.000]	7.73*** [0.000]	18.41*** [0.000]	45.05*** [0.000]	43.17*** [0.000]
Dependent variable: $\ln(\text{HHI})_{\text{ct}}$					
Instruments					

Regulation _{jct}	0.023*** (0.007)	0.023*** (0.007)	0.219*** (0.035)	0.045 (0.041)	0.020* (0.011)
ln(competitors) _{ct}	0.689 (1.505)	0.689 (1.505)	-1.572 (1.288)	-2.182** (0.918)	-2.434*** (0.838)
Regulation _{jct} × ln(competitors) _{ct}			-0.163*** (0.025)	-0.039 (0.029)	-0.007 (0.005)
Regulation _{jct} × ln(penetration) _{ct}			-0.044 (0.029)	-0.118*** (0.028)	-0.134*** (0.029)
Number of products produced by firm			-0.007*** (0.002)	-0.010*** (0.002)	-0.009*** (0.002)
MTRhat _{jct} × ln(competitors) _{ct}	-0.078*** (0.012)	-0.078*** (0.012)	-0.014* (0.008)	-0.021** (0.009)	-0.018** (0.009)
MTRhat _{jct} × ln(penetration) _{ct}			-0.126*** (0.019)	0.090** (0.039)	0.080* (0.041)
MTRhat _{jct} × ln(competitors) _{ct} × ln(penetration) _{ct}				-0.238*** (0.035)	-0.232*** (0.037)
HHIhat × ln(competitors) _{ct}	-0.085 (0.187)	-0.085 (0.187)	0.204 (0.160)	0.255** (0.112)	0.282*** (0.104)
HHIhat × ln(penetration) _{ct}	0.480*** (0.119)	0.480*** (0.119)	0.084 (0.153)	-1.619*** (0.248)	-1.569*** (0.264)
HHIhat × ln(penetration) _{ct} × ln(competitors) _{ct}				-0.120*** (0.014)	-0.117*** (0.015)
1 st Stage R ²	0.237	0.237	0.391	0.518	0.521
1 st Stage F-test	27.21*** [0.000]	27.21*** [0.000]	57.52*** [0.000]	49.11*** [0.000]	52.32*** [0.000]
Dependent variable: ln(MTR) _{jct} × ln(HHI) _{ct}					
Instruments					
Regulation _{jct}		-0.205 (0.188)	-7.418*** (0.919)	-5.636*** (0.691)	-1.505*** (0.223)
ln(competitors) _{ct}		115.601** (53.689)	82.885* (42.284)	-5.410 (39.028)	22.492 (36.503)

Regulation _{jct} × ln(competitors) _{ct}		5.820*** (0.649)	4.355*** (0.483)	0.159 (0.142)
Regulation _{jct} × ln(penetration) _{ct}		-1.960*** (0.619)	-0.270 (0.435)	1.225** (0.492)
Number of products produced by firm		-0.029 (0.127)	-0.160* (0.083)	-0.173** (0.083)
MTRhat _{jct} × ln(competitors) _{ct}	-1.297* (0.746)	-0.771 (0.590)	-0.186 (0.603)	-0.426 (0.587)
MTRhat _{jct} × ln(penetration) _{ct}		-0.650 (0.651)	4.618*** (0.775)	5.008*** (0.834)
MTRhat _{jct} × ln(competitors) _{ct} × ln(penetration) _{ct}			-2.805*** (0.700)	-2.828*** (0.766)
HHIhat × ln(competitors) _{ct}	-14.175** (6.640)	-10.888** (5.268)	0.527 (4.844)	-2.442 (4.558)
HHIhat × ln(penetration) _{ct}	15.475*** (3.636)	12.595*** (2.295)	33.532*** (5.210)	32.951*** (5.135)
HHIhat × ln(penetration) _{ct} × ln(competitors) _{ct}			3.622*** (0.360)	3.581*** (0.406)
1 st Stage R ²	0.109	0.162	0.327	0.337
1 st Stage F-test	7.40*** [0.000]	15.21*** [0.000]	37.19*** [0.000]	39.93*** [0.000]
Dependent variable: ln(MTR) _{jct} × ln(penetration) _{ct}				
Instruments				
Regulation _{jct}		0.132*** (0.023)	0.142*** (0.019)	-0.013*** (0.004)
ln(competitors) _{ct}		-2.799** (1.345)	0.434 (0.431)	-0.086 (0.425)
Regulation _{jct} × ln(competitors) _{ct}		-0.114*** (0.017)	-0.114*** (0.014)	0.002 (0.003)
Regulation _{jct} × ln(penetration) _{ct}		0.032* (0.018)	0.004 (0.012)	-0.005 (0.015)

Number of products produced by firm	-0.008** (0.003)	-0.003 (0.002)	-0.003 (0.002)
MTRhat _{jct} × ln(competitors) _{ct}	0.010 (0.011)	-0.007 (0.007)	-0.007 (0.006)
MTRhat _{jct} × ln(penetration) _{ct}	1.020*** (0.027)	0.754*** (0.035)	0.790*** (0.035)
MTRhat _{jct} × ln(competitors) _{ct} × ln(penetration) _{ct}		0.191*** (0.029)	0.157*** (0.030)
HHIhat × ln(competitors) _{ct}	0.368** (0.169)	-0.038 (0.054)	0.010 (0.054)
HHIhat × ln(penetration) _{ct}	-0.218*** (0.082)	-0.237** (0.119)	-0.509*** (0.147)
HHIhat × ln(penetration) _{ct} × ln(competitors) _{ct}		-0.074*** (0.011)	-0.091*** (0.013)
1 st Stage R ²	0.977	0.984	0.983
1 st Stage F-test	2134.60*** [0.000]	8885.98*** [0.000]	10569.36*** [0.000]
Dependent variable: ln(HHI) _{ct} × ln(penetration) _{ct}			
Instruments			
Regulation _{jct}	-0.024*** (0.004)	-0.001 (0.006)	0.000 (0.002)
ln(competitors) _{ct}	-0.818*** (0.255)	-0.229 (0.155)	-0.223 (0.150)
Regulation _{jct} × ln(competitors) _{ct}	0.018*** (0.003)	0.003 (0.004)	0.001* (0.001)
Regulation _{jct} × ln(penetration) _{ct}	-0.001 (0.004)	0.004 (0.005)	0.004 (0.005)
Number of products produced by firm	0.001* (0.001)	0.002*** (0.001)	0.002*** (0.001)
MTRhat _{jct} × ln(competitors) _{ct}	0.006* (0.003)	0.004* (0.002)	0.004* (0.002)

MTRhat _{jct} × ln(penetration) _{ct}	0.015*** (0.005)	-0.054*** (0.010)	-0.054*** (0.010)
MTRhat _{jct} × ln(competitors) _{ct} × ln(penetration) _{ct}		0.059*** (0.009)	0.059*** (0.008)
HHIhat × ln(competitors) _{ct}	0.099*** (0.032)	0.028 (0.019)	0.027 (0.019)
HHIhat × ln(penetration) _{ct}	0.892*** (0.038)	1.094*** (0.049)	1.096*** (0.051)
HHIhat × ln(penetration) _{ct} × ln(competitors) _{ct}		0.003 (0.003)	0.003 (0.003)
1 st Stage R ²	0.954	0.964	0.964
1 st Stage F-test	316.61*** [0.000]	2351.86*** [0.000]	1973.66*** [0.000]
Dependent variable: ln(MTR) _{jct} × ln(HHI) _{ct} × ln(penetration) _{ct}			
Instruments			
Regulation _{jct}		1.133*** (0.172)	-0.131*** (0.035)
ln(competitors) _{ct}		1.782 (3.388)	-2.292 (3.370)
Regulation _{jct} × ln(competitors) _{ct}		-0.920*** (0.127)	0.016 (0.026)
Regulation _{jct} × ln(penetration) _{ct}		0.065 (0.111)	0.000 (0.129)
Number of products produced by firm		-0.015 (0.020)	-0.018 (0.020)
MTRhat _{jct} × ln(competitors) _{ct}		-0.105** (0.052)	-0.105** (0.049)
MTRhat _{jct} × ln(penetration) _{ct}		6.665*** (0.328)	6.970*** (0.324)
MTRhat _{jct} × ln(competitors) _{ct} × ln(penetration) _{ct}		1.334*** (0.271)	1.046*** (0.277)

HHIhat \times ln(competitors) _{ct}	-0.073 (0.425)	0.301 (0.426)
HHIhat \times ln(penetration) _{ct}	0.729 (1.102)	-1.578 (1.327)
HHIhat \times ln(penetration) _{ct} \times ln(competitors) _{ct}	-0.477*** (0.100)	-0.623*** (0.113)
1 st Stage R ²	0.982	0.982
1 st Stage F-test	6602.23*** <i>[0.000]</i>	7712.37*** <i>[0.000]</i>

Source: Author's calculations based on the combination of variables from the Merrill Lynch dataset and the Teligen data corresponding to the best deals available at every quarter.

Notes: These are the first stage results from Table B6, where each column corresponds to the same column in Table B6. The regressions include all the exogenous variables in Table B6. Last three instruments in each panel are constructed as follows: we first regressed HHI on number of competitors, market penetration and regulation plus the full set of country-operator and time binary indicators; we then obtained the residuals from this regression and interacted them with the other exogenous variables (Wooldridge, 2002, p.235-237). All equations include country-operator and a full set of time binary indicators. P-values for diagnostic tests are in brackets and italics. Standard errors clustered (i.e. robust to heteroskedasticity and autocorrelation of unknown form) at the country-operator-usage level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.

TABLE B12 – COMPETITION AND WATERBED EFFECT - First Stage Results

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: $\ln(\text{MTR})_{\text{jct}}$						
Instruments						
Regulation _{jct}	-0.074*** (0.017)	-0.087*** (0.020)	-1.022*** (0.112)	-1.024*** (0.116)	-1.142*** (0.103)	-0.292*** (0.048)
Regulation _{jct} × $\ln(\text{competitors})_{\text{ct}}$			0.765*** (0.081)	0.767*** (0.085)	0.860*** (0.075)	-0.005 (0.021)
Regulation _{jct} × $\ln(\text{penetration})_{\text{ct}}$			-0.330*** (0.092)	-0.330*** (0.092)	-0.235*** (0.076)	0.066 (0.083)
Number of products produced by firm			-0.012 (0.016)	-0.012 (0.015)	-0.027** (0.011)	-0.031*** (0.011)
MTRhat _{jct} × $\ln(\text{competitors})_{\text{ct}}$			0.058 (0.066)	0.057 (0.066)	0.001 (0.063)	-0.015 (0.060)
MTRhat _{jct} × $\ln(\text{penetration})_{\text{ct}}$			-0.166** (0.080)	-0.165* (0.086)	0.911*** (0.100)	0.986*** (0.101)
MTRhat _{jct} × $\ln(\text{competitors})_{\text{ct}}$ × $\ln(\text{penetration})_{\text{ct}}$					-0.784*** (0.068)	-0.780*** (0.071)
1 st Stage R ²	0.025	0.035	0.120	0.120	0.254	0.277
1 st Stage F-test	19.92*** [0.000]	19.30*** [0.000]	15.44*** [0.000]	15.08*** [0.000]	48.43*** [0.000]	33.83*** [0.000]
Dependent variable: $\ln(\text{MTR})_{\text{jct}} \times \ln(\text{competitors})_{\text{ct}}$						
Instruments						
Regulation _{jct}			-1.248*** (0.153)	-1.196*** (0.158)	-1.372*** (0.141)	-0.424*** (0.077)
Regulation _{jct} × $\ln(\text{competitors})_{\text{ct}}$			1.041*** (0.113)	1.002*** (0.117)	1.142*** (0.104)	0.122*** (0.027)
Regulation _{jct} × $\ln(\text{penetration})_{\text{ct}}$			-0.451*** (0.131)	-0.463*** (0.137)	-0.321*** (0.110)	0.099 (0.105)
Number of products produced by firm			-0.021 (0.024)	-0.024 (0.023)	-0.046*** (0.016)	-0.051*** (0.017)

MTRhat _{jct} × ln(competitors) _{ct}	1.140*** (0.087)	1.173*** (0.090)	1.090*** (0.084)	1.064*** (0.080)
MTRhat _{jct} × ln(penetration) _{ct}	-0.355*** (0.133)	-0.375*** (0.138)	1.245*** (0.171)	1.373*** (0.175)
MTRhat _{jct} × ln(competitors) _{ct} × ln(penetration) _{ct}			-1.179*** (0.123)	-1.184*** (0.129)
1 st Stage R ²	0.375	0.373	0.481	0.516
1 st Stage F-test	73.01*** [0.000]	88.95*** [0.000]	132.96*** [0.000]	112.13*** [0.000]
Dependent variable: ln(MTR) _{jct} × ln(penetration) _{ct}				
Instruments				
Regulation _{jct}		0.134*** (0.025)	0.168*** (0.021)	-0.001 (0.005)
Regulation _{jct} × ln(competitors) _{ct}		-0.107*** (0.018)	-0.134*** (0.015)	0.005 (0.003)
Regulation _{jct} × ln(penetration) _{ct}		0.046*** (0.020)	0.019 (0.014)	0.009 (0.017)
Number of products produced by firm		-0.007*** (0.003)	-0.002 (0.002)	-0.002 (0.002)
MTRhat _{jct} × ln(competitors) _{ct}		-0.021*** (0.010)	-0.005 (0.006)	-0.007 (0.006)
MTRhat _{jct} × ln(penetration) _{ct}		1.037*** (0.027)	0.726*** (0.033)	0.738*** (0.033)
MTRhat _{jct} × ln(competitors) _{ct} × ln(penetration) _{ct}			0.227*** (0.025)	0.220*** (0.025)
1 st Stage R ²		0.976	0.984	0.983
1 st Stage F-test		1737.00*** [0.000]	11102.54*** [0.000]	13631.34*** [0.000]
Dependent variable: ln(MTR) _{jct} × ln(competitors) _{ct} × ln(penetration) _{ct}				
Instruments				
Regulation _{jct}			0.214*** (0.027)	-0.007 (0.008)

Regulation _{jct} × ln(competitors) _{ct}	-0.174*** (0.020)	0.004 (0.004)
Regulation _{jct} × ln(penetration) _{ct}	0.036* (0.019)	0.028 (0.022)
Number of products produced by firm	0.000 (0.004)	0.000 (0.004)
MTRhat _{jct} × ln(competitors) _{ct}	-0.023** (0.009)	-0.026*** (0.009)
MTRhat _{jct} × ln(penetration) _{ct}	-0.397*** (0.061)	-0.379*** (0.059)
MTRhat _{jct} × ln(competitors) _{ct} × ln(penetration) _{ct}	1.364*** (0.046)	1.355*** (0.046)
1 st Stage R ²	0.984	0.984
1 st Stage F-test	6820.54*** <i>[0.000]</i>	7309.58*** <i>[0.000]</i>

Source: Author's calculations based on the combination of variables from the Merrill Lynch dataset, the Teligen data corresponding to the best deals available at every quarter and the matched MTRs. Notes: These are the first stage results from Table 3, where each column corresponds to the same column in Table 3. The regressions include all the exogenous variables in Table 3. Last three instruments in each panel are constructed as follows: we first regressed MTR on number of competitors, market penetration and regulation plus the full set of country-operator and time binary indicators; we then obtained the residuals from this regression and interacted them with the other exogenous variables (Wooldridge, 2002, p.235-237). All equations include country-operator and a full set of time binary indicators. P-values for diagnostic tests are in brackets and italics. Standard errors clustered (i.e. robust to heteroskedasticity and autocorrelation of unknown form) at the country-operator-usage level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.