APPENDIX A

A.1 | Proof of Lemma 1

In t_2, firm i's customers discover that they value the advanced version, from which they derive utility U. Depending on p_{ai}, they might buy the advanced version or the basic version offered by firm i (they cannot switch to firm j for the advanced version because of high switching costs). In t_2, firms take the price and demand of the basic version as given. x_b identifies the location of the farthest customer on the segment that has acquired the basic version from firm i. The highest p_{ai}, such that all captive customers of firm i buy the advanced version, is $p_{ai}^*=p_{bi}+\Delta$, where $\Delta=(U-u)-x_b(T_a-T_b)$. It is not profitable for firm i to set a price for the advanced version that is below p_{ai}^* since demand does not change. Conversely, we can now show that any price above p_{ai}^* does not maximize profits. Suppose that the optimal price for the advanced version is $\hat{p_{ai}}>p_{bi}+\Delta$. A customer who is indifferent with respect to buying the advanced version or buying the basic version is then defined by $\frac{(U-u)-(p_{ai}-p_{bi})}{T_a-T_b}<x_b$. In this case, firm i chooses p_{ai} to maximize:

$$\frac{(U-u)-(p_{ai}-p_{bi})}{T_a-T_b}(p_{ai}-c)+\left[x_b-\frac{(U-u)-(p_{ai}-p_{bi})}{T_a-T_b}\right]p_{bi}.$$

After taking the first-order condition, $\hat{p_{ai}}=p_{bi}+\frac{(U-u)-c}{2}$. Note that $p_{ai}^*>\hat{p_{ai}}$ if $(U-u)-c\geq 2x_b(T_a-T_b)$. This latter condition is always verified in a symmetric equilibrium as long as $U-u-c\geq(T_a-T_b)$. Indeed, in a symmetric equilibrium, firms evenly split their market share, implying that x_b cannot be larger than ½.

A.2 | Proof of Lemma 2

Forward-looking customers anticipate that they will value the advanced version in t_2 and will have to pay the corresponding price. Thus, in t_1 their choice between firm i and firm j fully accounts for what will happen in t_2. The indifferent customer (x_b) in t_1 solves the following equation:

$$(u-p_{bi}-x_bT_b)+(U-p_{bi}-(U-u)+x_b(T_a-T_b)-x_bT_a)=$$
$$\left(u-p_{bj}-(1-x_b)T_b\right)+\left(U-p_{bj}-(U-u)+(1-x_b)(T_a-T_b)-(1-x_b)T_a\right).$$

After some simplifications, we obtain the following: $x_b=\frac{1}{2}+\frac{p_{bj}-p_{bi}}{2T_b}$, which corresponds to firm i's demand and market share of the basic version. Note that $x_b=\frac{1}{2}+\frac{p_{bj}-p_{bi}}{2T_b}$ is also the indifferent customer of the static game of the first period or, equivalently, the indifferent customer when customers are completely myopic and make consumption decisions according to their period by period utility. The latter result follows from the fact that, with high customer switching costs, the optimal price in the second period makes the marginal customer indifferent between buying the basic version and buying the advanced version.

We can now write the profit function of a generic firm i as

$$\pi_i=x_bp_{bi}+x_b\left(p_{ai}^*-c\right)$$

where $p_{ai}^*=p_{bi}+\Delta;\Delta=(U-u)-x_b(T_a-T_b)$ and $x_b=\left(\frac{1}{2}+\frac{p_{bj}-p_{bi}}{2T_b}\right)$.

Taking the first-order conditions and simplifying (after imposing symmetry), we obtain an equilibrium price for the basic version:

$$p_b^* = T_b - \frac{[(U-u)-c-(T_a-T_b)]}{2}.$$

Because of symmetry, the demand for each firm in t_1 is

$$x_b^* = 1 - x_b^* = \frac{1}{2}.$$

The price of the advanced version then can be obtained by substitution.

A.3 | Proof of Proposition 1a

First, $p_b^*(\mathrm{nsc}) = T_b > p_b^*(sc) = T_b - \frac{(U-u)-c-(T_a-T_b)}{2}$. Second, with simple algebra, one can show that $p_a^*(\mathrm{nsc}) = T_a + c \le p_a^*(sc) = T_b + \frac{[(U-u)+c)]}{2}$ if $U-u-c \ge 2(T_a - T_b)$.

A.4 | Proof of Proposition 1b

Let p_{avg} denote the average market price in t_2. With switching costs, $p_{\mathrm{avg}}(\mathrm{sc}) = 2T_b + \frac{(T_a-T_b)}{2} + c$; without switching costs, $p_{\mathrm{avg}}(\mathrm{nsc}) = T_b + T_a + c$. Thus, $p_{\mathrm{avg}}(\mathrm{nsc}) - p_{\mathrm{avg}}(\mathrm{sc}) = \frac{(T_a-T_b)}{2}$. It is easy to see that $p_{\mathrm{avg}}(\mathrm{nsc}) - p_{\mathrm{avg}}(\mathrm{sc}) > 0$ if $T_a > T_b$. Notice also that $\frac{\partial\left(p_{\mathrm{avg}}(\mathrm{nsc}) - p_{\mathrm{avg}}(\mathrm{sc})\right)}{\partial T_a} > 0$, such that the effect in Proposition 1b grows larger as the advanced version market becomes more (horizontally) differentiated.

A.5 | Proof of Lemma 3

For simplicity of exposition, we analyze the case in which the differentiation parameter is the same for the two versions, $T_a = T_b = T > 0$ and $c = 0$. With some additional algebra, we can show that the results hold when $T_a > T_b > 0$ and $c > 0$. Assume that there exists an equilibrium in which only δ customers buy the advanced version in the scenario with high switching costs. Simple calculations using the results in Lemma 2 show that $p_b^*(\mathrm{sc}) = T - \frac{\delta(U-u)}{2}$ and $p_a^*(\mathrm{sc}) = T + \frac{(2-\delta)(U-u)}{2}$. It is easy to check that $\hat{u} - p_a^*(\mathrm{sc}) < u - p_b^*(\mathrm{sc})$. Thus, $1-\delta$ customers do not buy the advanced version. It remains to be shown that $p_a^*(\mathrm{sc}) = T + \frac{(2-\delta)(U-u)}{2}$ is the optimal price for the firm in t_2. The firm could lower the price of the advanced version to the point at which all customers buy it, thereby increasing demand, though at a reduced price. If this option is preferable, it contradicts the idea that only δ customers buy the advanced version, so it cannot be an equilibrium. Let $\overline{p_a}(\mathrm{sc}) = \hat{u} - u + p_b^*(\mathrm{sc})$, such that all customers buy the advanced version. The firm chooses $p_a^*(sc) = T + \frac{(2-\delta)(U-u)}{2}$ instead of $\overline{p_a}(\mathrm{sc}) = \hat{u} - u + T - \frac{\delta(U-u)}{2}$ if and only if $\delta p_a^*(\mathrm{sc}) > \overline{p_a}(\mathrm{sc})$, which holds if $\delta\left(T + \frac{(3-\delta)(U-u)}{2}\right) > (\hat{u} - u) + T$. It is straightforward to see that the inequality is more likely to hold for larger values of U and δ and smaller values of $\hat{u}$.

A.6 | Extension 1: Relatively small switching costs

With sufficiently large switching costs, each firm is a monopolist in the second period, and its price is capped only by the price of its basic version. Here, we explore the case in which switching costs are relatively low before their removal.

Consider a customer who has acquired the basic version from firm i. If in t_2 such a customer values the advanced version, he/she can buy it from firm i or from firm j. In the latter case, the customer will have to pay, in addition to the price, a switching cost, s. To simplify the algebra we assume that $s < T_a$, such that at least some customers' preferences for the underlying characteristics of the advanced version can outweigh the switching costs, and $c = 0$. All other assumptions in the baseline model remain unchanged.

We solve the model by backward induction starting from period t_2. A customer who has bought from firm i in t_1 will be indifferent between the two firms in the choice of the advanced version if $U - T_a x_a - p_{ai} = U - T_a(1 - x_a) - p_{aj} - s$, which implies that $x_a = \frac{1}{2} + \frac{p_{aj} - p_{ai} + s}{2T_a}$. Instead, for customers who bought from firm j, the indifferent customer is $x'_a = \frac{1}{2} + \frac{p_{aj} - p_{ai} - s}{2T_a}$.

For small switching costs, finding equilibria in a model in which preferences across periods remain fixed becomes cumbersome. Indeed, profit functions are discontinuous around the location of the indifferent customer. Thus we focus on the more tractable case in which preferences are different and independent across periods.

In t_2, of all customers who value the advanced version, a share (x_b) has bought the basic version from firm i, while another share (1 - x_b) has bought the basic version from firm j. Firm i chooses p_{ai} to maximize $x_b\left(\frac{1}{2} + \frac{p_{aj} - p_{ai} + s}{2T_a}\right)p_{ai} + (1 - x_b)\left(\frac{1}{2} + \frac{p_{aj} - p_{ai} - s}{2T_a}\right)p_{ai}$. Firm j chooses p_{aj} to maximize $x_b\left(\frac{1}{2} + \frac{p_{ai} - p_{aj} - s}{2T_a}\right)p_{aj} + (1 - x_b)\left(\frac{1}{2} + \frac{p_{ai} - p_{aj} + s}{2T_a}\right)p_{aj}$. Solving the system obtained from the first-order conditions gives $p_{ai} = T_a + \frac{(2x_b - 1)s}{3}$ and $p_{aj} = T_a - \frac{(2x_b - 1)s}{3}$.

In t_1, the indifferent customer anticipates what happens when he/she values the advanced version in t_2. The probability that a customer who has bought from firm i will still buy from firm i is given by $\frac{1}{2} + \frac{p_{aj}^* - p_{ai}^* + s}{2T_a} = \frac{1}{2} + \frac{5 - 4x_b}{6T_a}s$, while the probability that the customer will buy from j is $\frac{1}{2} - \frac{5 - 4x_b}{6T_a}s$. The probability that a customer who has bought from firm j will buy from firm i is given by $\frac{1}{2} + \frac{p_{aj}^* - p_{ai}^* - s}{2T_a} = \frac{1}{2} + \frac{-1 - 4x_b}{6T_a}s$, while the probability that the customer will still buy from firm j is $\frac{1}{2} + \frac{1 + 4x_b}{6T_a}s$. So, the indifferent customer in period t_1 solves the following equation:

$$(u - p_{bi} - x_b T_b) + \left(\frac{1}{2} + \frac{5 - 4x_b}{6T_a}s\right)\left(U - T_a - \frac{(2x_b - 1)s}{3} - \frac{1}{2}\left(\frac{1}{2} + \frac{5 - 4x_b}{6T_a}s\right)T_a\right)$$
$$+ \left(\frac{1}{2} - \frac{5 - 4x_b}{6T_a}s\right)\left(U - T_a + \frac{(2x_b - 1)s}{3} - \frac{1}{2}\left(\frac{1}{2} - \frac{5 - 4x_b}{6T_a}s\right)T_a - s\right).$$

After some simplifications, we obtain $x_b = \frac{\left(T_b + p_{bj} - p_{bi}\right) + \frac{2s^2}{3T_a}}{\frac{4s^2}{3T_a} + 2T_b}$. Note that for s = 0, we go back to the case in which there is no link between periods.

Firm i chooses p_{bi} to maximize: $\pi_i = x_b p_{bi} + \frac{1}{2T_a}\left(T_a + \frac{(2x_b - 1)s}{3}\right)^2$.

After computing the first-order conditions and imposing symmetry, we obtain the following equilibrium price for the basic version: $p_{bi} = p_{bj} = T_b - \frac{2s}{3}\left(1 - \frac{s}{T_a}\right)$.[15]

The price of the advanced version can then be obtained by substitution. Thus, in a symmetric equilibrium $p_{ai} = T_a$ and $p_{aj} = T_a$. Finally, $p_{\text{avg}} = T_b - \frac{2s}{3}\left(1 - \frac{s}{T_a}\right) + T_a$

Looking at the average price equation we can draw some conclusions. First, the removal of customer switching costs (i.e., s = *0*) always leads to a greater average price. This effect is

[15]We discard intrabrand price effects, which reflects the case in which the value that customers get from the advanced version is sufficiently higher than the value that they obtain from the basic version; specifically, $(U - u) - \frac{3}{2}(T_a - T_e) > \frac{2s}{3}\left(1 - \frac{s}{T_a}\right)$, which, given our assumptions on the parameters, always holds when s is small enough.

achieved through an increase in the basic version price while the advanced version price remains unchanged. Second, because $\frac{\partial\left(p_{\text{avg}}(\text{nsc})-p_{\text{avg}}(\text{sc})\right)}{\partial T_a}=\frac{4\text{s}}{3\text{T}_\text{a}^2}>0$, the removal of customer switching costs generates a larger price increase when the advanced version market is more (horizontally) differentiated. Both findings mimic those we derive in the basic model.

A.7 | Extension 2: Endogenous quality

Consider the following version of the baseline model. In t_2, before choosing the optimal price for the advanced version, firms simultaneously invest to determine their respective quality of the advanced version. The quality of the advanced version of firm i is equal to $U_i=u+A_i$, where u is the (exogenous) quality of the basic version, while A_i is a function of firm i's investment. Investment to enhance the quality of the advanced version generates the following cost: $C(A_i)=\frac{aA_i^2}{2}$, where $a>0$ is a scalar and is assumed to be small enough.[16]

We start first with the investment in quality in the case of high customer switching costs. In this case, customers cannot switch firms for the advanced version. Thus, the price of the advanced version will be the one we have obtained in Lemma 1, that is, $p_{ai}^*=p_{bi}+A_i-x_b(T_a-T_b)$. Note that an investment in quality has a positive direct effect on the price of the advanced version. Firm i chooses A_i to maximize $x_b\left(p_{ai}^*-c\right)-\frac{aA_i^2}{2}$. After solving the first order condition, one obtains that $A_i^*=\frac{x_b}{a}$.

We can now analyze the price of the basic version. Firms choose the optimal price of the basic version by anticipating their future investment in quality and their optimal choice of the price of the advanced version. In t_1, firm i maximizes the following profit function:

$$x_b p_{bi}+x_b\left(p_{ai}^*-c\right)$$

where $p_{ai}^*=p_{bi}+\frac{x_b}{a}-x_b(T_a-T_b)$ and $x_b=\left(\frac{1}{2}+\frac{p_{bj}-p_{bi}}{2T_b}\right)$.

Taking the first-order conditions and simplifying (after imposing symmetry), we obtain an equilibrium price for the basic version:

$$p_b^*=T_b-\frac{\left[\frac{1}{a}-(T_a-T_b)-c\right]}{2}.$$

Because of symmetry, the demand for each firm in t_1 is $x_b^*=1-x_b^*=\frac{1}{2}$. This also implies that the equilibrium level of quality will be $A_i^*=\frac{1}{2a}$. Further substitutions show that $p_{ai}^*=T_b+\frac{c}{2}$ and that the average price is $2T_b+\frac{T_a-T_b}{2}+c-\frac{1}{2a}$, which is lower than the average price when the quality of the advanced version is exogenous.

Consider now the case in which customer switching costs are zero. The model must be solved by backward induction. The indifferent customer in the advanced version is $x_a=\frac{1}{2}+\frac{p_{aj}-p_{ai}}{2T_a}+\frac{A_i-A_j}{2T_a}$. As expected, the demand of firm i increases when it offers a higher quality to the customers. Next, we can compute the optimal prices, given qualities. The best response functions of the two firms are:

$$p_{ai}\left(p_{aj},A_i,A_j\right)=\frac{T_a}{2}+\frac{c}{2}+\frac{p_{aj}}{2}+\frac{A_i-A_j}{2}$$

and

[16]We assume that $a<\frac{1}{T_a-T_b+c}$.

$$p_{aj}(p_{ai}, A_j, A_i) = \frac{T_a}{2} + \frac{c}{2} + \frac{p_{ai}}{2} + \frac{A_j - A_i}{2}.$$

Solving the system, one obtains: $p_{ai}(A_i, A_j) = c + T_a + \frac{A_i - A_j}{3}$ and $\pi_{ai}(A_i, A_j) = \frac{1}{18T_a}(3T_a + A_i - A_j)^2$.

We can now solve for the equilibrium qualities. Firm i chooses A_i to maximize $\pi_{ai}(A_i, A_j) - \frac{aA_i^2}{2}$. Assuming parameters satisfy the second order conditions, after imposing symmetry, we find that: $A_i^* = A_j^* = \frac{1}{3a}$. In turn, $p_{ai}^* = p_{aj}^* = c + T_a$. Thus, the equilibrium price does not change. Note that firms invest less in quality in this scenario compared with the high-customer-switching-costs case because in the latter they have captive customers and can appropriate a greater share of the value created by their investments in quality.

To summarize, the removal of customer switching costs generates a greater average price increment when the quality of the advanced version is endogenous vis-à-vis when it is exogenous. Because the investment in quality is lower after the removal of customer switching costs, profits will also experience a greater increment.

APPENDIX B

TABLE B1 List of countries in this study

Country	MNP adoption	Number of competitors
Hong Kong	2000Q1	6
Netherlands	2000Q1	5
United Kingdom	2000Q1	4
Switzerland	2000Q1	3
Spain	2000Q4	3
Norway	2001Q2	2
Australia	2001Q3	4
Denmark	2001Q3	4
Sweden	2001Q3	3
Belgium	2002Q1	3
Portugal	2002Q1	3
Italy	2002Q2	3
Germany	2002Q4	4
France	2003Q2	3
Greece	2003Q3	4
Finland	2003Q3	3
Ireland	2003Q3	3
The U.S.	2003Q4	18
Lithuania	2004Q1	3
Hungary	2004Q2	3
Cyprus	2004Q3	4
Austria	2004Q4	5

TABLE B1 (Continued)

Country	MNP adoption	Number of competitors
Iceland	2004Q4	2
Estonia	2005Q1	3
Luxembourg	2005Q1	3
Malta	2005Q3	2
Slovenia	2005Q4	3
South Korea	2005Q4	4
Czech Republic	2006Q1	3
Slovakia	2006Q1	2
Poland	2006Q1	3
Croatia	2006Q1	3
Saudi Arabia	2006Q3	3
Oman	2006Q3	2
South Africa	2006Q4	3
Japan	2006Q4	4
Latvia	2007Q1	4
Pakistan	2007Q1	7
Canada	2007Q1	11
Morocco	2007Q1	3
New Zealand	2007Q2	2
Israel	2007Q4	4
Singapore	2008Q2	4
Mexico	2008Q2	4
Egypt	2008Q2	3
Brazil	2008Q3	9
Macedonia	2008Q3	3
Malaysia	2008Q4	6
Bulgaria	2008Q4	3
Romania	2008Q4	5
Turkey	2008Q4	3
Dominican Republic	2009Q3	4
Ecuador	2009Q4	3
Peru	2010Q1	3
Jordan	2010Q2	5
Thailand	2010Q4	7
Albania	2010Q4	4
India	2011Q1	15
Georgia	2011Q1	7
Kenya	2011Q2	4

TABLE B1 (Continued)

Country	MNP adoption	Number of competitors
Colombia	2011Q3	4
Ghana	2011Q3	5
Bahrain	2011Q3	3
Panama	2011Q4	4
Vietnam	2011Q4	7
Chile	2012Q1	5
Belarus	2012Q1	5
Moldova	2012Q4	4
Nigeria	2013Q2	8
Kuwait	2013Q2	3
Russia	2013Q4	11
UAE	2013Q4	2
Azerbaijan	2014Q1	3
Armenia	2014Q2	4
Honduras	2014Q2	3
El Salvador	2015Q3	5
Kazakhstan	2015Q3	4
Senegal	2015Q3	3
Maldives	2016Q1	2
Iran	2016Q3	6
Tanzania	2017Q1	8

Note: The table shows the countries in our sample that implemented MNP up to 2017Q1. Countries in our sample that have not implemented MNP as of 2017Q1 are as follows (competitors averaged for the period of study in parentheses): Afghanistan (5), Algeria (2), Andorra (1), Angola (1), Argentina (4), Bahamas (1), Bangladesh (6), Barbados (2), Belize (1), Benin (4), Bermuda (2), Bolivia (2), Bosnia and Herzegovina (2), Botswana (2), Burkina Faso (2), Burundi (4), Cabo Verde (1), Cambodia (5), Cameroon (2), Central African Republic (3), Chad (2), China (3), Congo (3), Costa Rica (2), Cote d'Ivoire (4), Democratic Republic of Congo (6), Djibouti (1), Equatorial Guinea (1), Ethiopia (1), Faroe Islands (1), Fiji (1), French Polynesia (1), Gabon (3), Greenland (1), Grenada (2), Guatemala (3), Guinea (4), Guinea-Bissau (2), Guyana (1), Haiti (2), Indonesia (7), Iraq (5), Isle of Man (1), Jamaica (2), Kyrgyzstan (6), Laos (3), Lebanon (2), Lesotho (1), Liberia (3), Macao (3), Madagascar (3), Malawi (2), Mali (2), Mauritania (2), Mauritius (2), Micronesia (1), Monaco (1), Montenegro (2), Mozambique (2), Myanmar (1), Namibia (2), Nepal (4), New Caledonia (1), Nicaragua (2), Niger (3), Palestine (1), Papua New Guinea (2), Paraguay (3), Philippines (5), Puerto Rico (6), Rwanda (2), Saint Kitts and Nevis (2), Sao Tome and Principe (1), Serbia (2), Seychelles (2), Sierra Leone (3), Solomon Islands (1), South Sudan (4), Sri Lanka (4), Sudan (2), Suriname (2), Swaziland (1), Syria (2), Tajikistan (5), Timor-Leste (2), Togo (2), Trinidad and Tobago (1), Tunisia (2), Turkmenistan (1), Uganda (5), Ukraine (8), Uruguay (2), Uzbekistan (5), Venezuela (3), Yemen (3), Zambia (3), and Zimbabwe (3).

TABLE B2 Comparison of *ARPU* treated and control groups 8 quarters before and after MNP

MNP implementation	*ARPU* (log) control (1)	Obs. control	*ARPU* (log) treated (2)	Obs. treated	Difference (1)–(2)	*p*-value	Obs. combined
8 quarters before	2.46	342	2.50	246	−0.04	.62	588
7 quarters before	2.50	382	2.50	248	0.00	.99	630
6 quarters before	2.47	353	2.53	262	−0.06	.45	615
5 quarters before	2.55	334	2.48	266	0.07	.46	600
4 quarters before	2.50	346	2.46	274	0.04	.61	620
3 quarters before	2.45	343	2.46	280	−0.01	.94	623
2 quarters before	2.40	338	2.44	281	−0.04	.65	619
1 quarter before	2.45	324	2.42	280	0.03	.72	604
MNP Implementation Quarter	2.39	353	2.52	336	−0.12	.16	689
1 quarter after	2.34	331	2.52	330	−0.18	.03	661
2 quarters after	2.37	308	2.51	327	−0.14	.09	635
3 quarters after	2.28	294	2.52	321	−0.24	.00	615
4 quarters after	2.36	278	2.53	320	−0.17	.04	598
5 quarters after	2.30	299	2.54	318	−0.24	.00	617
6 quarters after	2.23	291	2.52	316	−0.28	.00	607
7 quarters after	2.32	253	2.53	304	−0.21	.01	557
8 quarters after	2.29	267	2.53	304	−0.24	.00	571

Note: The table shows the *t*-test between control and treated groups that are constructed for Figure 1.

TABLE B3 Results of OLS regressions testing the effects of MNP on firms pricing strategy after introducing MVNO controls

Variables	(1) ARPU Prepaid (log)	(2) *ARPU* ***Postpaid*** (log)	(3) ARPU (log)	(4) ARPU Prepaid (log)	(5) *ARPU* ***Postpaid*** (log)	(6) ARPU (log)	(7) ARPU Prepaid (log)	(8) *ARPU* ***Postpaid*** (log)	(9) ARPU (log)
PostMNP	0.142 (.004)	0.055 (.189)	0.161 (.002)	0.140 (.005)	0.055 (.192)	0.160 (.002)	0.140 (.005)	0.054 (.198)	0.158 (.003)
Total MVNOs	−0.004 (.020)	0.000 (.956)	0.000 (.959)						
Specialized MVNOs				−0.004 (.017)	0.000 (.895)	0.000 (.856)			
Prepaid MVNOs							−0.008 (.010)	−0.001 (.735)	−0.001 (.506)
HHI	0.039 (.431)	0.072 (.059)	0.063 (.199)	0.039 (.425)	0.072 (.059)	0.063 (.198)	0.039 (.424)	0.072 (.058)	0.063 (.197)
GDP	0.190 (.000)	0.154 (.000)	0.105 (.000)	0.191 (.000)	0.155 (.000)	0.109 (.000)	0.215 (.000)	0.161 (.000)	0.121 (.000)
Penetration	−0.454 (.001)	−0.051 (.628)	−0.528 (.000)	−0.450 (.001)	−0.052 (.617)	−0.532 (.000)	−0.452 (.001)	−0.056 (.592)	−0.540 (.000)
Constant	2.351 (.000)	3.259 (.000)	3.093 (.000)	2.349 (.000)	3.258 (.000)	3.090 (.000)	2.338 (.000)	3.255 (.000)	3.083 (.000)
Observations	6,542	6,542	6,542	6,542	6,542	6,542	6,542	6,542	6,542
R^2	.487	.528	.545	.487	.528	.545	.488	.528	.545
Number of firms	216	216	216	216	216	216	216	216	216
Firm fixed effect	YES	YES	YES	YES	YES	YES	YES	YES	YES
Quarterly time fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: The *p*-values are in parentheses. Robust standard errors are clustered by firm and remain consistent with alternative specifications. We construct three measures to account for entry rate of MVNOs. *Total MVNOs* (*Mean* = 0.178, *SD* = 0.705; min = 0, max = 13) measures the cumulative number of MVNO entries up to quarter *t* in each country. The variable includes both specialized MVNOs and those that target segments of prepaid and postpaid customers simultaneously. The *Specialized MVNOs* (*Mean* = 0.028, *SD* = 0.188; min = 0, max = 4) variable reflects the cumulative number of MVNO entries by operators that target either prepaid or postpaid segments, up to quarter *t* in each country. Finally, *Prepaid MVNOs* (*Mean* = 0.091, *SD* = 0.434; min = 0, max = 6) measures the cumulative number of MVNO entries by operators that target only the prepaid segment up to quarter *t* in each country. These measures only account for the number of entries by MVNOs and do not take exits into account.

TABLE B4 Results of OLS regressions showing MNP effect on service quality

Variables	(1) *Minutes of Use*[a] (log)	(2) *Data Usage*[a] (log)	(3) CAPEX (log)	(4) 4G Installed Base
PostMNP	0.065 (.515)	1.191 (.442)	−0.083 (.195)	−0.044 (.015)
Prepaid	−0.642 (.000)	0.277 (.902)		
PostMNP × *Prepaid*	−0.038 (.764)	−0.789 (.674)		
HHI	−0.022 (.499)	0.375 (.136)	0.103 (.016)	−0.029 (.405)
GDP	0.105 (.006)	−0.068 (.561)	0.046 (.251)	0.036 (.430)
Penetration	0.297 (.008)	1.666 (.024)	0.390 (.010)	−0.165 (.078)
Constant	5.196 (.000)	2.684 (.013)	16.081 (.000)	0.098 (.575)
Observations	9,762	2,004	12,387	2,021
R^2	.228	.870	.098	.504
Number of firms	330	144	434	242
Firm fixed effect	YES	YES	YES	YES
Quarterly time fixed effects	YES	YES	YES	YES

Note: The *p*-values are in parentheses. Robust standard errors are clustered by firm and remain consistent with alternative specifications. We compute the natural logarithm of *Minutes of Use*, *Data Usage*, and *CAPEX* to reduce their skewness. *Minutes of Use* (*Mean* = 4.988, *SD* = 0.752; min = 0.693, max = 7.979). *Data Usage* (*Mean* = 14.45, *SD* = 3.02; min = 1.60, max = 21.91). *CAPEX* (*Mean* = 16.79, *SD* = 1.95; min = 5.91, max = 22.88). *4G Installed Base* (*Mean* = 0.20, *SD* = 0.31; min = 0, max = 1). The sample size drops in some models due to missing values.

[a]While we do not have data on the breakdown of *Minutes of Use* by service type, we can estimate it indirectly through the following regression model: $MinuteseofUse_{it} = \beta_0 + \beta_1 PostMNP_{it} + \beta_2 Prepaid_{it} + \beta_3 Prepaid_{it} \times PostMNP_{it} + \bar{\theta} Controls_{it} + \varepsilon_{it}$.The goal of this regression is to use the variation in prepaid share over time to estimate the average minutes provided in a prepaid plan (i.e., our measure of quality). This variable is captured by the parameter β_2, which measures the difference in *Minutes of use* between prepaid and postpaid services. Eventually, we can estimate whether MNP has an impact on the prepaid plan's *Minutes of Use* using the parameter β_3. We follow a similar approach to estimate the effect of MNP on prepaid plan's *Data Usag*e.

TABLE B5 Results of OLS regressions showing MNP effect on different country-level variables

Variables	(1) HHI	(2) Number of firms
PostMNP	0.270 (.108)	−0.039 (.802)
Constant	6.506 (.000)	2.125 (.000)
Observations	10,045	10,045
R^2	.327	.134
Number of countries	178	178
Country fixed effect	YES	YES
Quarterly time fixed effects	YES	YES

Note: The *p*-values are in parentheses. Robust standard errors are clustered by country. The unit of analysis is country-quarter. *Number of firms* (*Mean* = 2.686, *SD* = 1.846; min = 1, max = 17) refers to the number of firms in each country in a given quarter.

TABLE B6 Results of OLS regressions showing the importance of conversion funnel business model

Variables	(1) *ARPU*(log)	(2) *ARPU*(log)
PostMNP	0.016 (.856)	0.029 (.734)
PostMNP × *All Funnel*	0.198 (.035)	0.193 (.039)
All Funnel		0.344 (.000)
HHI	0.047 (.007)	0.048 (.004)
GDP	0.103 (.000)	0.113 (.000)
Penetration	−0.177 (.048)	−0.134 (.124)
Constant	2.813 (.000)	2.541 (.000)
Observations	26,976	26,976
R^2	.428	
Number of firms	563	563
Firm fixed effect	YES	—
Firm random effect	—	YES
Quarterly time fixed effects	YES	YES

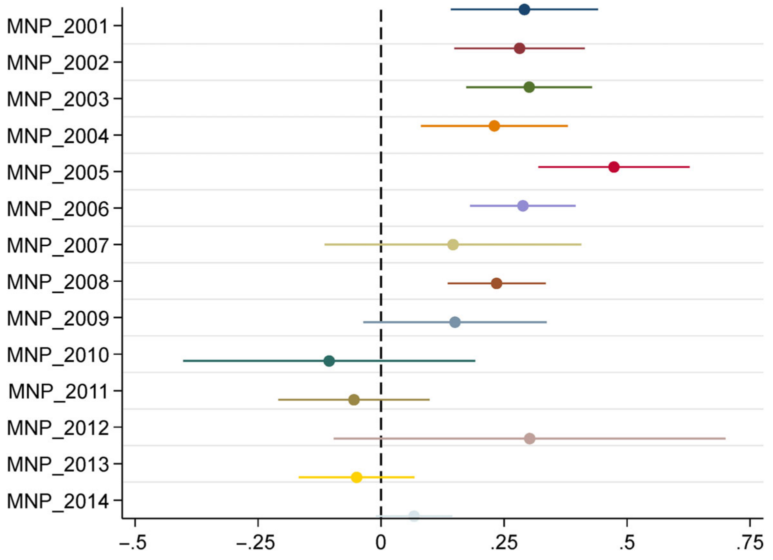
Note: The *p*-values are in parentheses. Robust standard errors are clustered by firm and remain consistent with alternative specifications. *All Funnel* (*Mean* = 0.63, *SD* = 0.48; min = 0, max = 1) is equal to 1 if all firms in a given country in the pre-MNP period provide both prepaid and postpaid services simultaneously and equal to 0 otherwise.

TABLE B7 Event-study difference-in-differences

Variables	(1) *ARPU*(log)	(2) *ARPU*(log)
PreMNP(−3 years)	0.009 (.458)	−0.002 (.904)
PreMNP(−2 years)	−0.006 (.497)	0.003 (.758)
MNP Year	0.044 (.000)	0.089 (.000)
PostMNP(+1 year)	0.058 (.025)	0.123 (.000)
PostMNP(+2 years)	0.136 (.000)	0.223 (.000)
PostMNP(+3 years)	0.148 (.000)	0.259 (.000)
PostMNP(+4 years)	0.178 (.000)	0.316 (.000)
HHI	0.015 (.642)	0.027 (.334)
GDP	0.017 (.436)	0.048 (.000)
Penetration	−0.696 (.000)	−0.539 (.000)
Constant	3.078 (.000)	3.025 (.000)
Observations	8,504	8,504
R^2	.231	
Number of firms	331	331
Firm fixed effect	YES	—
Firm random effect	—	YES
Year fixed effects	YES	YES

Note: The *p*-values are in parentheses. Robust standard errors are clustered by firm. Firms located in countries that never implemented MNP are not included in this analysis.

TABLE B8 MNP coefficient estimates for different cohorts



Note: The graph shows the cohort-specific point estimates (circle markers) and the intervals (colored bars) for MNP coefficients. The coefficients show the effects of MNP on *ARPU*(log) separately for each cohort between 2001–2014. Because there is no variation in treatment timing (MNP implementation) within each separate regression, this setup should avoid any bias affecting staggered difference-in-differences estimation.

TABLE B9 Stacked OLS regression

Variables	(1) *ARPU*(log)
PreMNP(−3 years)	−0.017 (.024)
PreMNP(−2 years)	−0.023 (.009)
MNP year	0.033 (.015)
PostMNP(+1 year)	0.041 (.254)
PostMNP(+2 years)	0.071 (.026)
PostMNP(+3 years)	0.093 (.001)
PostMNP(+4 years)	0.102 (.000)
HHI	0.002 (.945)
GDP	0.008 (.821)
Penetration	−0.575 (.000)
Constant	4.117 (.000)
Observations	7,348
R^2	.975
Cohort-specific firm fixed effect	YES
Cohort-specific year fixed effect	YES

Note: The *p*-values are in parentheses. Robust standard errors are clustered by firm. The table shows event-study difference-in-differences estimates with unit and time fixed effects saturated with indicators for the specific stacked dataset.