Analysis of the role of international network effects on the diffusion of 3G mobile communication networks

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Abstract

Previous studies have found evidence of important network effects in mobile telecommunications at the national level. However, there is a lack of empirical research concerning network effects at the international level. In this paper, we provide empirical evidence that mobile phones diffusion is positively influenced not only by national network effects, but also by international network effects. International network effects were defined as the installed base of mobile phone subscribers of handset export partner countries weighted by their geographical proximity to the home country. Based on our findings, we conclude that the policies most conducive to increase mobile penetration rates concern international standardization and technological choice, rather than price regulation. Moreover, competitive and innovative markets of complementary products that generate indirect network effects -such as mobile handsets and mobile Internet applications- are key factors for the diffusion of new generations of wireless communications. We used a quarterly database of 105 countries from 2007 Q1 to 2010 Q1. Our specification of mobile service demand follows the multinomial logit model with inverted market shares and includes instrumental variables. The model was estimated by the Arellano-Bond dynamic panel-data estimator that uses one-step difference GMM.

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1. Introduction

Network effects are defined as a situation in which the consumer's utility of adopting or using a product depends on the number of other consumers using the same product. The successful diffusion of new technologies or services in many industries such as telecommunications, video games, music, software or transportation, among others, depend greatly on network effects. According, to previous research by Doganoglu and Grzybowski (2007), network effects had a larger impact than price reductions on the diffusion of 2G mobile phones in Germany.

In this paper, we focus on the network effects in the 2G and 3G mobile communications market. Our objective is to measure the international network effects using a wide sample of countries. The study of international network effects is important in order to understand the interconnection between the diffusion patterns of new technologies in different countries, as well as to confirm the existence of an increased feedback between installed base and quality of service in a context of growing interdependence between countries. In particular, this topic has important implications on international standardization and compatibility between technologies in different countries.

We define the international direct network effects in mobile telecommunications for each country as the total subscribers of mobile phones in the destination countries of mobile handset exports, weighted by the geographical distance between the home country and the partner countries. Although the novelty of our research is on studying the international network effects, we also analyze the network effects at the national level. In this context, we take into account the direct network effect of the national installed base of mobile subscribers.

Previous works focused only on the national level network effects of few selected countries (Doganoglu and Grzybowski, 2007; Grajek , 2010; Birke and Swann, 2006). However, to the best of our knowledge, no empirical study concerning network effects in telecommunications, between countries with strong commercial ties and geographical proximity, has been done yet.

We use a multinomial logit model, as explained in Train (2009), in order to specify the utility function of subscription to different mobile phones technologies for consumers in each country. We follow the model proposed by Berry (1994), which allows us to calculate the mean utility using inverted market shares.

In addition, we overcome some of the endogeneity problems that, according to Birke (2009), have hampered early empirical work. Specifically, to account for the endogeneity of mobile service prices, we used the lagged values of price and per capita income as instrumental variables. To control for the endogeneity of mobile phone subscribers, we used as instrumental variables the lagged values of mobile phone subscribers, population, and the total of mobile phones and fixed lines subscribers.

The estimation of the multinomial logit model with instrumental variables was performed using the state-of-the-art Arellano-Bond dynamic panel-data estimator using one-step difference GMM. This estimator is appropriate for situations with few time periods and many individuals, as well as for models with dependent and independent variables that are dynamic and depend on their own past realizations. The data set is an unbalanced panel that covers 105 countries from the first quarter of 2007 to the first quarter of 2010.

2. Relevant Literature

Network effects can be classified into direct and indirect. Direct network effects consist in the dependency between consumer value and the installed base of product users. In mobile communications, subscribers can communicate with more people the larger the installed base of subscribers. Therefore, the more subscribers the more utility for the individual consumer.

Direct network effects in national mobile phone markets have been found in the literature. Using aggregated market data Doganoglu and Grzybowski (2007) and Grajek (2010) analyzed the direct network effects in mobile phones in the German and Polish mobile telephone market respectively. Both studies found strong and significant network effects which constitute essential factors determining mobile phones diffusion, even more important than price reduction. Employing detailed market data, Birke (2009) show that members of the same household coordinate choice of mobile phone operator; and Birke and Swann (2006) (2005) show that correlation of operator choice in different countries is due to tariff-mediated network effects as opposed to other causes.

The mentioned studies have focused on the role of national network effects on mobile telephony adoption. However, these studies do not analyze the role of international network effects, which are increasingly important as transportation and telecommunications services improve and countries get more interconnected.

Among the few studies on international network effects, Suarez (2005) investigate 2G technology choice patterns between countries in North, South and Central America (95 operators) from the third quarter of 1992 to the second quarter of 2001. The author found that technology choice was interrelated in a selected subset of countries with which they have strong ties than to the worldwide situation. Nevertheless, as Birke (2009) pointed out, the used methodology does not allow to effectively distinguish between network effects and other effects leading to choice correlation, and the distinction between strong ties (the three closest countries) and weak ties (all other countries) is somewhat arbitrary and connections between countries are not directly taken into account, but only as an aggregate.

Indirect network effects, on the other hand, are generated if the utility of adopting a good is influenced by complementary relations between goods. In mobile telecommunications networks, indirect network effects consist of the dependence of consumer utility of mobile phone subscription and complementary goods or services, such as smart phones with multiple functions (digital camera, or games) as well as numerous mobile Internet applications.

Empirical evidence of indirect network effects has been found in various markets such as hardware and software (Gandal (1994)) , CD players and CD titles (Gandal et al. 2000), video games consoles and video games (Clements and Ohashi, 2005), Video Cassette Recorders and video content (Ohashi , 2003), and banks and ATM network (Saloner and Shepard (1995)). However, due to the lack of detailed data on handset variety, there are no studies that offer empirical evidence of the indirect network effects in mobile phone markets.

In this study, we analyze both national and international direct network effects in wireless telecommunications markets. We measure the international direct network effects in a country by taking into account the total subscribers of mobile phones in the destination countries of mobile handset exports, weighted by the geographical proximity. We also take into account the national installed base of mobile subscribers to measure the national direct network effect, as well as the mobile service charge to find out the price effect.

3. Econometric method, model specification and panel data

3.1. Multinomial logit model with inverted market shares and Arellano-Bond dynamic panel estimator

Our analysis uses a multinomial logit model to measure the international and national network effects, as well as the price effect, on countries mobile phone subscribers. The logit model is the most widely used discrete choice model, since the formula for the choice probabilities takes a closed form and is straightforward to interpret. In addition, the logit formula is derived from assumptions about the characteristics of choice probabilities, namely the independence from irrelevant alternatives (IIA) property, explained below, which implies that the model is consistent with utility maximization (Train , 2009).

We obtained the estimates of the demand parameters of the multinomial logit model by inverting the market share function, following the method developed by Berry (1994). This procedure does not need assumptions on either the parametric distribution of unobservables or on the actual process that generates prices. The approach by Berry (1994) has been used in empirical studies on network effects, where, additionally to traditional ways of differentiation, products can be differentiated according to their network size (Birke , 2009). In this section we give a brief explanation of the multinomial logit model with inverted market shares.

In the logit model, the utility U_{njt} that the consumer obtains from product j is composed by an observed part (V_{njt}) known by the researcher based on some parameters, and an unknown part (ϵ_{njt}) treated as random. The logit model is obtained by assuming that each ϵ_{njt} is independently and identically distributed (i.i.d) extreme value (Train , 2009). An important assumption of the logit model is that errors are independent. This assumption implies that the error for one alternative provides no information about the error for another alternative. In other words, V_{njt} is correctly specified and the remaining, unobserved part of utility is white noise (Train , 2009).

Utility is usually specified to be linear in parameters: $V_{njt} = \beta' x_{njt}$, where x_{njt} is a vector of observed characteristics of product j . With this specification, the logit probabilities become[1]

$$P_{nit} = \frac{\epsilon^{\beta' x_{nit}}}{\sum_j \epsilon^{\beta' x_{njt}}}. \quad (1)$$

The ratio of the logit probabilities for any two alternatives i and k, is

$$\frac{P_{nit}}{P_{nkt}} = \frac{\frac{\epsilon^{\beta' x_{nit}}}{\sum_j \epsilon^{\beta' x_{njt}}}}{\frac{\epsilon^{\beta' x_{nkt}}}{\sum_j \epsilon^{\beta' x_{njt}}}} = \frac{\epsilon^{\beta' x_{nit}}}{\epsilon^{\beta' x_{nkt}}} = \epsilon^{\beta' x_{nit} - \beta' x_{nkt}} \quad (2)$$

Since the ratio is independent from alternatives other than i and k, it is said to be independent from irrelevant alternatives or IIA. While the IIA property is realistic in some choice situations, it is inappropriate whenever the ratio of probabilities for two alternatives changes with the introduction or change of another alternative.[2]

In our model, we observe J products in I countries at different points in time. The J products are the mobile phone technologies: analog, cdmaOne, GSM, PDC, IDEN, TDMA, cdma2000 (family) and WCDMA (family). The utility of consumers in country i for technology j depends on the characteristics of the product:

$$U(x_{jit}, p_{ijt}, \xi_{ijt}, \theta_d), \quad (3)$$

where x_{ijt} are observed characteristics of the product, in our case international and national network effects, p_{ijt} is the mobile phone service price by technology, ξ_{ijt} are unobserved product characteristics, such as quality, and θ_d are demand parameters.

More specifically, the utility function can be written as:

$$U_{ijt} = \beta' x_{it} - \alpha p_{ijt} + \xi_{ijt} + \epsilon_{ijt}, \quad (4)$$

[1]For a more detailed explanation on how to obtain the logit probabilities see Train (2009)

[2]We tried to estimate a more flexible nested logit model, that is not constraint by the IIA property. However, the estimated results indicated that for some parts of the data the model was not consistent with the utility maximization assumption. In particular, the parameter measuring the degree of independence in unobserved utility among the alternatives in a given nest exceeded 1.

where ϵ_{ijt} is assumed to be iid extreme value $[\exp(-\exp(-\epsilon_{ijt}))]$ across products and consumers, in other words it is an idiosyncratic taste variable (Berry , 1994).

The market share of product j in market i at time t is given by the logit formula

$$s_{ijt}(\delta) = \frac{\exp^{\delta_{ijt}}}{(\sum_{k=0}^{N} \exp^{\delta_{ikt}})}. \tag{5}$$

With the mean utility of the outside good (no mobile phone subscription) normalized to zero,

$$\ln s_{ijt} - \ln s_{i0t} = \delta_{ijt} = \beta' x_{ijt} - \alpha p_{ijt} + \xi_{ijt}, \tag{6}$$

which means that δ_{ijt}, or the mean utility level, is uniquely identified directly from an algebraic calculation using observed market shares.

To account for the endogeneity of prices, it is necessary to use instrumental variables correlated with the endogenous variables but uncorrelated with the unobservable demand shocks. Instrumental variables used in the literature include proxies for cost factors, such as telecommunications equipment. In contrast, in this study, the instrumental variables used for mobile service prices are the lagged values of mobile service charge and per capita GDP. For total mobile phone subscribers, we used as instruments the lagged values of mobile phone subscribers, population and mobile and fixed lines subscribers.

The above multinomial logit model with inverted market shares and including instrumental variables was fitted using the Arellano-Bond dynamic panel-data estimator with one-step difference GMM. We used the Arellano-Bond (1991) dynamic panel estimator because of three reasons. First, The estimator is designed for situations with small T, large N panels, meaning few time periods (13 quarters from 2007 Q1 to 2010 Q1) and many individuals (105 countries in Model 1 and 184 in Model 2). Second, it is suitable for linear functional relationships with a single left-hand-side variable that is dynamic, depending on its own past realizations, in this case mobile phone subscribers. Third, it is appropriate when there are few independent variables that are not strictly exogenous, meaning correlated with past and possibly current realizations of the error, such as mobile service price and mobile phone subscribers of other countries.

The employed estimator is called difference GMM since the Arellano-Bond estimation starts by transforming all regressors by differencing and uses the Generalized Method of Moments (Hansen 1982). The Arellano-Bond dynamic panel-data estimation with one-step difference GMM was performed using the Xtabond2 command of Stata 11.

3.2. Model specification

The specification of the main model (Model 1) is the following:

$$\ln s_{ijt} - \ln s_{i0t} = \beta'_{Nat} National_{it} + \beta'_{Int} International_{it} - \alpha price_{ijt} + \xi_{ijt} \tag{7}$$

were s_{ijt} is the country i mobile phone subscribers of technology j in time t, s_{i0t} is the population without mobile subscription in country i and in time t, $National_{it}$ are the national network effects in country i and time t (installed base of country i), $International_{it}$ indicate the installed base of handset export partner countries weighted by distance or $\sum_k subs_k jt/$ distance between i and k, where $k \in$ mobile handset export partner of country i, and $price_{it}$ is $\sum_i$ (effective price per minute of Operator l in market i*Operator's share in market i) / per capita GDP of country i.

For comparison we also estimated a model that includes a different measure of international network effects without the weight by mobile handset exports and distances between countries. In this model (Model 2), the international network effects $World_{it}$ are defined as the world mobile phone subscribers - the mobile phone subscribers in country i.

$$\ln s_{ijt} - \ln s_{i0t} = \beta'_{Nat} National_{it} + \beta'_{World} World_{it} - \alpha price_{ijt} + \xi_{ijt} \tag{8}$$

In both models the instrumental variables used for prices are the lagged values of mobile phone service price and and per capita GDP, and the instruments for total mobile subscribers are the lagged values of mobile phone subscribers, population and mobile and fixed lines subscribers

3.3. Panel data

In this study, we employed an unbalanced panel data set of 224 countries and territories with quarterly data from the first quarter of 2007 to the first quarter of 2010.

The main estimation model (Model 1) analyzes the data of 105 countries. A second model is estimated for comparison purposes using data of 183 countries. A list of the countries included in model 1 (countries not indicated by an asterisk) and in model two (all the countries) is displayed in Table 1.

-Table 1 here-

The details and sources of the employed data are presented in Table 2. Mobile phones subscribers by technology, country and quarter were obtained from the Wireless Intelligence Database and were used to calculate the independent variable of the model. In addition, based on the total mobile phone subscribers per country, we calculate the national and international network effects of the mobile phone market. The national network effects are defined as the total mobile phone subscribers in each country. The international network effects are defined as the total mobile phone subscribers of the destination countries of mobile handset exports , weighted by the distance to such countries. The data on destination countries of mobile handset exports were taken from the UN Comtrade Database and the distance between countries were obtained from the CEPII Distances Database.

Mobile phone service price per country was calculated from the effective price per minute (eppm) charged by each operator in dollars, weighted by the market share of the same operator. Operators effective price per minute and market shares were taken from the Wireless Intelligence Database. For international comparison, the mobile phone service price was divided by the GDP per capita in dollars of the Penn World Table.

-Table 2 here-

3.4. Summary statistics

The summary statistics of mobile service price, international network effects measure, GDP per capita, total mobile phone subscribers and GSM subscribers, for the countries with available data on the 4th quarter of 2009, are displayed in Table 3.

-Table 3 here-

The top 16 countries with the highest measurement of international network effects in the last quarter of 2009 are in Europe, except for South Korea. This reflects three basic facts which are likely to influence each countries decision to adopt mobile phone technologies: high volumes of telecommunications equipment trade, abundant mobile phone subscribers in the partner countries and short distances between them. It may also reflect the fact that the European countries adopted the same GSM-based technological standard for 2G and 3G and therefore, this common standardization increases both telecommunications equipment trade and mobile phones subscription. On the other hand, low income countries have the lowest measurement of international network effects.

Similarly, the top 16 countries with the highest measurement of national network effects at the end of 2009 are in Europe, except for Singapore. In other words, the countries with the highest number of mobile phone subscribers, and therefore market size, are located in Europe.

Low-income countries have, in general, lower mobile service charge than high-income countries. Among developing nations, Latin American countries, such as Chile, Ecuador, Argentina and Peru, have the highest service charge in 2009. In contrary, within high-income countries, the US, Ireland and South Korea have the lowest service charges. On the other hand Japan, Netherlands, Swiss and Spain are the countries with the highest charges for mobile phone services among developed countries.

4. Estimation results: international and national network effects

The estimation results of Models 1 and 2 are presented in Table 4. The coefficients in Model 1 are statistically significant and have the expected signs. The results show evidence of significant positive national and international network effects, as well as negative price effects. In Model 2, when international network effects are defined as world subscribers without the subscribers of country i, the national network effects are positive and significant, but the international network effects are not significant. The price variable is negative as expected but it is also not statistically significant.

-Table 4 here-

The mean elasticity of the estimated parameters, shown in Table 5, was calculated in order to interpret and compare the coefficients of Models 1 and 2. Based on the calculated elasticities, the results show that international network effects are an important driver of mobile phones diffusion. According to our results an additional 1% increase in the mobile phone subscribers in the destination countries of mobile handset exports raises the mobile phone subscribers of a given country by 18%. This finding suggest the existence of a feedback circle between increased mobile subscribers and increased mobile handset availability.

-Table 5 here-

In addition, we show that a 1% increase in the total mobile phones subscribers in a country increases the number of subscribers using a given mobile phone technology by 30%. As expected, mobile service price affects negatively the diffusion of mobile phones. However, the contribution of price reduction to increasing the difussion of mobile phones cannot be compared to the national and international network effects. Specifically, a 1% decrease in mobile phones service charge increases national mobile phones subscription only by 2.8%.

These results imply that the policies most conducive to increase mobile penetration rates concern strategies that promote international direct and indirect network effects such as international standardization and technological choice, rather than price regulation. Competitive and innovative markets of complementary products that generate indirect network effects, such as mobile handset and mobile Internet applications are key factors for the diffusion of new generations of wireless communications.

5. Conclusions

In this paper, we measured the direct national and international network effects in mobile communications diffusion, for a wide sample of countries. Previous literature has stressed the importance of direct network effects in the difussion of mobile telecommunications at the national level (Birke and Swann (2006), Birke and Swann (2005), Doganoglu, T., & Grzybowski, L. (2007), (Grajek, M. (2010). Furthermore, Suarez (2005) found the existence of network effects in the technology choice among different countries in North, Central and South America. However, to the best of our knowledge, a study on international direct network effects in the mobile communications market has not been done yet.

Our evidence shows that both national and international direct network effects are more important factors than price reduction in the diffusion of wireless telecommunications. In particular, our results indicate that, for a sample of 105 countries from the first quarter of 2007 to the first quarter of 2010, the national direct network effects on mobile phones diffusion are almost double than the international direct network effects. The statistically significant and positive coefficient of international direct network effects suggests the existence of a feedback circle between increased mobile subscribers and increased mobile handset export. In addition, our estimation results indicate that price reduction is not the main driver of mobile phones diffusion.

We conclude that the policies most conducive to increase mobile penetration rates concern strategies related to international direct and indirect network effects such as standardization and technological choice, rather than price regulation. Previous empirical research indicates that markets with strong network effects have a tendency to be highly concentrated and the theoretical literature has often found a de facto standardization in network markets (Birke , 2009). Gruber and Verboven (2001) showed evidence that setting a single technological standard accelerates the diffusion of analogue mobile phone technologies considerably; and the same author expected similar beneficial effects for digital technologies. However, international coordination on mobile technological standards is still necessary because despite the presence of strong national and international network effects, nowadays there are multiple mobile phone technology standards in use.

The main characteristic of 3G mobile phone technologies is that it offers new multimedia services including data transfer and mobile Internet applications. Therefore, compared to older mobile phone technologies, the relationship between traditional mobile communications and such complementary services becomes stronger. Therefore, competitive and innovative markets of complementary products that generate indirect network effects, such as mobile handset and mobile Internet applications are key factors for the diffusion of new generations of wireless communications.

In this study, we focused on direct network effects in mobile telecommunication markets, both national and international. Due to the increasing importance of compatible products and services such as mobile Internet applications and handset functionality, it is necessary to understand the interaction between number of mobile phone subscribers and the quantity of new service release in different countries. Further research using detailed data on mobile handset variety or number of complementary services in the market in various countries will definitely contribute to better understand the national and international indirect network effects in the "next generation" mobile communication market.

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Table 1: List of countries for the network effects analysis

Afghanistan *[3]	Colombia	India	Mongolia	Solomon Islands *
Albania	Comoros *	Indonesia *	Morocco *	Somalia *
Algeria	Congo *	Iran *	Mozambique *	South Africa
Angola *	Costa Rica	Iraq *	Namibia	Spain
Antigua and Barbuda *	Cote d' Ivoire	Ireland	Nepal *	Sri Lanka
Argentina	Croatia	Israel *	Netherlands	St. Vincent & Gren.
Armenia	Cuba *	Italy	New Zealand	Sudan *
Australia	Cyprus	Jamaica	Nicaragua	Suriname *
Austria	Czech Rep.	Japan	Niger	Sweden
Azerbaijan	Denmark	Jordan	Nigeria *	Switzerland
Bahamas	Dominica *	Kazakhstan	Norway	Syria *
Bahrain	Dominican Rep.	Kenya	Oman	Taiwan *
Bangladesh *	Ecuador	Kiribati *	Pakistan	Tajikistan *
Barbados *	Egypt	Korea	Palau *	Tanzania
Belarus *	El Salvador	Kuwait *	Panama	Thailand
Belgium	Equat. Guinea *	Kyrgyzstan	Papua New Guinea *	Togo *
Belize *	Eritrea *	Lao *	Paraguay	Tonga *
Benin *	Estonia	Latvia	Peru	Trinidad and Tobago
Bermuda *	Ethiopia	Lebanon	Philippines *	Tunisia
Bhutan *	Fiji	Lesotho *	Poland	Turkey
Bolivia *	Finland	Libya *	Portugal	Turkmenistan *
Bosnia	France	Lithuania	Puerto Rico *	Uganda
Botswana *	Gabon *	Luxembourg	Qatar	Ukraine *
Brazil	Gambia *	Macao	Romania	United Arab Emirates
Brunei Darussalam *	Georgia *	Macedonia	Russia	United Kingdom
Bulgaria	Ghana *	Madagascar	Rwanda *	United States
Burkina Faso *	Greece	Malawi	Saint Kitts and Nevis *	Uruguay
Burundi *	Grenada *	Malaysia	Saint Lucia *	Uzbekistan *
Cambodia *	Guatemala	Maldives *	Samoa *	Vanuatu *
Cameroon *	Guinea *	Mali	Sao Tome & Principe *	Venezuela *
Canada	Guinea Bissau *	Malta	Saudi Arabia	Vietnam
Cape Verde *	Guyana	Marshall Isl. *	Senegal	Western Samoa *
Cayman Islands *	Haiti *	Mauritania *	Seychelles *	Yemen
Central African Rep. *	Honduras	Mauritius	Sierra Leone *	Zambia
Chad *	Hong Kong	Mexico	Singapore	Zimbabwe
Chile	Hungary	Micronesia *	Slovakia	
China	Iceland	Moldova	Slovenia	

[3]Model 1 uses data of the countries that are not indicated by an asterisk. Model 2 uses data of all the countries.

Table 2: Data sources of international network effects models from the 1^{st} quarter of 2007 to the 1^{st} quarter of 2010

Data sources	
Variable	Source
Mobile phone subscribers by technology	Wireless Intelligence Database
Mobile handset exports Classification HS2007 Code 851712	UN Comtrade Database
Distances between countries	CEPII Distances Database
Effective price per minute (eppm) per operator	Wireless Intelligence Database
Operators market share	Wireless Intelligence Database
Per capita GDP (US$ Dollars)	Penn World Table
Variables definition	
National Network Effects	Total mobile subscribers in each country
International Network Effects	ratio of “mobile subscribers in partner countries” and “distance partner country and country i”
World Network Effects	World mobile subscribers - mobile subscribers country i
Mobile service Price	ratio of “eppm * Operators market share” and “per capita GDP”

Table 3: Summary statistics of main variables in network effects analysis 4^{th} quarter 2009

Summary Statistics 2009 (4^{th} quarter)					
Country	Mobile Service Price	International network effects	GDP per capita	Total mobile phone subscribers	GSM Subscribers
Albania	0.096	180618.277	7212.715	4024993	4024993
Argentina	0.081	173174.747	13612.56	48396360	47366261
Australia	0.151	229910.556	47565.84	25084131	25084131
Austria	0.148	1157978.663	41062.52	11428882	11428882
Belgium	0.192	1465530.07	38579.58	12383715	12383715
Brazil	0.121	221867.022	10521.17	176643778	165303869
Bulgaria	0.102	657597.211	12565	10937649	10937649
Canada	0.123	515346.977	40022.88	22613055	8292735
Chile	0.110	216064.983	13689.23	17623034	17196998
China	0.024	519664.452	8113.773	722552000	666462000
Colombia	0.016	91627.614	8534.705	40315246	40315246
Croatia	0.187	662061.281	17019.95	6059858	6059858
Czech Republic	0.167	1144799.041	25552.71	13531054	13411034
Denmark	0.113	1017104.328	37376.77	7535942	7527742
Ecuador	0.104	139300.274	6800.167	13527700	13164981
Egypt	0.047	23251.736	5231.524	54416232	54416232
Finland	0.117	1060773.55	34764.99	7965595	7965595
France	0.171	1151905.098	34385.48	58539614	58539614
Greece	0.118	482834.594	30201.43	20783474	20783474
Hungary	0.098	1219632.545	18001.29	11333000	11333000
India	0.009	767083.4768	3588.021	525474133	421656506
Ireland	0.077	668992.872	35877.96	5406604	5406604
Israel	0.099	693110.309	28452.49	9688679	7010000
Italia	0.222	879596.648	30894.59	87990415	87990415
Japan	0.367	596605.594	35011.48	110617300	75051600
Korea	0.090	1147897.417	26674.96	48363400	26191561
Latvia	0.006	622821.996	14128.27	2327766	2288772
Lithuania	0.056	643108.844	15466.05	4613713	4613713
Macedonia	0.043	281325.970	8664.121	2108347	2108347
Malaysia	0.084	669262.035	12778.4	30566000	30566000
Mexico	0.058	310688.413	12887.42	83160107	76567501
Netherlands	0.318	1516939.82	44583.42	19697001	19697001
Norway	0.200	611525.251	56498.84	5184465	5151395
Pakistan	0.009	199773.863	2439.55	97579940	97578867
Peru	0.079	160463.389	8258.313	20149113	19138946
Poland	0.081	883562.265	18366.35	44527214	44312214
Portugal	0.193	429089.598	22338.55	16412525	16412525
Romania	0.043	939834.700	11705.06	30088000	29645920
Russia	0.028	198315.791	15703.98	207856424	207309250
Singapore	0.033	804870.945	51230.71	7379534	7379534
Slovakia	0.096	898700.549	21414.07	5819901	5819901
Slovenia	0.064	426908.727	28131.42	2105793	2105793
South Africa	0.177	179442.867	8647.157	50529000	50529000
Spain	0.253	719990.623	30907.55	53833599	53833599
Sri Lanka	0.001	8482.460	4411.003	14805087	14805087
Sweden	0.139	971856.902	39295	12138257	12115257
Switzerland	0.256	954731.746	44374.58	9075001	9075001
Thailand	0.019	719195.636	8688.686	66309297	64862862
Tunisia	0.037	137878.071	6897.657	10081934	10081934
Turkey	0.067	458096.374	10886.32	63225000	63225000
United Kingdom	0.181	1090048.428	37000.91	79623996	79623996
United States	0.061	405872.8602	45613.88	285564885	119157903
Uruguay	0.037	384479.094	12403.12	3888697	3888697

Table 4: Results of dynamic panel-data estimation, one-step difference GMM

	Model 1	Model 2
	Handset export partner subscribers	World subscribers
	Coefficients	
$\beta_{International}$	0.00002*[4] (0.000001)[5]	—
β_{World}	—	0.00003 (0.00003)
$\beta_{National}$	0.0031*** (0.0007)	0.0033*** (0.0007)
α_{Price}	-44042.64* (20567.01)	-1190.25 (3347.27)
Number of observations	637	1056
Number of groups	123	184
Observations per group		
minimum	0	0
average	5.18	5.74
maximum	9	9

[4]*** Indicates that the parameter is statistically significant at 1% level, ** at 5% level and * at 10% level.
[5]Values within parenthesis are robust standard errors

Table 5: Elasticities of dynamic panel-data estimation, one-step difference GMM

Mean elasticities of estimated coefficients		
	Model 1	Model 2
$\beta_{International}$	0.178	—
β_{World}	—	0.173
$\beta_{National}$	0.309	0.361
α_{Price}	-0.029	-0.028