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**Конкуренция в вертикально интегрированных  
отраслях на примере рынка телекоммуникационных услуг  
(Competition in vertically integrated industries:  
telecommunications example)**

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### **Abstract**

This paper investigates the mobile telecommunications market of Uzbekistan with a public vertically integrated producer by using panel data econometrics. The analysis covers investigation of the market structure, prices and welfare parameters including estimation of the effect of possible partial privatization of the VIP. It shows that current prices are below the "fair" ones, which generates additional social surplus, and that partial privatization is likely to have a negative effect on the social surplus.

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**LIST OF ABBREVIATIONS**

<b>VIP</b> .....	Vertically Integrated Producer
<b>MVNO</b> .....	Mobile Virtual Network Operator
<b>MTR</b> .....	Mobile Termination Rate
<b>DWL</b> .....	Dead Weight Loss
<b>CES</b> .....	Constant Elasticity of Substitution
<b>ECPR</b> .....	Efficient Component Pricing Rule
<b>EXAP</b> .....	Exogenous Access Pricing
<b>ENAP</b> .....	Endogenous Access Pricing
<b>CS</b> .....	Consumer Surplus
<b>ARPM</b> .....	Average Revenue Per Minute
<b>ARPU</b> .....	Average Revenue Per User
<b>MOU</b> .....	Minutes of Usage
<b>PPP</b> .....	Purchasing Power Parity
<b>GDP</b> .....	Gross Domestic Product
<b>AR</b> .....	Auto Regression
<b>OPEX</b> .....	Operating Expenditures
<b>CAPEX</b> .....	Capital Expenditures
<b>GMM</b> .....	Generalized Method of Moments
<b>B2B</b> .....	Business-to-Business
<b>SM</b> .....	Service Margin
<b>PS</b> .....	Producer Surplus
<b>USD</b> .....	United States Dollars

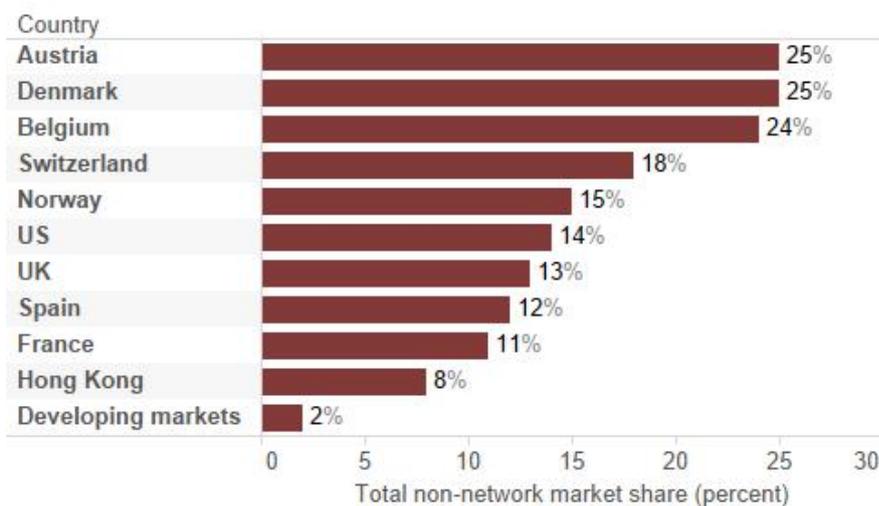
## INTRODUCTION

### 0.1 Case description and relevant background

The object of interest of current research is the effect of different industry characteristics on market outcome measured as equilibrium price and social welfare. Namely, we focus on monopolistic upstream player and mixed ownership over this player as the two industrial characteristics, also covering the question of possible privatization of a VIP. After some theoretical description of the situation we proceed with empirical assessment using telecommunications market of Uzbekistan as an example.

Uzbekistan telecommunications market is a good example as it incorporates the two mentioned characteristics, which is quite uncommon for modern telecommunication markets. While, especially in developing economies, state-ownership or mixed-ownership for a leading telecommunication provider is quite natural, this is rarely combined with it and only it being vertically integrated.

There are actually three typical situations relating to vertical integration in telecoms: one player fully controls the infrastructure that other players use, one player controls the infrastructure for some type of telecom products that other players use or several players control parallel or complementary infrastructure that all of them use. In



Picture 1 — MNVOs shares across countries  
Source: McKinsey & Company

other words, there may be a monopolist on the whole upstream market, a monopolist on the upstream market for some types of products with competitive situation for others or a competitive situation on the whole upstream market. The first situation used to be quite common in late XX century when telecom industries were just emerging, while currently most of the companies have and use their own network — situation 3. The share of mobile virtual network operators (MVNOs) — companies that own no network and operate using

infrastructure of some other company — is currently quite low in developed economies and close to zero in developing ones (McKinsey, 2014), though rapidly growing as a new telecom trend. The situation of type 2 sounds quite artificially as most of the telecommunication offerings now require infrastructure of a similar type or even can be delivered using exactly the same infrastructure. For example, one will rarely find an industry with voice network being competitive but data network being provided by only one player.

Uzbekistan is exactly the case of situation 2 — a state owned company "Uzbektelecom" has an exclusive control over international telecommunication channel granted by law (CMRU, 2004), while not being an exclusive owner of local network. Other four companies in the industry pay an interconnect charge similar to mobile termination rate (MTR) to "Uzbektelecom" for each and every minute of international calls. Apart from that, "Uzbektelecom" is considering possible partial privatization in the near future.

## 0.2 Goals of the study

As an ultimate goal of the study we aim to address the question whether partial privatization of "Uzbektelecom" is going to benefit the society of Uzbekistan.

In order to do that we apply both theoretical and empirical analysis. As for the theoretical part, we build an industry model for Uzbekistan telecommunications industry referring to latest papers, show the potential changes in the model in case of partial privatization and refer to potential effects for the given industry structure. The effects significantly depend on the objective function of "Uzbektelecom" — whether it is socially interested or not. We figure that out using panel data analysis for a set of peer-countries by estimating demand and price models and comparing the actual Uzbekistan metrics with the predicted ones.

## 0.3 Contribution and relevancy of the study

In this work we combine three distinct spheres of analysis that have not previously been studied together: theory of a vertically integrated monopoly, theory of mixed-ownership and partial privatization and econometric analysis of industrial parameters. Here we try to assess the potential effect of partial privatization of a vertically integrated monopoly that controls part of the infrastructure and check the setup applying econometric techniques.

In context of potential partial privatization of a state scale company with nearly \$0.3 Bn in revenues the potential effect on prices and social welfare assessment becomes highly important and policy relevant.

## CHAPTER 1

### Theoretical model

#### 1.1 Previous findings

In the context of our research it is reasonable to examine previous findings on several topics: vertical integration, public and mixed ownership, privatization effects, telecommunications industrial studies, econometric papers on prices analysis. We start by examining the vertically integrated companies, the effects of presence of vertically integrated companies on the equilibrium prices. Then we will turn to analysis ownership effects — how changing the objective function of a company influences the equilibrium prices and welfare. Finally, we will turn to econometric studies in the relevant field.

##### 1.1.1 Vertical integration

(Perry, 1989) provide extensive analysis of the basics of vertical integration. The authors start by clearly defining a vertically integrated company by a company that covers two distinctive processes in such a way that either an output of the upstream section is fully used as a part or all the input for the downstream section or all of one of the inputs for the downstream section is received from the upstream section. This includes the most restrictive definition when all of the output of the upstream process is used as an input for the downstream one and fulfills all its demand but is not limited to this restrictive form: a vertically integrated company may sell part of its upstream production output to the market or buy some of the inputs for the downstream production from the market. The authors distinguish between vertical integration and vertical combination, where a company that owns the processes corresponding to two consequent steps of the value chain but which does not exploit this fact by having a large share of intra-company operations is not vertically integrated but present a vertical combination. The authors continue by examining the case of a vertically integrated monopolist — the case when a monopolist on the upstream market integrates forward into a competitive or monopolistically competitive downstream market. The most common situation is when the monopolist's output is used as one of the inputs on the downstream market in variable proportions. It allows the monopolist to achieve higher efficiency if moved to the downstream market by avoiding the inefficiency caused by marginalization of the input, which is in details discussed by (McKenzie, 1951). The key issue here is how this integration forward influences the social welfare. There are two forces that work in the opposite directions. First, production efficiency is increased and the previous DWL partially comes into the producer's profit, the scale of which depends upon the production function characteristics. Second, the price on the downstream market may

rise above the efficient level and cut the social surplus on this market. The key questions here are whether the price does increase and, if yes, is the size of the negative effect at least as great as the positive one generated from production improvements.

(Schmalensee, 1973) were one of the first who intensively addressed this question regarding the effect of presence of a vertically integrated monopolist on market prices and efficiency. The authors showed that under some conditions on the downstream production function and the demand function <sup>1</sup> the downstream price level indeed rises. Though they did not estimate the effect on the social welfare. (Hay, 1973) continued the analysis and concluded that the same effect can be achieved in many other cases not covered in the previous work. (Warren-Boulton, 1974) made a serious contribution to the topic and concluded two things: even if all the previous conditions are not satisfied, the price may still rise and even if rises, social welfare may sometimes rise as well in the rare cases defined by rigid constraints on the input substitution for the downstream production. (Mallela and Nahata, 1980) continue the investigation of the conditions for the directional price changes and formulate clear conditions for the case of constant elasticity of substitution (CES) production function with the elasticity less than unity. (Westfield, 1981) first formulates more rigorous framework and comes to exact cases in which the change in downstream price can be negative given the CES production function with the same condition of low elasticity. All the names authors assumed competitive downstream market. However, it must not always be the case. (Waterson, 1982) model the same situation but sets the downstream market to be an oligopoly, which is much closer to the situation of the current paper.

The key "so-whats" from the mentioned works is that downstream prices are more often expected to rise than fall, especially if the monopolist is integrating along the production chain; that the expected increase in the monopolist's profit is quite significant due to one capturing value from the both of the effects; that total welfare loss is not expected to be significant.

However, it is of great importance to account for the strategic side of the issue. Although in the situations described downstream price does not always rise and welfare does not always contract, there are other factors that may facilitate the negative effect. (Williamson, 1971) mention a possible effect of vertical integration on the barriers for entry. The authors note that integration of the value chain stages create stronger investment barriers for entry and may reduce competition consequently. If this happens, the market prices are expected to increase causing a reduction in the social welfare.

So we primarily conclude that vertical integration as a fact may be both of a benefit and of a problem for the market in terms of efficiency and social welfare. Integration helps to

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<sup>1</sup>The authors analyzed Cobb-Douglas production function and a constant elasticity demand function with elasticity greater than unity

avoid several market failures and helps to boost production efficiency on the downstream market, although it creates potential for limiting competition.

A very interesting and important extension of this concept is the idea of market foreclosure. (Rey and Tirole, 2007) discuss this in details, we will briefly summarize the key ideas. In simple words, market foreclosure is a situation when a firm owning some essential facility limits or fully denies the access to it for the firms using it in order to translate its monopoly power to the downstream market, which is potentially competitive. This may take place not only when the adjacent industry uses the bottleneck output as an essential input but also when final consumers use the two products complementary. In order to exploit the potential benefits, the monopolist — owner of the essential facility — may act in various ways, including vertical integration with a downstream player, selling exclusivity to a downstream player, price discrimination, refuse to cooperate in case of economies of scope and scale. All these actions severely influence competition in the downstream market.

Economists of Chicago school argued against the mentioned problems noting that there is no need in translating the monopoly power to the downstream market: the monopolist has all power to extract the full profit of the unique final goods market by setting access charges, while distraction of the competition may make one worse off (Bork, 1978; Posner, 2009). However, as (Rey and Tirole, 2007) argue, this is not the case and such a monopoly cannot extract the full profit without using any exclusionary methods.

In order to control for the terms and conditions offered by a monopoly owning a bottleneck facility regulatory approach is often chosen. A widely spread approach of regulation is controlling for the access price charged by the monopolist. (Laffont and Tirole, 1994) show that the first best solution in this case in setting the access prices being equal to the monopolist's marginal costs. This, however, generate losses to the monopolist due to huge fixed cost on the infrastructure, which cannot be covered without introduction of distortive taxes. This leads to a need of above-marginal-cost pricing which will allow to finance the fixed cost. However, a problem of asymmetric information is of great relevance here as the difference in the information sets of the monopolist and the regulator is huge. (Baumol and Sidak, 1994) develop the idea and propose their efficient component pricing rule (ECPR). This rule claims that access charge must be equal to the sum of two terms: the incremental cost of supplying the unit of good and the opportunity cost of supplying this one more unit of good. The second term captures the benefits that the monopolist forgoes by supply the good to its potential competitors. This approach, however, is still significantly affected by incomplete and asymmetric information.

Modern approach to access pricing sets avoiding the need to estimate the monopolist's parameters as one of the main targets. A possible solution is to estimate the minimum feasible operating cost and use it as an exogenous parameter (EXAP) for regulation, while (Kahn,

(Tardiff, and Weisman, 1999) describe serious difficulties regulators encountered trying to evaluate the named expression. (Fjell, Pal, and Sappington, 2013) propose an alternative endogenous pricing approach (ENAP), which uses the revealed information as a source of knowledge. ENAP uses actual monopolist's average cost of providing access, which varies with actual industry output. The authors show that comparing to EXAP, ENAP creates strong incentives for the supplier to reduce its operating costs and carefully reveals the information that allows to reach an efficient equilibrium.

Inefficient access pricing is, however, not the only problem caused by presence of a vertically integrated monopolist. So even assuming that this problem may be more or less successfully solved by proper regulation, we may still not end up with the efficient solution. The key idea here is that there exist mechanisms apart from access pricing that allow the supplier to exclude some or all of the downstream players from using the essential facility. (Economides, 1998) describe "sabotage" — the non-price discriminating actions of the essential facility owner that exclude fully or partially other downstream players from using the facility. In the article mentioned the authors use quality degradation as an exclusion mechanism. An essential facility owner, who also participates in an oligopolistic downstream market with its subsidiary, has a possibility to lower the quality of the input it provides to its subsidiary's competitors. They end up with showing that it is always optimal, even when it is cost-disadvantageous, to raise the competitors' costs by lowering the quality of the input provided in order to improve the competitiveness of its subsidiary. At the same time it is suboptimal for the monopoly to raise the cost for the whole industry including its own subsidiary. (Beard, Kaserman, and Mayo, 2001) develop the idea of sabotage and model a more complex situation. They set the downstream market to be a Bertrand oligopoly with differentiated products. The authors examine two cases: with and without regulation of the access price — and test whether the supplier has incentives to vertically integrate forward or use non-price discrimination methods. They conclude that in both cases there are strict incentives to vertically integrate an incentive to sabotage exists only in case of the upstream price regulation that is binding.

From the literature mentioned we may conclude that presence of a vertically integrated producer may influence the industry in various way including those connected with access pricing and not related to the pricing process. Vertical integration helps to overcome different market failures and lower transaction costs in situations like investment specificity. At the same time a vertically integrated monopolist may reduce competition on the downstream market and reduce social welfare.

### 1.1.2 Mixed ownership and privatization

In the previous discussions we always assumed that the players including a vertically integrated one used profit function as an objective one. In case of private firms it is a solid assumption for most of the times. However, if one or more firms is not private but a publicly owned one, the situation may change as profit maximization is hardly the real goal for government. (De Fraja and Delbono, 1989) model the situation when there is a public firm, which uses the social welfare equation as a goal function, and several private firms. They show that under some conditions regarding the market structure privatization of a public company may increase social surplus given no improvements in production efficiency. This means that nationalization of some firm and making it care about social surplus may have a destructive effect on the surplus itself. (Matsumura, 1998) develop this idea by allowing for partial privatization. In this case the objective function of a partially privatized firm will be a weighted average of its own profit and social welfare equation with weight corresponding to the shares of private and public parties in the ownership structure. In the research mentioned there is also a coefficient that allows for different weights for consumer and producer surplus to be used. The authors end up with corner solutions (full nationalization and full privatization) not being optimal, while partial privatization allows to attain the highest values of social surplus. The described models illustrate that in some cases acting in the way to maximize the objective function results in a suboptimal outcome in terms of this objective function. (Crawford and Varian, 1979) describe a case when distortion of the objective function allows the player to reach higher payoff. However, this raises a question of signaling a change of the objective function to the other players in a credible way. One of the best methods of showing such type of credibility is an intentional loss of power (Schelling, 1980). Such a loss may be caused by legal changes. A good example is exactly the partial privatization, which signals the commitment to changing the objective function.

However, in the works mentioned and in other papers of that time authors make an implicit (or sometimes explicit) assumption of the exogenous decision making process. In other words, the authors assume that the party that has greater share in the ownership structure translates its interests in some weight, corresponding to the share of the party (or some function of it). While at least due to the issue mentioned in the previous paragraph this may not be the case. Later works on this topic develop an endogenous process of objective function setting based on the bargaining, not on weighting. (Kamijo and Tomaru, 2014) use a two stage game to model the bargaining process in order to evaluate the optimal privatization extent. The authors end up with the conclusion that an optimal ownership structure depends on the marginal cost and capital values.

An interesting development of privatization and mixed ownership issues is the model

that includes a vertically integrated producer (Wen and Yuan, 2010). The authors compare the benefit from privatization caused by avoiding using distortive taxes and increase in X-efficiency with some switching cost and reduction of the social surplus resulted from a shift to profit maximization instead of social surplus maximization. The authors show that if an increase in X-efficiency is not significant and distortion from public ownership is not severe then privatization of the VIP will lead to an increase in prices on the downstream market and to a decrease in social welfare, which is an important conclusion for us.

From the papers mentioned we may conclude that objective functions of the players and the way they are chosen significantly influence the effect from both partial and full privatization. The effect of privatization of social welfare can be positive in case there used to be major distortions from a publicly owned VIP. If the distortions were acceptable, generally, moving to a profit maximizing VIP will generate the negative aspects of VIP discussed in the previous section, which will decrease social welfare.

### 1.1.3 Econometric methods

In order to estimate the presence of social concerns in the telecommunications market one may use econometric methods to estimate a "private" equilibrium and compare it with the actual data. (J. A. Hausman and Ros, 2013) propose an intensive analysis of mobile prices in Mexico. The authors estimate the demand and price equations based on the panel data for a sample of countries. The authors propose several specification for the demand model, from which they derive an estimate for the price and income elasticities. Next the "fair" price equation is estimated based on the objective characteristics of the countries. From this analysis the authors conclude that prices in Mexico are lower than the fitted ones in the past several years. Then the authors estimate the consumer surplus equation and end up with an estimation of a gap in the CS as a result of lower prices.

(Wallsten, 2001) also use panel data for analysis of telecommunication markets in developing countries. The authors include privatization of an incumbent in the model. Applying a fixed-effects regression the authors uncover negative effects of privatization on quantity of services provided. However, in case of proper regulation, which the authors capture by a modified model, privatization may produce positive effect on quantity and social welfare.

(Waterman and Weiss, 1996) apply the analysis to the situation of vertical integration on c cable TV market. The authors compare the integrated and non-integrated markets and end up with presence of vertical integration negatively influencing the market outcomes in terms of price, quantity and efficiency.

## 1.2 Model setup

Uzbekistan mobile market can be divided into two vertical stages: infrastructure owners and service operators. At the same time, two goods are traded on the market: local calls and international calls. The upstream market for the local calls and both downstream markets are oligopolistic, while the upstream market for the international calls is monopolistic and includes only one player — "Uzbektelecom". We avoid building two separate models for the two goods and accounting for the mutual cross-effects as it does not add much value for the issue of interest but adds much complexity to the modeling process. Instead, we look at the market as if it traded bundles of local and international minutes in the constant proportion:

$$X = \omega_{1i} \times X_{local} + \omega_{2i} \times X_{int}$$

where  $X$  is a good under analysis - a bundle of one minute in size,  $X_{local}$  and  $X_{int}$  are minutes of local and international traffic correspondingly, while  $\omega_i$  are the weight that sum to unity and illustrate the proportion of local and international traffic in the total traffic usage in the  $i^{th}$  country:

$$X = \frac{Local\ traffic}{Total\ traffic} \times X_{local} + \frac{International\ traffic}{Total\ traffic} \times X_{int}$$

The market price —  $P$  — is calculated correspondingly by a weighted average of market prices for local —  $P_{local}$  — and international traffic —  $P_{int}$ :

$$P = \omega_{1i} \times P_{local} + \omega_{2i} \times P_{int}$$

The access price —  $MTR'$  — "Uzbektelecom" charges for one unit of  $X$  is an actual access price —  $MTR$  — diluted according to the weight of international calls in the total bundle:

$$MTR' = MTR \times \omega_{2i} = MTR \times \frac{International\ traffic}{Total\ traffic}$$

We further proceed with modeling as if there was only one type of calls in the market and the VIP were charging an  $MTR'$  access price for it.

It is reasonable to assume that on the downstream market the players interact according to Bertrand-competition as mobile services do not have real capacity limits for a reasonable interval of quantities. However, for our goals we do not really need to decide on the competition model to make a conclusion regarding the issue under analysis.

We do not make an assumption regarding the objective function of "Uzbektelecom" and consider it to be a conclusion from the model. However, we limit the choice by two qualitatively contrary options: either "Uzbektelecom" is at least partially socially concerned,

which will lead to access prices being low enough and retail price being low enough as well due to Bertrand-competition on the downstream market, or not socially concerned at all, which will lead to access prices being higher and retail prices being higher as well. It should be noted that by being socially concerned we do not necessarily mean having social surplus component in the objective function — here we speak of the underlying motives of the owners of the player. This is important because, as has been shown by [\(Crawford and Varian, 1979\)](#), distortion of the objective function may be a way to attain the underlying goals. So, we may generally say that "Uzbektelecom" makes its decision regarding the access price —  $MTR'$  and retail price by maximizing the following objective function:

$$U_{VIP} = f(CS; \pi_{VIP}; \pi_{other}) = g(MTR'; P)$$

## CHAPTER 2

**Empirical analysis**

In the following sections we focus on applying econometrics in order to verify whether or not "Uzbektelecom" is actually socially concerned — whether social surplus is its objective function at least partially. In order to do that, we use a panel of countries to estimate demand and price equations. If we end up with Uzbekistan mobile prices be at their fair values or above, we will conclude that "Uzbektelecom" is, roughly speaking, following a profit maximizing strategy and targets maximum government earnings (or at least does not target maximizing social surplus). If, however, we find out that actual prices are lower than the predicted values, we will conclude that "Uzbektelecom" is indeed following the social welfare maximizing strategy at least partially.

**2.1 Data description**

In order to estimate the model we use The World Bank data on development parameters: GDP per capita measured at market prices and PPP, countries population, countries GDP and penetration of mobile communications; and Analysys Mason data on mobile prices for the period from 2005 to 2015. Following (J. A. Hausman and Ros, 2013) we use not tariffs listed by mobile operators but actuals — the actual price paid per minute by the customers (ARPM), which is measured by the average revenue per user (ARPU) divided by average minutes of usage per user (MOU):

$$ARPM = \frac{ARPU}{MOU} = \frac{Local\ traffic}{Total\ traffic} \times ARPM_{local} + \frac{International\ traffic}{Total\ traffic} \times ARPM_{int}$$

This approach is preferable as it accounts for the product and tariff mixes across years and countries as well as different types of discounts, packages and additions. ARPM includes all voice traffic including both local and international calls. In other words, it can be looked at as a price for a bundle of 1 weighted minute with weight corresponding to proportions of local and international traffic in the country.

**2.2 Countries sample selection**

Dependence of interest is reasonable to be estimated on a sample of peer-countries according to some metric that captures different levels of countries development. Building and estimating a price or demand model on a full set of countries requires an additional analysis of key development factors that influence the variable of interest. Analysis of a sample of

comparable countries instead helps to avoid that procedure as small variation in those factors within the sample allows to omit them.

Sampling may be done in many different ways using any development metrics, while here we focused on the GDP per capita approach using The World Bank data. (J. A. Hausman and Ros, 2013) used GDP per capita at market prices and showed that GDP per capita at PPP leads to similar results. As the level of Uzbekistan GDP per capita is significantly lower than one of Mexico, using the same sample of countries is not appropriate and assuming GDP per capita at market prices sufficiency for analysis can also lead to wrong results.

In order to proceed, countries were analyzed from scratch according to both metrics mentioned and 29 countries were chosen for further analyses. Picture 2.1 illustrated main results of the procedure. Exactly as in previous works, both GDP per capita metrics lead to the same conclusions despite significant difference from Mexico and its peers. We have omitted several countries that are close to Uzbekistan by GDP but do not provide the required data on mobile penetration or prices (shown in gray on the map). The data for year 2015 for the sampled countries can be seen from the table 2.1.

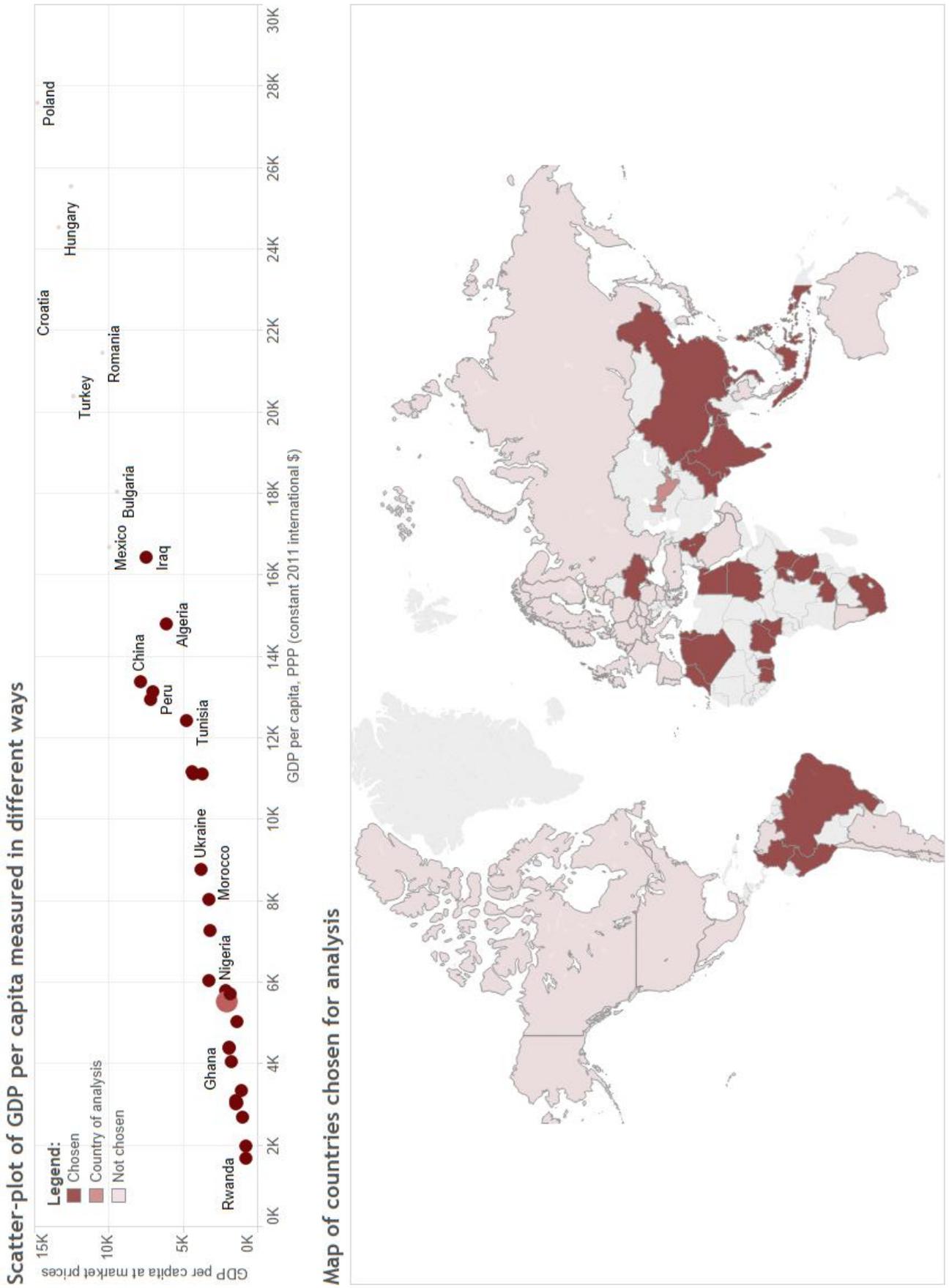
The sample of countries includes 29 countries with the GDP per capita at PPP varying from \$1,692 (Rwanda) to \$17,026 (Brazil), while Uzbekistan has the GDP per capita of \$5,532. Despite significant range within the sample, the difference between Uzbekistan level and upper and lower quartiles is nearly 75% on average and median is nearly 110% of Uzbekistan level. Further details are illustrated by the box plots shown on the picture 2.2, where values for Uzbekistan are shown by a large pink dot. Apart from one clear outlier — Brazil — which is much above other countries in the sample by one of the four parameters, the sample appears to be quite uniform. In further analysis we stick to PPP version of the GDP per capita parameter, so even the outlying Brazil observation is not of a problem here.

From the geographical point of view, as can be seen on the Tableau dashboard attached - picture 2.1, the sample is well diversified and includes several Latin American countries (Brazil, Colombia, Peru), many African countries (Algeria, Sudan, Tanzania etc.) and several Eurasian ones (Ukraine, China, India etc.)

For comparison, (J. A. Hausman and Ros, 2013) countries sample had 17 countries with nearly the same range of data: highest GDP per capita value in the sample was around 3 times of Mexico's, which the authors were analyzing. In our sample we have the same multiple of around 3,5 times.

Taking a look at the data sample, it can be seen that Uzbekistan is characterized by quite low levels of all the examined parameters. However, regarding the mobile prices, it's level is one of the lowest, which can serve as a primary evidence of socially interested VIP. However, further analysis is required to confirm such a conclusion.

Analyzing the prices for the period of time shows that mobile prices in Uzbekistan have



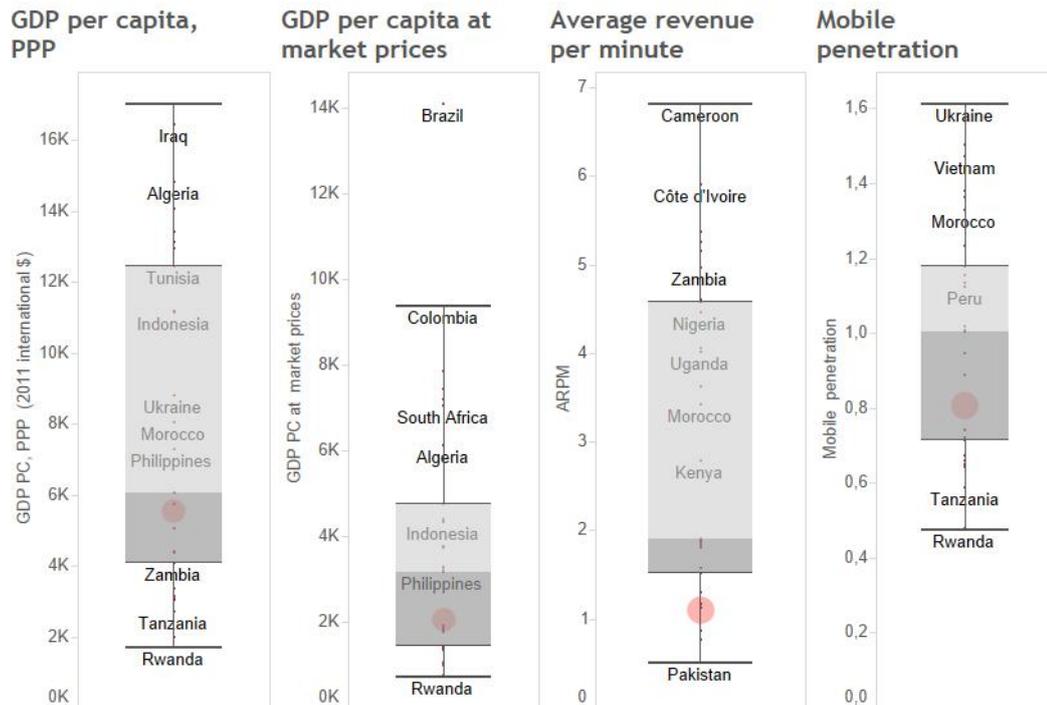
Picture 2.1 — Selection of countries according to their GDP per capita 2015  
Source: The World Bank

Table 2.1 — Key data on Uzbekistan and peer countries, 2015

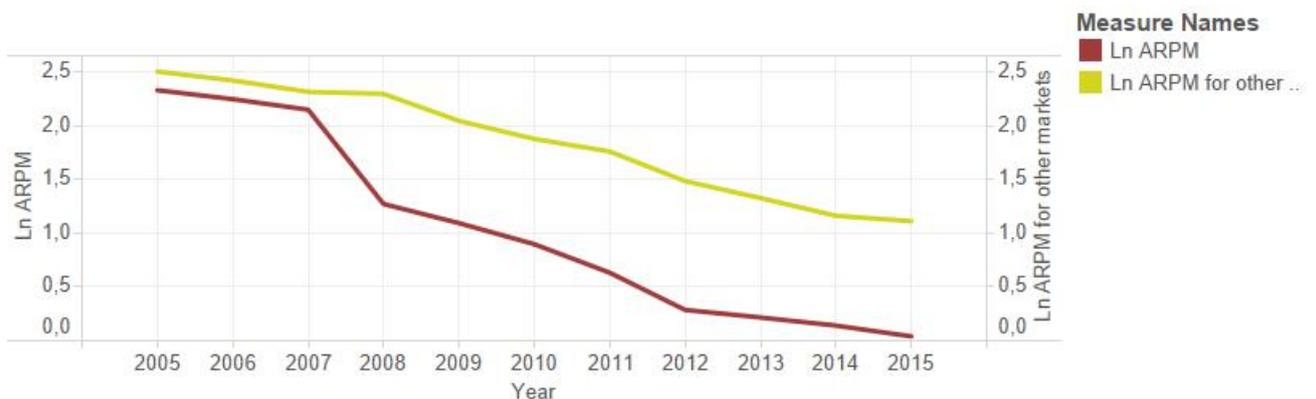
Country	GDP PC at market prices (USD)	GDP PC, PPP (2011 international \$) (USD)	ARPM (USD cents)	Mobile penetration
Algeria	6 116	14 811	3,6	113%
Bangladesh	1 038	3 355	1,2	66%
Brazil	14 088	17 027	4,6	138%
Cameroon	1 405	3 027	6,8	64%
China	7 850	13 394	1,9	89%
Colombia	9 370	14 056	4,1	123%
Côte d'Ivoire	1 440	3 121	5,9	100%
Egypt	3 713	11 132	1,6	116%
Ghana	1 903	4 407	1,8	102%
India	1 777	5 734	1,1	71%
Indonesia	4 323	11 135	1,3	118%
Iraq	7 426	16 445	4,6	95%
Kenya	1 378	3 062	2,8	74%
Morocco	3 270	8 052	3,4	133%
Nigeria	3 235	6 066	4,5	72%
Pakistan	1 349	5 038	0,5	74%
Peru	7 178	12 954	5,2	112%
Philippines	3 148	7 271	1,9	118%
Rwanda	718	1 692	1,5	47%
South Africa	7 031	13 134	5,3	150%
Sri Lanka	4 373	11 178	1,8	101%
Sudan	1 854	4 378	1,9	67%
Tanzania	969	2 691	1,9	59%
Tunisia	4 738	12 425	5,4	136%
Uganda	754	1 982	4,0	48%
Ukraine	3 753	8 787	0,9	161%
Uzbekistan	2 037	5 532	1,1	80%
Vietnam	2 089	5 798	0,8	147%
Zambia	1 757	4 067	5,0	65%

Source: The World Bank, Analysys Mason

([databank.worldbank.org/data/](http://databank.worldbank.org/data/), [analysismason.com/](http://analysismason.com/))



Picture 2.2 — Box plots of key data sets for Uzbekistan and peer-countries, 2015



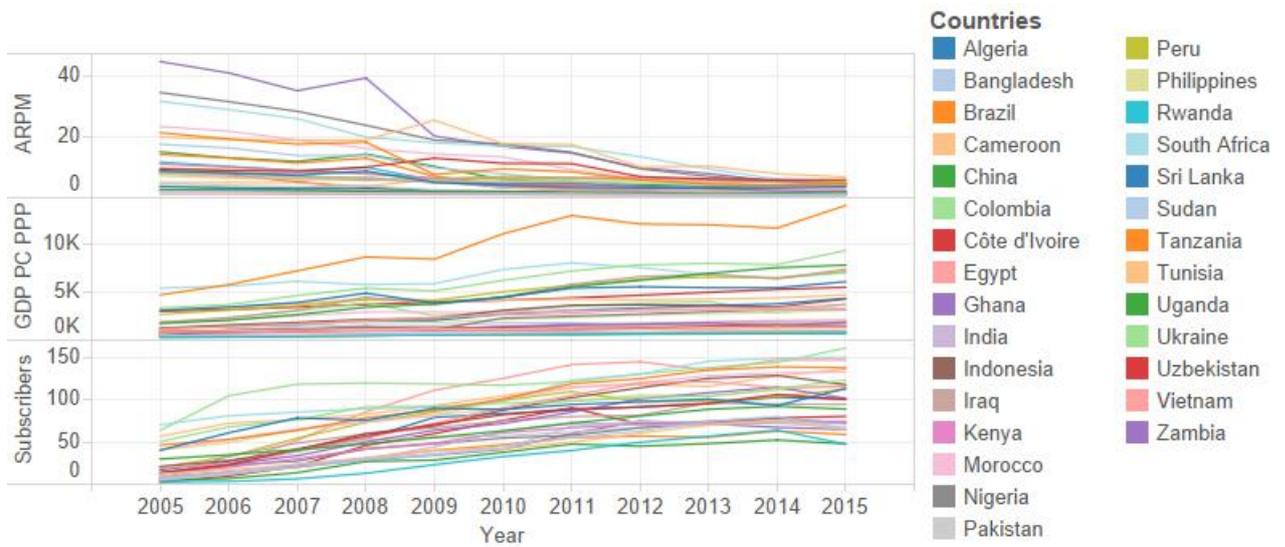
Picture 2.3 — Mobile price in Uzbekistan vs. average price in other countries in logs

always been lower than in other countries on average, while in the latest years the difference became much more significant. Overall gap is not an issue as it may be just a consequence of lower development level or transitional nature of the economy but such an increase in the gap's size is of great interest.

### 2.3 Data preparation

Before proceeding to extensive modeling it is always a good idea to make a visual check of the data used — picture 2.4 shows the three main series for the sampled countries. It can be seen that all the three series are obviously non-stationary as they show significantly

changing mean over time.



Picture 2.4 — Time series for main data on sampled countries

Applying unit root tests to key data series: GDP per capita, average revenue per minute, mobile penetration — confirms the non-stationary nature of the series, which is expected in case of such data. It is naturally caused by most of these variables stably changing with time — GDP per capita usually grows over time with economic development, mobile penetration also increases with expansion of telecommunication infrastructure, the effect of which is even greater during the period of analysis (2005 — 2015) in the developing countries as this is the period of massive telecom development for them. Mobile prices historically have a strong downward trend due to rising intensity of competition between providers and reducing self-cost of providing corresponding services. Further modeling with original series may lead to apparent dependencies caused by spurious regression issues. In order to cope with the mentioned issue, we transform the series into differences of logarithms of underlying values. Repeated unit root tests — table 2.2 — show that the transformed series are covariance-stationary and can be used in modeling.

## 2.4 Demand estimation

In order to check the assumptions regarding the form of the demand curve and cross-check the income and price elasticities of demand, we first estimate the demand equation on the sample of peer countries chosen. As a measure of quantity we use the mobile penetration metric due to high data quality on this parameter and its availability for the developing countries, while total mobile usage is much harder to collect. Mobile penetration fully captures the effect of new users and churn and partially accounts for intensity of usage as it is affected by users having two or more devices. However, this metric does not account

Table 2.2 — Series stationarity tests

Panel unit root test: Summary Series: DLSUBS Sample: 2005 2015			Panel unit root test: Summary Series: DLPRICE Sample: 2005 2015			Panel unit root test: Summary Series: DLSUBS Sample: 2005 2015		
Method	Stat.	Prob.	Method	Stat.	Prob.	Method	Stat.	Prob.
Null: Unit root			Null: Unit root			Null: Unit root		
Levin, Lin, Chu	-15.5	0.00	Levin, Lin, Chu	-8.2	0.00	Levin, Lin, Chu	-7.4	0.00
Null: Unit root			Null: Unit root			Null: Unit root		
ADF - Fisher	210.4	0.00	ADF - Fisher	161.9	0.00	ADF - Fisher	170.5	0.00
PP - Fisher	297.6	0.00	PP - Fisher	179.0	0.00	PP - Fisher	178.7	0.00
(a)			(b)			(c)		
Mobile penetration			Revenue per minute			GDP per capita		

for users using their unique device more or less intensively as a consequence of changes in prices.

As the explanatory variables we will take a look at mobile prices as a measure of price and GDP per capita as a measure of income. Then we will modify a model to include several dummy variables to account for some possible structure changes and differences and an AR(1) term to test for possible self-dependence.

Direct inclusion of mobile prices into the estimated equation is likely to cause endogeneity problem due to mutual dependence and omitted equation due to presence of a supply equation in the same variables — there exist unobserved variables included in the error term that affect both the independent and the dependent variables. Proceeding with direct modeling will make the Least-Squares estimates inconsistent and biased as the estimated effects will implicitly include the effects generated by the omitted supply equation. In order to verify the suspicion of joint endogeneity we apply A. Hausman specification test, which confirms the initial hypothesis <sup>1</sup>.

In order to cope with this problem we apply so-called "Hausman instruments", proposed by A. Hausman and W. Taylor ([J. A. Hausman and Taylor, 1981](#)). This approach heavily relies on cost-based approach to pricing as it proposed using self-cost (average variable cost) as an instrument for prices. Such an assumption is of hard usage for industries like telecommunications, although ([J. A. Hausman and Ros, 2013](#)) use exactly this approach is the modeling. The key difficulty is CAPEX nature of telecommunications and nearly absence

<sup>1</sup>Hausman specification test sets exogenous nature of price as a null hypothesis and rejects this hypothesis with P-value less than 1%. The corresponding statistics is equal to 11.01 and is distributed as chi-square with 1 degree of freedom.

of variable cost. Interconnection costs and channel rents account for more than 90% of operating expenditures of a typical modern telecommunications provider, while depreciation of the infrastructure, which is not a variable cost, make a significant (at least as great as OPEX) addition to the cost base. Apart from that, cost data is quite hard to collect and is rarely used in such estimations. Following (J. A. Hausman and Ros, 2013), we use an average mobile price at the markets excluding the one of analysis as a proxy for the average variable cost as it implicitly includes all the variable cost allocated during the pricing process. These prices are highly correlated due to similar cost factors in the peer countries and their error terms are expected to be uncorrelated. The error terms mentioned illustrate unanticipated demand shocks such as lifting a ban on voice-over-IP technologies in some country, which are usually not correlated between countries. So we use an average of other 28 countries' mobile prices as an instrument for the price variable.

From the data illustration above clear heterogeneity of data can be seen: there are significant differences between countries in all of the data series. This means a need of accounting for these differences by capturing either fixed or random panel data effects. A decision on better specification can be made using Hausman specification test (J. A. Hausman, 1978), the idea of which is in comparison of the two possible specifications. Applying the test for our model results in rejecting the hypothesis of random-effects specification being preferred with less than 1% significance level <sup>2</sup>. From that we conclude that usage of fixed-effects specification is more appropriate comparing to random-effects specification. Ignoring that will lead to biased and inconsistent results (J. A. Hausman and Taylor, 1981), (Baltagi, 2008). Here we use first-difference approach to estimation of fixed effects by working with differences of logarithms of all the variables. This approach can provide even more precise estimates comparing to dummy-variables fixed-effects estimation (Wang and Ho, 2010). Applying the first-difference estimation solves the fixed-effects issue as the cross-sectional structural differences cancel out in the process of differencing.

To estimate the demand model we apply the first-difference generalized method of moments (GMM) estimation for the regression model:

$$DLSubs_{ti} = \beta_1 \times DLPrice_{ti} + \beta_2 \times DLGDPPC_{ti} + \epsilon_{ti}$$

In the equation above  $DLSubs$  is the difference of logarithms of mobile penetration in the  $i^{th}$  country in the  $t^{th}$  year,  $DLPrice$  is the difference of logarithms of average mobile prices per minute in the  $i^{th}$  country in the  $t^{th}$  year,  $DLGDPPC$  is the difference of logarithms of GDP per capita measured at PPP in the  $i^{th}$  country in the  $t^{th}$  year,  $\epsilon$  is a normally distributed with zero mean and constant unconditional variance error term.

---

<sup>2</sup>The corresponding statistics is equal to 12.2 and is distributed by Chi-Square with 2 degrees of freedom, which corresponds to a P-value less than 1%

Estimating the model in the form written above yields the following results illustrated in the table 2.3. The coefficients estimates obtained have expected signs — a positive

Table 2.3 — Estimation of demand model with fixed effects

Dependent Variable: DLSUBS

Method: Panel Generalized Method of Moments

Sample (adjusted): 2006 2015

Periods included: 10

Cross-sections included: 29

Total panel (balanced) observations: 290

Period SUR (PCSE) standard errors & covariance (d.f. corrected)

Instrument specification: C DLGDPPP DLPRICEIV

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLPRICE	-0.620247	0.083040	-7.469256	0.0000
DLGDPPP	0.976621	0.131088	7.450143	0.0000

coefficient for income level and a negative one for price level. Having used logarithms values for regression we may interpret the estimates as corresponding elasticities. So the resulted price elasticity is around  $-0.62$  and income elasticity is around  $0.97$ . ([J. A. Hausman and Ros, 2013](#)) using the same specification have obtained the corresponding values of  $-0.52$  and  $0.43$ . The price elasticity is very close to the one we have obtained but the income one is twice lower. This may be explained by the difference in the level of sampled countries development: the countries in our sample have GDP per capita are many times lower (for example, our target country — Uzbekistan — has GDP per capita at PPP of \$5.5 th., while their target country — Mexico — has the one of \$14.5 th.).

In the previous works estimating own-price elasticity for mobile services, ([J. A. Hausman, Pakes, and Rosston, 1997](#)) estimated an elasticity of  $-0.506$ , ([Madden, Coble-Neal, and Dalzell, 2004](#)) — of  $-0.53$ , ([Duk Hee Lee and Dong Hee Lee, 2006](#)) — of  $-0.482$  to  $-0.643$ , while ([Kathuria, Uppal, and Mamta, 2009](#)) ended up with the value of  $-2.12$ .

As for the income elasticity, ([Garbacz and Thompson, 2007](#)) found the values from  $0.93$  to  $1.21$ , ([Duk Hee Lee and Dong Hee Lee, 2006](#)) estimated the income elasticity in Korean mobile market to be from  $0.626$  to  $0.655$ .

Substituting the PPP GDP per capita metric for the market prices GDP per capita also results in significant estimates for both prices and GDP. The price elasticity becomes a bit smaller in absolute value down to  $-0.49$ , while income elasticity significantly increases up to  $1.99$ . Both metrics stay significant at 1% significance level. The difference in the resulted estimates comes from the difference in methodologies of deflating the GDPs. Further on we will work with the PPP version of the metric only. This approach is more appropriate when

working with non-internationally traded goods (Callen, 2007), while mobile connection is one of such goods.

The analyzed time period includes the years of global financial crisis of 2007-2009. This major event might have had an effect on the subscribers behavior caused by, for example, separation and contraction of the B2B segment. In order to test this hypothesis we generated several dummy variables corresponding to different years and sequences of years of the crisis and included them in the relationship as a multiple for income and prices. The best fit was reached with the dummy variable corresponding to the years 2007-2008 as a multiple for income level.

Table 2.4 — Estimation of demand model with time dummy variable

Dependent Variable: DLSUBS  
Method: Panel Generalized Method of Moments  
Sample (adjusted): 2006 2015  
Periods included: 10  
Cross-sections included: 29  
Total panel (balanced) observations: 290  
Period SUR (PCSE) standard errors & covariance (d.f. corrected)  
Instrument specification: C DLGDPPP DLPRICEIV IS07\_08\*DLGDPPP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLPRICE	-0.609845	0.079542	-7.667003	0.0000
DLGDPPP	0.698978	0.125406	5.573729	0.0000
IS07_08*DLGDPPP	0.874746	0.248125	3.525430	0.0000

The results are shown in the table 2.4. We see that price elasticity shows almost no change comparing to the specification without the dummy variable, while the income elasticity changed significantly. One may note a serious decline in the value of income elasticity down to 0.70, while in times of crisis the elasticity increases by 0.87 up to 1.87. Such an increase in the elasticity in times of economic declines may be explained by intensive contractions of mobile usage, especially for business needs, which is more rapid than the average growth of mobile usage in normal times. As normal times, fortunately, usually last for longer periods than crises, an "weighted average" elasticity converges to some middle value.

Following (J. A. Hausman and Ros, 2013), we test the applicability of the instrument used — average prices over the sample of countries — by using the time variable as an instrument instead. The results are shown in the table 2.5 and they are very close to the model with the sample average price instrument in terms of the value of the estimates — the amplitude of change is around 10% of the previously estimated values. The corresponding standard error of the price elasticity estimate is a bit higher when year is used as an instrument due to its

low quality in terms of correlation with the explanatory variable.

Table 2.5 — Estimation of demand model with time as an instrument

Dependent Variable: DLSUBS  
 Method: Panel Generalized Method of Moments  
 Sample (adjusted): 2006 2015  
 Periods included: 10  
 Cross-sections included: 29  
 Total panel (balanced) observations: 290  
 Period SUR (PCSE) standard errors & covariance (d.f. corrected)  
 Instrument specification: C DLGDPPP YEAR IS07\_08\*DLGDPPP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLPRICE	-0.655707	0.085013	-7.713052	0.0000
DLGDPPP	0.639145	0.120900	5.286542	0.0000
IS07_08*DLGDPPP	0.906922	0.249356	3.637060	0.0003

We then modify the model to include a possible self-dependence effect by including an AR(1) term — the dependent variable lagged for one period. Such a move is to capture possible effects from various shocks that last for more than one period but have a declining amplitude. In context of our model this means that mobile penetration is partially defined by the mobile penetration in the previous year. Or in the context of modeling the differences, a negative (positive) shock of mobile penetration influences the sign and the amplitude of the shock in the next period. Random effects modeling in such a setup is not preferable (Hsiao, 2014) due to emerging correlation with the AR(1) term. Hausman test used previously to determine the optimal specification without the AR(1) term here leads to the same conclusion: random effects modeling preference is rejected at 1% significance level<sup>3</sup>.

The results of the dynamic model estimation can be found in the table 2.6: all the four included variables are significant including the AR(1) term. An addition of the AR term is beneficial for the regression — the standard error of the regression reduces by approximately 45%<sup>4</sup>. The elasticities in this specification of the model are close to the one estimated before: the price elasticity is around -0.63, income elasticity in times of crises is close to 1,42 and in normal periods it's nearly 0,39. We see that the price elasticity is almost equal to the one found before. The income elasticities differ a bit: the elasticity corresponding to the "heavy" times is almost the same, while the "normal" one is almost twice as small as previously. The

<sup>3</sup>Setting random effects as optimal specification leads to the test statistics being equal to 29.3, which is distributed by Chi-Square with 3 DoF

<sup>4</sup>In the specification without the AR term the s.e. of regression was nearly 0.234, while with the AR term it is less than 0.126

Table 2.6 — Estimation of a dynamic demand model

Dependent Variable: DLSUBS

Method: Panel Generalized Method of Moments

Sample (adjusted): 2007 2015

Periods included: 9

Cross-sections included: 29

Total panel (balanced) observations: 261

Period SUR (PCSE) standard errors &amp; covariance (d.f. corrected)

Instrument specification: C DLGDPPP DLPRICEIV IS07\_08\*DLGDPPP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLPRICE	-0.422499	0.080957	-5.216037	0.0000
DLGDPPP	0.260166	0.081199	3.204046	0.0015
IS07_08*DLGDPPP	0.692103	0.248701	2.782877	0.0058
AR(1)	0.329073	0.062637	5.253617	0.0000

possible reasons for such a change include possible cannibalization of the sensitivity by the AR term — some of the effect previously allocated for the changes in income levels is now captured and better explained by the previous mobile penetration shocks.

We continue by building an alternative model with another dependent variable measuring the quantity demanded — total outbound voice traffic. It is preferable in some times as it also captures the effect on the intensity of mobile usage. Mobile penetration only covers the number of SIMs in use, while the total traffic also covers the minutes of usage. Proceeding with the same specification we used before, we estimate the regression with income and prices using the instrument for the price variable. The results can be seen from the table 2.7.

The key insight from this alternative approach to estimation is that price elasticity is larger in absolute terms —  $-1.09$  instead of nearly  $-0.6$ . This is caused by exactly the effect mentioned above: changes in traffic also capture the changes of intensity of usage, which inflates the elasticity. Income elasticity, on the contrary, is smaller in absolute terms, which may be caused by capturing the cannibalization effect previously omitted. When penetration is used to measure quantity, moving from using several devices (for ex., for business and for private) is considered to be a significant contraction of quantity, while in terms of traffic a serious substitution is taking place. What is more, due to limited traffic data availability the sample in the last regression does not cover the crisis years (for this reason the dummy variable for them was not included), for which the elasticity was shown to be greater. In terms of precision, this model is slightly less precise, which may be caused by a smaller sample, but more accurate in terms of interpretation and economic meaning of the variables.

Table 2.7 — Estimation of demand model with traffic as the dep. variable

Dependent Variable: DLVOICE

Method: Panel Generalized Method of Moments

Sample (adjusted): 2009 2015

Periods included: 7

Cross-sections included: 19

Total panel (balanced) observations: 133

Period SUR (PCSE) standard errors & covariance (d.f. corrected)

Instrument specification: C DLGDPPP YEAR IS07\_08\*DLGDPPP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLPRICE	-1.085478	0.157895	-6.874676	0.0000
DLGDPPP	0.286035	0.107377	2.663846	0.0087

Penetration is better when some development issues are of interest (affordability of mobile services, development of the infrastructure, coverage). The AR(1) or AR(2) terms are not significant if included into the equation.

Overall, we have estimated the demand equation having shown clear significance of the two main demand factors: income and prices. Apart from that, significance of a structural dummy and an AR term was also shown when penetration is used as a dependent variable. The price elasticity of penetration estimated varies around  $-0,6$  units. The income elasticity in heavy periods is shown to be more than unity and vary around 1.40, while the elasticity in normal economic times is below unity and varies around  $0.40 - 0.70$ . These facts mean that mobile penetration in terms of subscriptions is significantly affected by mobile prices and income levels in the country. In times of economic calm mobile services are considered as a necessity, while in times of economic downturns they are perceived more as a luxury good. When voice traffic is used as a dependent variable, price elasticity becomes significantly higher and reaches  $-1.09$  units, which is caused by more accurate capturing of quantity changes.

After the demand model is estimated and some knowledge about the shape of the demand is formed, further analysis is to undercover some equilibrium "fair" price level that is predicted by objective structural characteristics of an economy.

## 2.5 Price model estimation

In order to make any comparison of Uzbekistan price with some hypothetical equilibrium one, we need to estimate the price model. We continue using the same set of data for this purposes but not the average revenue per minute (ARPM) is the dependent variable instead

of the mobile penetration. We also continue using a fixed-effects specification of the model and now estimate it using the Least-Squares method due to no need in instrumental variables estimation. So, we fit the following model:

$$DLPrice_{it} = C + \beta_1 \times DLGDPPP + \beta_2 \times DLPriceIV + \epsilon_{it}$$

We include the average price in other countries, which we previously used as an instrument, due to it being a good proxy for average variable cost, which may be of great importance in the pricing process in case of cost-based pricing approach being used.

Table 2.8 — Estimation of price model with fixed effects

Dependent Variable: DLPRICE

Method: Panel Least Squares

Sample (adjusted): 2006 2015

Periods included: 10

Cross-sections included: 29

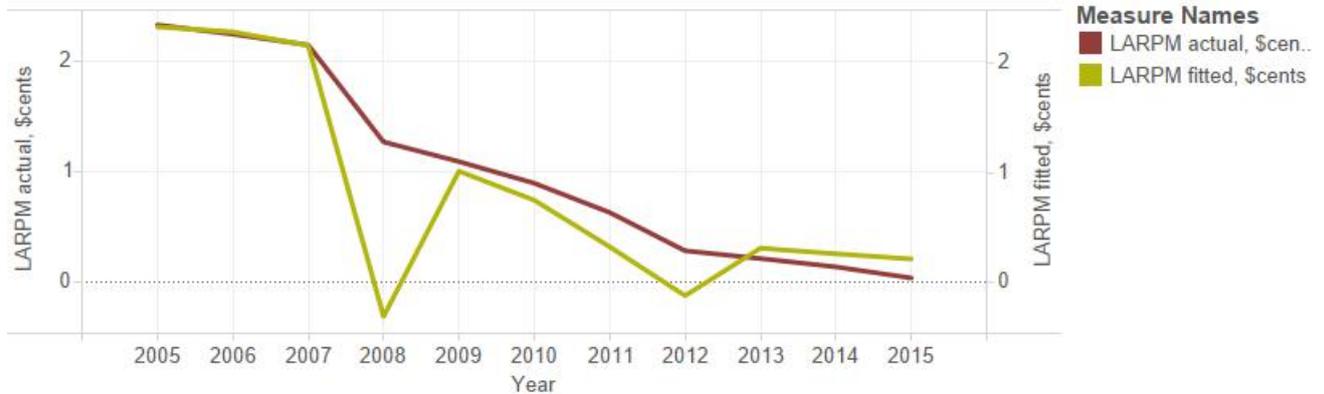
Total panel (balanced) observations: 290

Period SUR (PCSE) standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.102758	0.029372	-3.498476	0.0006
DLGDPPP	0.391352	0.110995	3.525849	0.0005
DLPRICEIV	0.428062	0.182103	2.350659	0.0195
Effects Specification				
Cross-section fixed (dummy variables)				
R-squared	0.271967			
Adjusted R-squared	0.187639			
S.E. of regression	0.161633			

The table 2.8 shows main results of the estimation. The two included parameters — income and prices in other countries — and a constant are all significant at 2% significant level. The constant illustrates a time trend, which corresponds to approximately a 10% yearly decline in mobile prices. This is consistent with the industry stylized fact of constantly decreasing mobile prices mentioned before. The estimations shows positive effect of an increase in income per capita on mobile prices with the elasticity of 0.39, while an increase in other countries' prices, which is a proxy for an increase in average variable costs, results in an increase in local mobile prices with the elasticity of 0.43. So the impact of cost base is the strongest one in terms of elasticity, while it is still lower than unity. This means that average variable cost is taken into account in the pricing process, while non-zero elasticity

of demand leads to non-perfect placement of the cost increase burden on the consumers. In other words, consumers and producers split the effect of an increase in average variable cost and producers carry the larger share.



Picture 2.5 — Actual vs. fitted LnARPM

Comparing the actual values of mobile prices for Uzbekistan with the predicted ones — picture 2.5 — we may see that the model quite well predicts the values of ARPM except for the crises period of 2008, when it overestimates the contraction of prices. One may see that Uzbekistan prices used to be above the predicted fair values or at least as great as the predicted once, while for the past three years the prices are below the predicted values. This may be interpreted as current prices for calls in Uzbekistan, which include both local and international ones, are below the prices which would have obtained in an average economy with the same level of economic development as Uzbekistan has.

In order to verify the qualitative conclusion we test the robustness of our estimates by making the changes to the model. In the original specification we ended up with prices in the past three years being on average nearly 13% lower than the predicted ones. Using GDP per capita at market prices instead of the PPP one, we obtain a very close result of the gap of 10% of the actual prices. Usage of lagged average prices variable instead of simple average prices, which is to capture a lagged effect of cost changes, results in the gap of around 19%. We conclude that although the quantitative result varies with the choice of specification, qualitatively the conclusion of Uzbekistan prices being lower than expected ones is quite robust.

## 2.6 Social welfare estimation

We estimate the impact on the social surplus accounting for the two parts of it: consumer and producer surpluses. We ignore the government in this analysis by setting no taxes. This does not influence the qualitative results in terms of the welfare and efficiency but simplifies the calculations and formulas.

### 2.6.1 Consumer surplus

In order to assess the impact of the price gap on consumer surplus, we model the impact as follows:

$$\Delta CS = (p_p q_p - p_a q_a) / (1 - \epsilon)$$

where  $p_a$  and  $q_a$  are the actual prices and quantities, while  $p_p$  and  $q_p$  are the predicted ones, and  $\epsilon$  is the estimated price elasticity of demand (J. Hausman, 2003).

From the definition of price elasticity we know that for small changes in prices (the gap we analyze is indeed acceptable) the following relationships for the predicted quantity holds:

$$q_p = q_a \times \left( \frac{p_p}{p_a} \right)^\epsilon$$

Combining two equations we may arrive to an expression of the gap in the consumer surplus as a share in total actual spends on the mobile services:

$$\frac{\Delta CS}{p_a q_a} = \frac{1}{1 - \epsilon} \times \left[ \left( \frac{p_p}{p_a} \right)^{1-\epsilon} - 1 \right]$$

We substitute the estimated predicted price as a multiple of the actual one using a gap of 13% found:  $p_p/p_a = 1/(1 - 0.13)$  — and the elasticity of demand equal to  $-0.63$  for the case of penetration used as a quantity measure and equal to  $-1.09$  in case of traffic used as a measure of quantity. We end up with the gap in consumer surplus of around 14% of total mobile expenditures in both approaches no matter which variable we choose to estimate the demand equation. In other words, with current prices Uzbekistan population enjoys 14% higher consumer surplus comparing with the predicted situation. We also conclude the result to be very sensitive to the price gap and almost not sensitive at all to the elasticity value.

### 2.6.2 Producer surplus

In modeling the producer surplus we make an assumption of perfectly elastic supply — horizontal supply curve. Such an assumption is very reliable due to the nature of the good examined. There is no reason for the marginal cost to increase with an increase in voice traffic as only the utilization of an existing infrastructure changes. On some reasonable interval of quantities (until the infrastructure can no longer handle the traffic) the marginal cost is constant.

We start from setting the change in producer surplus equation:

$$\Delta PS = p_p q_p - p_a q_a + AC \times (q_a - q_p)$$

Moving to a share of the change in the producer surplus in total current expenditures:

$$\frac{\Delta PS}{p_a q_a} = \frac{p_p q_p}{p_a q_a} + \frac{AVC}{p_a} \times \frac{q_a - q_p}{q_a} - 1$$

where  $AVC$  is the average variable cost or, alternatively,  $\frac{AVC}{p_a}$  is  $1 - SM$ , where  $SM$  is the current service margin for the industry %. Substituting the equation for  $q_p$  we get:

$$\frac{\Delta PS}{p_a q_a} = \left(\frac{p_p}{p_a}\right)^{1-\epsilon} + (1 - SM) \times \left[1 - \left(\frac{p_a}{p_p}\right)^{-\epsilon}\right] - 1$$

As a proxy for industry average service margin we use a value of 59%, which is an average of the key players present in Uzbekistan<sup>5</sup>. Substitution of the estimated values brings us to a gap of PS of  $-10.0\%$  for the case of penetration estimation and the value of  $-6.6\%$  in the case of traffic estimation. For both cases the net gap in social welfare is positive (SW is higher in reality than the predicted one). The net gap is nearly  $4.3\%$  for penetration estimation and  $7.2\%$  in case of the traffic equation. So the society is currently better off. Evaluating the total market expenditures to be approximately equal to \$2.5 Bn<sup>6</sup>, we conclude that Uzbekistan society currently enjoys 107.5 to 180.0 mln USD of additional social surplus annually comparing to the predicted values.

## 2.7 Results

### 2.7.1 Key insights

From the empirical analysis we conclude several important things.

First, we concluded that demand for mobile services is of usual shape in this market. Mobile services are perceived as a necessity in usual times and have an income elasticity of 0.26 to 0.69. In times of economic downturns it is perceived as a luxury good with an elasticity of 1.5 to 1.7. Its price elasticity depends on whether the quantity variable is penetration or traffic usage. In the first case the elasticity varies around  $-0.62$ . In the second case the elasticity is higher in absolute value and reaches  $-1.09$ .

Second, we estimated the price model based on the income and cost parameters. From that we concluded that mobile prices in Uzbekistan are lower than the predicted values by 10% to 19% depending on the specification chosen. This result is robust to changes in the specification of the model.

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<sup>5</sup>Uzbektelecom reports the value of 50%, Mobile TeleSystems report the value of 56%, VimpelCom reports the value of 72%

<sup>6</sup>Uzmobile has mobile revenue of \$0.3 Bn and reports to have a market share of 12%

Third, we showed Uzbekistan society benefiting from the price gap in terms of the social surplus — the positive gap is from 4.3% to 7.2% of the current expenditures on mobile services, which correspond to 107 to 180 mln USD annually. Its consumer surplus is higher than the predicted value by nearly 14% of current expenditures, while the producer surplus is lower by 10.0% to 6.6% of current spends depending on the dependent variable choice.

### 2.7.2 Policy implications

From actual prices being lower than the predicted values we conclude that "Uzbektelecom" is socially concerned in terms of its objective functions. Under the assumption of small cost of public funds, we claim that privatization of "Uzbektelecom" will decrease social surplus as it will lead to it exploiting its monopoly power to generate higher profits as the profits will have a greater weight in its objective function comparing to the current situation.

This conclusion relies heavily on absence of other effects — while social interests usually lead to lower prices, lower prices do not necessarily mean social interests of the VIP. However, believing in the correct form of our model specification, we have captured most of the structural characteristics of the economy and the outstanding difference can be explained by social concerns only, although the quantitative effect explained by this factor may be overestimated.

### 2.7.3 Limitations and further steps

The approach described has several limitations, which were accepted in order to maintain the simplicity and parsimony of the analysis.

First, we ignore the potential effects of two goods being present on the market and merge them into one bundle-good. Modeling the two goods case with related demands is a possible development of the analysis. Apart from that, different groups of consumers with different shares of local and international traffics used may also be introduced. This may allow for introduction of price discrimination into the model.

Second, when estimating the potential effect of partial privatization, we limit the scope of potential objective functions down to a binary decision — whether "Uzbektelecom" cares about social surplus or not. An extension of the analysis can be made if a wider range of objective functions and properties of ownership are selected.

Third, we assume that partial privatization of a socially concerned VIP will lead to a loss of welfare, though it is not always the case (it depends on the cost of public funds, potential changes in X-efficiency and several other parameters). Though quite difficult, these parameters may be estimated in order to give a more precise estimation of the effect.

Fourth, we do not include presence of vertically integrated firms and presence of public or mixed owned companies on the market as explanatory variables into the regression analysis due to not having proper data. Inclusion of these variable may significantly increase the precision and capture the effect of these market structure parameters. In this paper we conclude that mixed ownership explains the gap between the actual values and the predicted ones, while in reality it may be explained by multiple factors.

## CHAPTER 3

### Conclusion

In this paper we have investigated the Uzbekistan market of mobile telecommunications in terms of its market structure, price and welfare parameters. Having applied panel data econometric techniques, we have estimated demand and price equations based on a sample of 29 peer countries. From that we also derived the equations for consumer and producer surpluses.

The estimated price equation showed that Uzbekistan prices are currently lower than the predicted "fair" ones, which we classified as evidence for socially interested nature of the publicly owned VIP. Uzbekistan was shown to enjoy additional social surplus of \$107-180 mln annually due to this price gap.

All of the above allowed us to formulate the recommendation that partial privatization of "Uzbektelecom" will probably lower the social surplus. The potential loss may reach \$180 mln annually, as an upper bound estimation, in case no positive effects from privatization arise and public ownership fully explains the existing price gap, which is, probably, unrealistic.

## Bibliography

- [1] Badi Baltagi. *Econometric analysis of panel data*. John Wiley & Sons, 2008.
- [2] William J Baumol and J Gregory Sidak. “The pricing of inputs sold to competitors”. In: *Yale Journal on Regulation* 11.1 (1994), pp. 171–202.
- [3] T Randolph Beard, David L Kaserman, and John W Mayo. “Regulation, vertical integration and sabotage”. In: *The Journal of Industrial Economics* 49.3 (2001), pp. 319–333.
- [4] Robert H Bork. *The Antitrust Paradox*. 1978.
- [5] Tim Callen. “PPP versus the market: which weight matters?” In: *Finance and Development* 44.1 (2007).
- [6] CMRU. “Resolution of the Cabinet of Ministers of the Republic of Uzbekistan 453”. In: (2004).
- [7] Vincent P Crawford and Hal R Varian. “Distortion of preferences and the Nash theory of bargaining”. In: *Economics Letters* 3.3 (1979), pp. 203–206.
- [8] Giovanni De Fraja and Flavio Delbono. “Alternative strategies of a public enterprise in oligopoly”. In: *Oxford Economic Papers* 41.2 (1989), pp. 302–311.
- [9] Nicholas Economides. “The incentive for non-price discrimination by an input monopolist”. In: *International Journal of Industrial Organization* 16.3 (1998), pp. 271–284.
- [10] Kenneth Fjell, Debashis Pal, and David EM Sappington. “Employing endogenous access pricing to enhance incentives for efficient upstream operation”. In: (2013).
- [11] Christopher Garbacz and Herbert G Thompson. “Demand for telecommunication services in developing countries”. In: *Telecommunications policy* 31.5 (2007), pp. 276–289.
- [12] Jerry Hausman. “Sources of bias and solutions to bias in the consumer price index”. In: *the Journal of Economic perspectives* 17.1 (2003), pp. 23–44.
- [13] Jerry A Hausman. “Specification tests in econometrics”. In: *Econometrica: Journal of the Econometric Society* (1978), pp. 1251–1271.
- [14] Jerry A Hausman, Ariel Pakes, and Gregory L Rosston. “Valuing the effect of regulation on new services in telecommunications”. In: *Brookings papers on economic activity. Microeconomics* 1997 (1997), pp. 1–54.
- [15] Jerry A Hausman and Agustin J Ros. “An econometric assessment of telecommunications prices and consumer surplus in Mexico using panel data”. In: *Journal of Regulatory Economics* 43.3 (2013), pp. 284–304.

- [16] Jerry A Hausman and William E Taylor. “Panel data and unobservable individual effects”. In: *Econometrica: Journal of the Econometric Society* (1981), pp. 1377–1398.
- [17] George A Hay. “An economic analysis of vertical integration”. In: *Industrial Organization Review* 1.3 (1973), pp. 188–198.
- [18] Cheng Hsiao. *Analysis of panel data*. 54. Cambridge university press, 2014.
- [19] Alfred E Kahn, Timothy J Tardiff, and Dennis L Weisman. “The Telecommunications Act at three years: an economic evaluation of its implementation by the Federal Communications Commission”. In: *Information Economics and Policy* 11.4 (1999), pp. 319–365.
- [20] Yoshio Kamijo and Yoshihiro Tomaru. “The endogenous objective function of a partially privatized firm: A Nash bargaining approach”. In: *Economic Modelling* 39 (2014), pp. 101–109.
- [21] R Kathuria, M Uppal, and Mamta. “An econometric analysis of the impact of mobile”. In: *Vodafone policy paper series* 9 (2009), pp. 5–20.
- [22] Jean-Jacques Laffont and Jean Tirole. “Access pricing and competition”. In: *European Economic Review* 38.9 (1994), pp. 1673–1710.
- [23] Duk Hee Lee and Dong Hee Lee. “Estimating consumer surplus in the mobile telecommunications market: The case of Korea”. In: *Telecommunications Policy* 30.10 (2006), pp. 605–621.
- [24] Gary Madden, Grant Coble-Neal, and Brian Dalzell. “A dynamic model of mobile telephony subscription incorporating a network effect”. In: *Telecommunications Policy* 28.2 (2004), pp. 133–144.
- [25] Parthasaradhi Mallela and Babu Nahata. “Theory of vertical control with variable proportions”. In: *The Journal of Political Economy* (1980), pp. 1009–1025.
- [26] Toshihiro Matsumura. “Partial privatization in mixed duopoly”. In: *Journal of Public Economics* 70.3 (1998), pp. 473–483.
- [27] Lionel W McKenzie. “Ideal output and the interdependence of firms”. In: *The Economic Journal* 61.244 (1951), pp. 785–803.
- [28] McKinsey. “Virtually mobile: What drives MVNO success”. In: *Telecom, Media & High Tech Extranet* (2014).
- [29] Martin K Perry et al. “Vertical integration: determinants and effects”. In: *Handbook of industrial organization* 1.4 (1989), pp. 183–255.
- [30] Richard A Posner. *Antitrust law*. University of Chicago Press, 2009.

- [31] Patrick Rey and Jean Tirole. “A primer on foreclosure”. In: *Handbook of industrial organization* 3 (2007), pp. 2145–2220.
- [32] Thomas C Schelling. *The strategy of conflict*. Harvard university press, 1980.
- [33] Richard Schmalensee. “A note on the theory of vertical integration”. In: *Journal of Political Economy* 81.2 (1973), pp. 442–449.
- [34] Scott J Wallsten. “An econometric analysis of telecom competition, privatization, and regulation in Africa and Latin America”. In: *The Journal of industrial economics* 49.1 (2001), pp. 1–19.
- [35] Hung-Jen Wang and Chia-Wen Ho. “Estimating fixed-effect panel stochastic frontier models by model transformation”. In: *Journal of Econometrics* 157.2 (2010), pp. 286–296.
- [36] Frederick R Warren-Boulton. “Vertical control with variable proportions”. In: *Journal of Political Economy* 82.4 (1974), pp. 783–802.
- [37] David Waterman and Andrew A Weiss. “The effects of vertical integration between cable television systems and pay cable networks”. In: *Journal of Econometrics* 72.1 (1996), pp. 357–395.
- [38] Michael Waterson. “Vertical integration, variable proportions and oligopoly”. In: *The Economic Journal* 92.365 (1982), pp. 129–144.
- [39] Jean-François Wen and Lasheng Yuan. “Optimal privatization of vertical public utilities”. In: *Canadian Journal of Economics/Revue canadienne d'économique* 43.3 (2010), pp. 816–831.
- [40] Fred M Westfield. “Vertical integration: does product price rise or fall?” In: *The American Economic Review* 71.3 (1981), pp. 334–346.
- [41] Oliver E Williamson. “The vertical integration of production: market failure considerations”. In: *The American Economic Review* 61.2 (1971), pp. 112–123.